

Productivity, exporting and innovation in Australian SMEs: Evidence from a longitudinal dataset

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Introduction:

This report, commissioned by ACOLA, presents the analysis of a longitudinal Australian dataset examining the cause and effect relationships between productivity, innovation, exporting and performance in a representative sample of Australian firms. Like the Australian economy, the dominant type of firm in the sample is an SME employing between 5 and 200 people.

A feature of the analysis is the panel of firms surveyed in 2010 and then resurveyed in 2012. Such panel data are rare in Australia and are the only way to determine causality in business outcomes.

The analysis shows that there is a relationship between innovation and productivity where innovation and R&D investment initially causes a decline in productivity but then results in productivity improvements.

The results also show that there is a cyclical relationship between innovation and collaboration where collaboration improves the innovativeness of firms and innovation also supports further collaboration.

Similarly, there is a cyclical relationship between exporting and innovation where exporting drives innovation and innovation drives exporting.

Method:

The study adopts the Community Innovation Survey (CIS) methodology as adapted by the Centre for Business Research (CBR) at Cambridge University (Cosh et al. 2012; Freel, 2005; OECD, 2006) in a sample of Australian firms. It draws on two sets of data, collected during 2010/1 and 2012. During 2010/1 questionnaires were mailed to 28,300 Australian firms, followed by two reminders. Impact List provided the sample frame, drawn from a database with information on more than 400,000 public and private firms. A random stratified sample (by size, industry and state) was drawn. Responses mirrored these strata well, reflecting a true cross section of Australian firms.

The response rate was 7.5 per cent with a total of 2,107 responses. In 2012 a detailed survey was distributed to 14,102 firms by survey and with the option of completing it online. A total of 1,710 firms completed the survey, for an overall response rate of 12 per cent for Australian firms. 413 firms responded to both surveys (hereafter panel data). This type of response rate is

becoming common in, for example Scotland (Freel, 2005 – 10% to 11.5%) and South Africa (Oerlemans et al., 2003 - 8.4%) and exceeds many other comparable studies undertaken lately in Australia.

The survey instrument included items and scales to measure organisational demographics, competitive and technological environments, capabilities, resources, innovation practices, growth aspirations and performance. Statistical tests for reliability and validity were conducted. Data were further analysed using chi-square tests of differences, Spearman's correlations, multiple and logistic regression. To create the variables needed for data analysis (e.g. labour productivity) the analysis used approaches developed by others (e.g. Cosh et al., 2012; Freel; 2007).

Descriptive Statistics:

This section gives a brief introduction to the sample in terms of age, size and industry. Numbers on the y-axis in figure 1 are the number of firms.

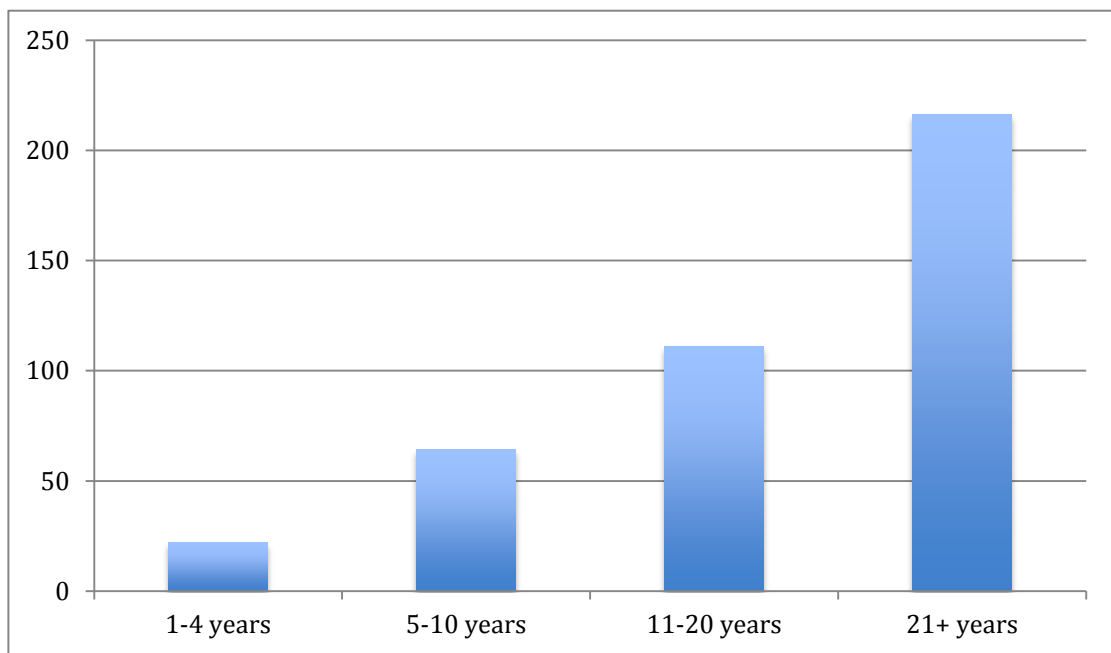


Figure 1. Distribution of firm age

Most firms in the sample are more than 11 years old. This challenges the commonly held view that SMEs have a very high failure rate. While there may be a high rate of turnover in the population of firms in the 1-4 year category, once these firms do get past these early stages they tend to persist over time.

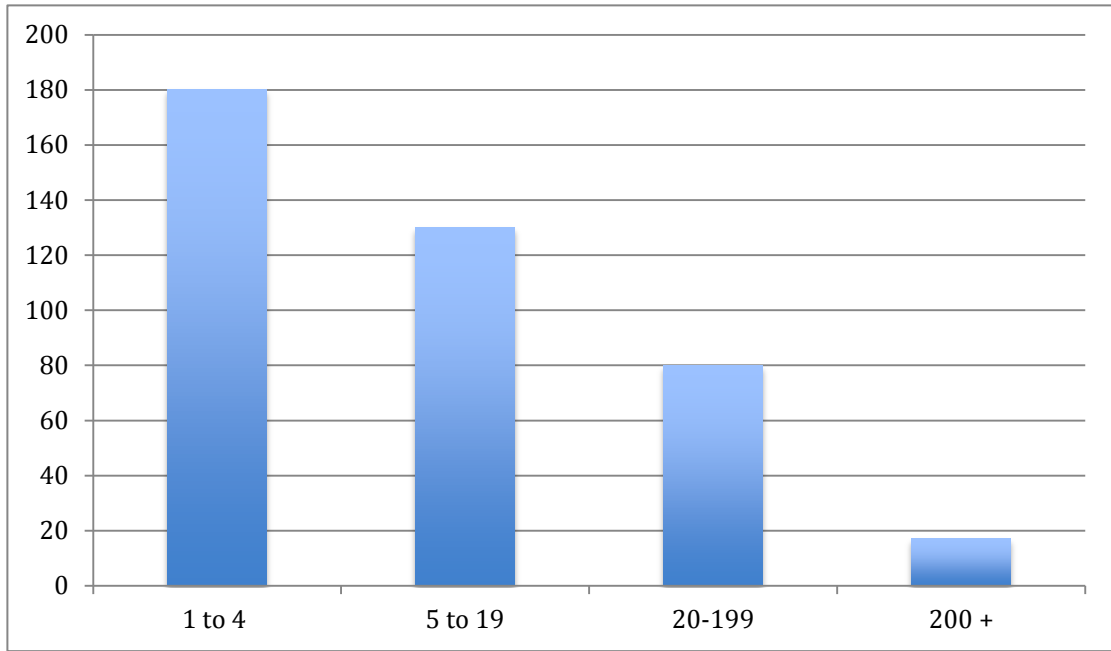


Figure 2. Distribution of firm size by number of employees

Consistent with ABS data, the sample of firms surveyed shows the dominance of the SME category (5-200 firms) (Figure 2). Micro firms of less than 5 people are also very common but overlooked in economic policy.

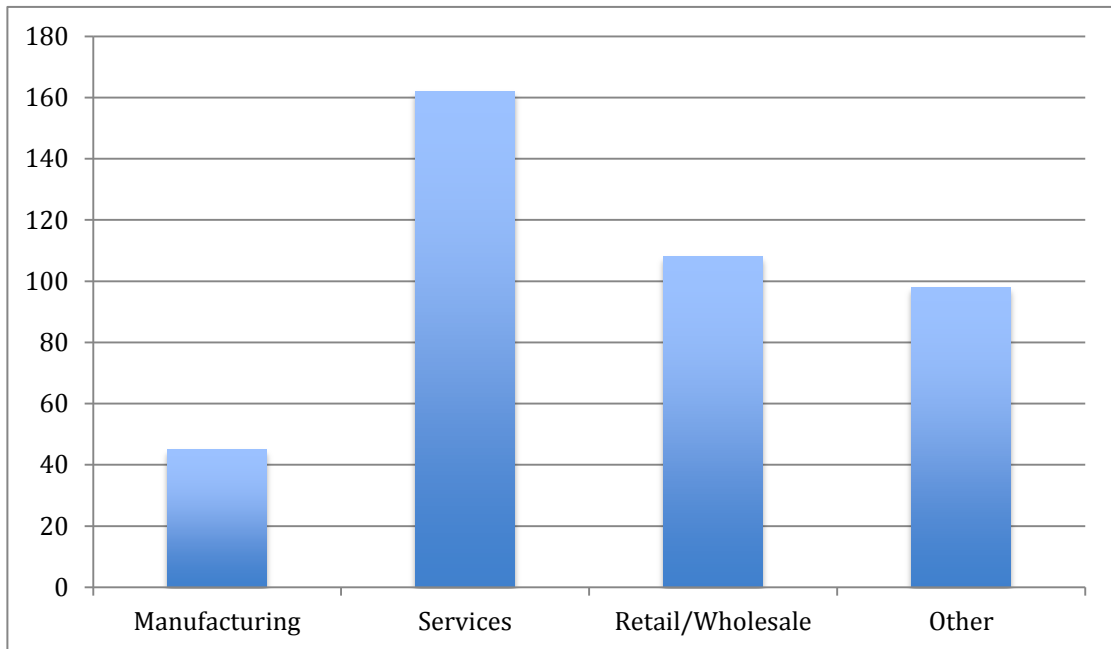


Figure 3. Firm type by industry category

The survey actually breaks these categories into 18 different industry codes but the chart above aggregates into four categories (Figure 3). Australia has become a service-based economy and this is also demonstrated by the sample. Consistent with media commentary, manufacturing represents a smaller number of firms.

Key Findings from Data Analysis:

What drives innovation in Australian firms?

For the first run of correlation analysis firms that reported innovations in 2012 were categorized into those that had innovated in the previous three years and those that hadn't (a binary variable).

Firm size is positively correlated with innovation. Larger firms are more likely to report innovations.

Other than firm size the best predictor of innovation is investment in developing the skills of employees. Managerial training is most highly correlated with innovation followed by training of professionals (e.g. engineers, scientists, accountants) and then training of other workers.

This finding also supports the importance of managerial skills in supporting innovation. The data also showed that formalized planning processes also predict innovation. Firms that had formal business plans, financial plans, HR plans and a board of directors were 13 % more likely to report innovations in the following time period. In short, well-managed firms are also more innovative.

Firms with growth aspirations were also more likely to report innovations in the subsequent time period.

Firms that reported R&D were also 7% more likely to report innovations in the subsequent time period. This figure reflects the uncertain outcomes of R&D but also the fact that many innovations are the result of normal business activities and do not stem from R&D investments.

A regression model was developed to examine the interaction of R&D and training. This model tested for more radical innovations that resulted in improved products, processes and services across the firm (innovation breadth).

In this model, training (managerial, professional and other) doubled the effectiveness of R&D with the reported likelihood of subsequent innovation increasing from 7 to 14%. It could be argued that firms with smarter employees are more able to reap the benefits of R&D investments by putting the resulting innovation into action within the firm.

Does innovation drive competitive performance and productivity?

These analyses looked for relationships between innovation in time one (reported innovation in the three years prior to 2011) and performance and productivity in time 2 (2012).

Productivity was measured as labour productivity as the ratio of business earnings per employee. Performance was captured as a composite measure of perceived competitive advantages including superior products, customer relationships and operating costs.

The correlation analysis does not show a straightforward relationship between innovation and productivity. This is probably because innovation can have an initially disruptive effect on 'business as usual' and also requires financial investments that can represent an initial drag on earnings. Clearly there will be a lagged relationship between innovation and productivity. For SMEs, R&D investments can be expensive and the data do show a negative correlation between R&D and productivity in the next time period.

The other difficulty is that labour productivity declines as firms grow. There is a relationship between firm size and decline in labor productivity in the data. For larger firms and more capital intensive firms, productivity of capital and total factor productivity is more important than labor productivity as a measure of true productivity performance (McKinsey, 2012)

To determine the effect of innovation on labour productivity the sample was separated into firms that had innovated in time period one, time period two, both time periods and none.

Firms that reported no innovations were 3.8 times more likely to report productivity improvements. Firms that reported innovations in the three years prior to 2011 but not in 2012 were 2 times more likely to report productivity improvement while firms that innovated in both time periods were only 1.2 times more likely to report productivity increases.

These results suggest that the labour productivity payoffs for innovation take at least three years to appear and are more likely to be strongly manifested after 4 years, particularly compared to non-innovators. This is consistent with other reports of the lagged relationship between innovation and productivity which can be in the realm of 5-15 years in the case of ICT innovations (The Economist, 2013).

However, if the relationship between innovation and labour productivity was controlled for firm size (to eliminate the size effect) the decline in labour productivity for innovators was not statistically significant. Innovative firms are growing firms and the decline in labour productivity can be attributed to increase in size.

On the other hand, self-reported competitive advantage (perceived performance) is predicted by innovation in the previous time period as well as innovation penetration across products, services and processes. Innovation makes firms more competitive in the subsequent time period (2-5 year lag) and this probably translates into productivity in later time periods if we look at the trend relationship between innovation and productivity in the preceding section.

Innovation breadth (innovating across the business in products, processes and services) is also highly correlated with performance in the subsequent time period.

The data also suggest a virtuous circle with productivity driving performance, which further drives productivity.

Taken together these results suggest caution with the current economic focus on short-term productivity improvements – especially labour productivity. At the level of firms rather than the economy in aggregate, innovation and competitive advantage are probably much more meaningful policy targets.

Does innovation drive internationalization?

Exporting and international income is essential for economic growth and the data also show a virtuous circle at work with the relationship between exporting and innovation. Competing in international markets drives innovation and innovation can also make firms more competitive internationally.

Firms that innovated in the three years prior to 2011 were three times more likely to have international sales compared to non-innovators. International sales in 2011 were also correlated with reported innovations in the 2012 survey.

Innovation, internationalization and digital business.

The longitudinal dataset gives an indication of the importance of digital business for innovation and growth. Firms that used the internet as a source of ideas for innovation were more likely to report increases in performance and international sales in the following time period.

In the ABS series on innovation, the internet is not recorded as a source of innovation in the survey due to the survey being based on an older European format.

A separate dataset of 500 firms taken in 2012 from a UQ study shows a significant correlation between digital business activities and international sales.

In more detail, firms that used the internet to improve customer experience, integrated their customer facing operations with digital internal processes and had digital integration with their supply chain were more likely to have international sales.

How does collaboration affect innovation and exporting?

This report shows an interesting relationship between innovation and collaboration. The usual assumption is that collaboration (formalized relationships and alliances) precedes innovation but the results here show

that innovation leads to collaboration. A regression model controlling for other variables showed that collaboration in 2011 also correlated with innovation in the following time period as per the commonly assumed relationship between collaboration and innovation

Exporting also leads to collaboration in the following time period and collaboration also predicts exporting in another virtuous circle relationship.

This finding makes sense if we think of how the value of innovation needs to be unlocked through new markets and supply chains. In some industries, this post innovation collaboration is critical to the survival of firms and this will be further elaborated with the case studies of SMEs collaborating with supply chains dominated by large multinational firms

Overarching themes from the analysis

This section draws together the main findings of the analysis that should be the focus of further discussion.

Productivity is a long-term agenda

Innovation clearly helps business performance but in the timeframe of this study reporting innovation from 2008 and then relating that to effects on the business in 2012 there is not a clear relationship between innovation and productivity. While the national debate on productivity is useful, targeting firm performance and innovation is an important leading target from addressing the productivity challenge.

Business Model Innovation

There are several datapoints suggesting that successful innovation is a 'whole of business' activity.

Innovation breadth across products, processes and services indicates changes to the entire business model and these are leading indicators of subsequent performance.

Investing in skills across the organization also improves the success of innovation and also improves productivity. Business model innovation is an important topic for the future of Australian business.

Virtuous Circles of Productivity, Growth, Performance and Innovation

The report has highlighted relationships between several variables suggesting that firms get on to virtuous circles of performance. For example performance leads to productivity and productivity leads to performance. Also, innovation leads to exporting and exporting leads to innovation.

Exactly how firms get on to these virtuous circles and then how do they stay there is a topic worthy of further investigation with datasets over longer time periods.

Case Studies of innovation in global supply chains:

To show the important role of collaboration in global supply chains to realize the benefits of some innovations the case studies will focus on two Australian firms. One of these, in the defense industry is yet to achieve commercial sustainability but the other is currently experiencing rapid growth in sales due to an equity partnership with GE.

An important feature of the cases is the potential role for government in facilitating the entry into these global supply chains. In the case of the EOS satellite tracking technology recent success has come through the collaboration with Northrop Grumman. This is a scale industry dominated by large budgets and big companies. Unless a small firm is allied with a defense prime contractor then accessing major markets is almost impossible. The Australian government has pursued two notable initiatives in assisting firms to access these markets.

Similarly, the case study of Nanosonics also shows the importance of global partners in accessing major governmental health budgets and dealing with regulations, testing and professional associations.

Nanosonics

Nanosonics was founded in 2001 in Sydney and has patented technology for a novel system to sterilize medical equipment. The traditional approach to disinfecting equipment such as probes and ultrasound has been through the use of carcinogenic chemicals such as formaldehyde. This process and the need to completely remove the chemicals before the next use takes time and involves the problem of disposing of hazardous waste.

The Nanosonics system involves a low-temperature cleaning process based on high-frequency vibration and hydrogen peroxide, which breaks down into water and oxygen. Disinfection takes seven minutes and can be done in the consultation room, thus improving the productivity of expensive endoscopes and ultrasound devices.

While the idea is simple, turning the concept into a functional product has taken several years and the company has produced several innovations associated with the product and now has 15 patent families and one design family.

The market opportunity for Nanosonics is significant with 500,000 ultrasound machines and 600 million procedures globally each year. This is growing at 8% per annum with Nanosonics estimating that 30% of these procedures would benefit from rapid and chemical free disinfection.

The challenge for Nanosonics has been the sheer size of the market and the need to capture customers quickly with their 'razorblade' business model. The machines themselves are profitable but the cartridges and disposables are

highly profitable.

The key to realizing the investment on R&D has been to distribute quickly and lock in big customers but for a company with negative cash flow and a \$130 million market capitalization this is hard to achieve.

Infection control is one of GE Healthcare's strategic technology areas and GE also controls around 25% of the international ultrasound market. In 2012 GE Healthcare purchased a \$7.5 million dollar off market equity stake after collaborating with Nanosonics in 2011 to develop the North American market for the Nanosonics product.

Success in the North American market has been rapid for Nanosonics since the GE collaboration and the equity stake has given the company much-needed funds for further development and investment in production facilities. GE's marketing and distribution network has been very important with representation and relationships with hospitals and clinics across the USA and Canada – something that Nanosonics could never achieve alone.

The marketing program in North America has involved bundling strategies, trial programs where one trial device has resulted in the average sale of 2.5 units and targeting high profile clinicians and institutions. High profile adopters of the technology include Johns Hopkins (Baltimore, MD), Mount Sinai (New York, NY) and Calgary Radiology (Canada). Sales revenue for FY 2012 has jumped from \$2.2 million in 2011 to \$12.3 million.

Electro-Optic Systems Holdings Ltd and the Australian Defence Technology Industry

EOS was founded in 1983 and has its origins in Australian astronomy research. Its core technologies in imaging and tracking have found applications in the defense industry with remote sighting and firing of weapons and the tracking of smaller orbiting space objects that can interfere with satellites.

One of the challenges for small firms in developing new technology for the international defense market is that for technologies to be accepted into service most need to be integrated into complex product systems (CoPS) that are sold internationally by prime defense contractors such as Lockheed Martin, Northrop Grumman and Raytheon. Without the sponsorship and development support of these 'defense primes' the chances of small Australian firms in entering these global military markets are very small.

EOS has had a strategic alliance with Northrop Grumman since 1985 that has not had the level of commitment seen in the Nanosonics case with GE. Grumman appears to have taken a wait and see approach to engaging with EOS as a relatively cheap 'real option'. In 2012 Grumman tendered for a major US army contract called CROWS (common remotely operated weapon station). It was announced in late 2012 that this tender was unsuccessful.

Given the gatekeeper role that defence primes play in the military technology industry, the Australian government has pursued initiatives to bring SMEs into contact with these companies. The Defence Materials Technology Centre (DMTC) based in Melbourne has a focus on developing technologies for end-users in the Australian Defence Force. An important objective of the DMTC is to expose SMEs to defense primes and Thales and BAE are core members of the DMTC. If this objective can be achieved and if SMEs can also partner with other larger organizations then this represents an important part of not just the ADF innovation system but also the Australian national innovation system.

The DMTC is modeled on the CRC structure, which has been documented as being an unfavourable structure for SMEs due to research agendas being dominated by the larger firms that sponsor the center (Cutler, 2008). However, if this problem does not occur in the DMTC then it represents an excellent vehicle for development of technology from smaller firms.

The ADF has also developed the Capability Technology Demonstrator (CTD) program, which has been in existence since 1997 and has delivered a significant number of successful demonstrations since inception. Of the 117 projects initiated, 104 have progressed through demonstration phase. Beyond demonstration, 12 technologies have been fully transitioned into service and 12 have potential enter service. CTD success rates rival private sector new product development commercialization rates (Barczak, Griffin, & Kahn, 2009).

The CTD program advertises technological challenges that need to be addressed in Australian military capability and then invites SMEs to apply for funding in the program. Not only do these firms get valuable feedback from users in the ADF and the opportunity to test the technology, at the completion of the demonstration the company may be recommended to other partners, including defense primes. The program assists SMEs to bridge the technological maturity gap where there is sufficient development and derisking to attract the attention of a major defence contractor.

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