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Determinants of innovation novelty: Evidence from Australian administrative data

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Abstract

We examine the determinants of innovation novelty ranging from new-to-firm to new-to-world innovation. Higher levels of novelty help firms capture a larger share of the market, increase exports, and create positive spillovers. Using firm-level panel data for 2005-06 to 2015-16, from administrative and survey sources, this paper provides the first exploration of the determinants of innovation novelty among Australian firms. Firm-specific variables such as R&D, collaboration, foreign ownership, business focus on innovation, skills in IT and business management are associated with higher levels of innovation novelty. There are important differences in the results based on firm size and industry.

JEL Codes: L21, L10, O31
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1 Introduction

Innovation improves firm performance and the prosperity of the overall economy. Firms introduce innovation at various levels of novelty: new-to-firm, new-to-industry, new-to-country or new-to-world. They choose different innovation strategies based on profit expectations, competition, and their ability to capture market share. Firms can choose which type of innovation to undertake, coming up with something genuinely new or modifying and adopting innovations undertaken by other firms. Innovation at lower levels of novelty, by definition, involves taking up higher-level innovations developed by others. Higher level innovations, therefore have the potential to create large spillover effects. They are thus particularly important from a policy perspective.

Results from Australia show that firms undertaking higher levels of innovation novelty generally have higher profits (Department of Industry, Science, Energy and Resources, 2016, page 42). The importance of higher levels of innovation novelty have long been recognised in the economics literature—see Schumpeter (1934) and Schumpeter (1939). Diffusion of innovation is important for economic growth in general and for closing the technology gap between low- and high-growth countries in particular OECD (2018a).

While higher levels of innovation novelty are likely to have large positive externalities, introducing new-to-world or new-to-country innovations are riskier and more expensive. Further, the benefits of these innovations are not entirely captured by the firm producing them (Treacy, 2004; Varadarajan, 2009). Standard economic theory about unpriced externalities suggests that these innovations will often be under-produced by the market. This underproduction of innovation often leads to calls for industrial or innovation policy to encourage more high-level innovation. Such policy responses require an understanding of factors that allow firms to undertake innovation.

Even though the impact of innovation and the resulting spillovers are widely acknowledged in theory and in the empirical literature, there is a lack of consensus on the determinants of innovation, especially in terms of distinguishing higher levels of innovation novelty from incremental innovations Barbosa et al. (2013). This paper contributes to filling this gap. In particular, we provide the first study of this question in Australia and add to the international literature on innovation

novelty determinants. First we try to understand factors that influence a firm's propensity to innovate at various levels of novelty. Second, we highlight any differences in these factors and their propensities by firm size and industry.

We use new innovation data within the Business Longitudinal Analysis Data Environment (BLADE). The datasets used in this analysis mainly come from the Business Characteristic Survey (BCS), an unbalanced panel of Australian firms over the financial years 2005–06 to 2015–16 coupled with administrative data from the Australian Taxation Office.

We find that firm-specific factors such as undertaking R&D, persistence of innovation, collaboration, foreign ownership, a business focus on innovation and core business skills in IT and management are associated with higher levels of innovation novelty. These firm-specific factors are more important for higher levels of innovation novelty than industry characteristics. Secondly, some of the determinants of higher levels of innovation novelty are firm-size and industry specific. For example, undertaking R&D and foreign ownership for large firms results in an increase in the probability of introducing higher levels of innovation. Results also suggest that export exposure is strongly associated with small to medium sized enterprises (SMEs) undertaking higher levels of innovation novelty.

The paper proceeds as follows. Section 2 provides some additional background and discusses the relevant literature on the determinants of innovation. The data sources are covered in Section 3 while Section 4 briefly provides the theoretical backdrop to our study. Section 5 is devoted to the empirical model and the estimation method. The results are presented in Section 6 followed by a brief conclusion.

2 Background and literature review

The productivity and growth slowdown experienced around the developed world has left countries searching for policies to stimulate innovation and productivity (see, for example, Andrews et al. (2016). OECD countries, including Australia are emphasising innovation-related policies to boost

long-term productivity and output (Commonwealth of Australia, 2015; OECD, 2018a; Department for Business, Energy and Industrail Strategy, 2019). In Australia, for example, the Government is the second largest source of funds for research and development (R&D) investment. In 2017–18, the industry sector received around AU$2.83 billion in tax incentives (see the SRI Budget Tables in Department of Industry, Science, Energy and Resources (2019)).

The literature highlights several factors that determine innovation and its levels of novelty. Firm level factors that are found important include foreign ownership, R&D, human capital, exports, attributes of management, firm size and age. In some studies, industry and country level factors were also identified as important for innovation, including market concentration, industry conditions, average age of firms and average turnover in specific industries. Firm-specific factors appear to be more important than industry level factors in determining the innovation status of a firm–Barbosa et al. (2013).

The nature of the innovation process changes within countries depending on their distance to the technology frontier (Knell and Srholec, 2009). Novelty of product innovation in frontier countries is mainly boosted by research and marketing capabilities. This research emphasises the importance of relying on strategies of internal capability building rather than depending on external information. In laggard countries, on the other hand, process upgrading and foreign ownership play a more important role in determining the innovation activity of firms.

The literature suggests that investments in human capital (in the form of worker training) boost innovation output among small Spanish manufacturing firms. González et al. (2016) found that R&D and worker training have complementary effects on the innovation decisions of large firms. The effect of R&D on innovation is reinforced when large firms invest in worker training. Higher ability of qualified workers also increases the number of innovations introduced.

Bhattacharya and Bloch (2004) suggest that R&D intensity, industry concentration and import and export intensity were important factors in determining subsequent innovations. However, the results differed depending on the technological environment. R&D intensity, market concentration, and export intensity significantly increases subsequent innovation for high-tech industries, while

profitability has a positive influence on subsequent innovation only for firms in low-tech industries.

The relationship between foreign ownership and the amount of innovation varies by study. Foreign ownership can augment innovation (Guadalupe et al., 2012; Falk, 2008; Corsi and Prencipe, 2018). Some studies found that process upgrading and foreign ownership were more important among laggard countries than countries at the technology frontier (Knell and Srholec, 2005). Some studies found no significant difference in innovation activity between foreign owned or domestic businesses in the Canadian manufacturing industry (Baldwin and Hanel, 2000; Díaz-Díaz et al., 2010). However, the results are not distinguished by novelty of innovation. To the best of our knowledge, this study is the first to examine the relationship between foreign ownership and novelty of innovation.

Exports have been shown to have a positive relationship with innovation (Peneder and Woerter, 2013). This is expected as higher levels of market penetration are dependent on competitive advantages as a result of product differentiation. Tuhin (2016) investigates the two-way relationship between innovation and the exporting status of Australian SMEs from 2004–05 to 2008–09. He finds that export and innovation behaviour of firms are interrelated. The study finds evidence that exporting leads to selection into innovative activity.

Innovation decisions of firms differ by size. For example, McGuirk et al. (2015) show small firms' innovation decisions to be more responsive to their absorptive capacity than larger firms. Larger firms were more likely to innovate among Swiss manufacturing firms (Peneder and Woerter, 2013; Vinding, 2006). Similarly, Bhattacharya and Bloch (2004) find a positive relationship between innovation activity and size using data on Australian manufacturing SMEs. In contrast, small firms were more likely to innovate in the Malaysian manufacturing industry Lee (2004). Given this, it is important to control for firm size and to allow for the relationship between determinants and innovation to differ for large firms and SMEs.

The relationship between innovation and competition has been the focus of a stream of literature for some time (Schumpeter, 2005; Nascia and Perani, 2002; Woerter, 2014). Using the Lerner Index, Aghion et al. (2005) show an inverted-U shape relationship between product market compe-

tition and innovation. The average technological distance between leaders and followers increases with competition and the inverted-U is steeper when industries are closer to each other in terms of productivity. Empirical evidence in support of this finding includes Peneder and Woerter (2013) study of Swiss firms and their level of research effort.

3 Data

We use data from the Australian Bureau of Statistics' (ABS) Business Longitudinal Analysis Data Environment (BLADE). BLADE is a series of integrated longitudinal datasets covering 2001–02 to 2015–16. It links survey and administrative data from the Australian Taxation Office (ATO) and ABS using the Australian Business Registry (containing Australian Business Numbers) as a backbone. The survey data are from the Business Characteristics Survey (BCS) and the administrative data from the ATO. The latter include Business Activity Statement (BAS), Business Income Tax and Pay-As-You-Go (PAYG) tax data. Demographic information (such as firm age and industry classification) are derived from a combination of data in the ABS Business Register and ATO records.

The BCS, an annual survey, and the administrative data used in this study covers the period from 2005–06 to 2015–16. We exclude micro-businesses from our study by removing all firms with one full time equivalent (FTE) employee or less. Firms with no identification number or industry division attached to them were also removed. The BCS is a census of firms with more than 300 employees and a stratified random sample for firms with less than 300 employees. As such, controlling for size (and estimating separately by small and large firms) in the regressions is important. Table 1 presents summary statistics, pooled across all years, from the integrated dataset used in this study.

[Table 1]

The core data cover all Australian Business Numbers (ABNs) registered for GST purposes at some point in time. The data include information such as itemised income and expenditure as well

as employment, wages, asset holdings and some financial obligations. The data contain an estimate of full-time equivalent employment (FTE) modelled by the Australian Bureau of Statistics from a combination of wages reported in PAYG and BAS and ancillary data sources.

The definition of innovation used in the BCS follows the Oslo manual (OECD, 2018b) and is captured by the introduction of new or significantly improved goods or services; operational processes; organisational/managerial processes; or marketing methods. Innovation is defined as: "An innovation is a new or improved product or process (or combination thereof) that differs significantly from the unit's previous products or processes and that has been made available to potential users (product) or brought into use by the unit (process)." The different types of innovation introduced by businesses are subsequently categorised by their level of novelty. Each type of innovation can be i) new to the business only, ii) new to the industry, iii) new to Australia or iv) new to the world. We use these four tiers of innovation novelty in this paper–Appendix Table A1 provides a summary of the different tiers.

Table 2 presents the innovation landscape in Australia in the financial year 2016-17. Table 2 is based upon the Australian Bureau of Statistics Innovation in Australian Businesses survey (Australian Bureau of Statistics, 2018). In 2016-17, 44.5 per cent of Australian firms reported some type of innovative activity. Size is highly correlated with innovation activity. The majority of SMEs and large firms were innovation active whereas micro firms (i.e. those with 0–4 employees) were less involved in any type of innovation activity.

[Table 2]

Innovation data are gathered every two years, we thus use the data only from those years which contain innovation data. Our panel is thus constructed from annual cross-sections, of the same firms, which are two years apart.[1]

Innovating and non-innovating firms look quite different. Firms that undertake higher levels of innovation novelty have higher turnover and labour productivity. Figures 1 and 2 show turnover and

[1] Our estimates are based upon reported innovation in financial years 2008-2009, 2010-2011, 2012-2013 and 2014-2015. We also use the 2006-2007 panel for lagged information about innovation and other variables.

labour productivity by innovation novelty status from our data. The median value of turnover by firms that introduced new-to-world innovation and new-to-Australia innovation was substantially larger compared to firms undertaking lower levels of innovation novelty (Figure 1). Firms that introduced innovations at higher levels of innovation novelty have labour productivity[2] that is about 1.6 times higher compared to firms that only introduced incremental innovations and about 1.7 times higher than firms that introduced no innovations (Figure 2).

[Figures 1 and 2]

The prevalence of innovation by novelty, type and firm size among the population of Australia firms is presented in Table 3, again based upon Australian Bureau of Statistics (2018). The four separate types of innovation occur at similar rates, between roughly 16 and 18 per cent of firms. However, innovation types differ significantly in their level of novelty. Goods and services innovation are more likely to be new to the world (8.4 per cent) compared with operational processes (3.1 per cent), marketing methods (2.5 per cent) or organisational/managerial processes (1.0 per cent).

[Table 3]

The relationship between innovation novelty and firm size differs according to innovation type. For example, goods and services innovations are most likely to be at a higher level among firms employing between 20 and 199 persons (12.7 per cent), whilst for marketing methods, this type of innovation is more likely in firms employing 5-19 persons (4.2 per cent). Innovation patterns in the BLADE data match very closely to those from Tables 2 and 3.

4 A Simple Theoretical Model

This section introduces a basic theoretical model to motivate our analysis. The theory closely follows a one-sector Schumpeterian model and only gives a brief outline of the main concepts important for this paper (for details see (Aghion and Howitt, 2009, Chapter 4).

[2]Labour productivity is defined as turnover divided by FTE.

Output Y_t of a final good in period t is produced using labour (L) and an intermediate input x_t according to

$$Y_t = (A_t L)^{1-\alpha} x_t^{\alpha} \tag{1}$$

where A_t reflects the productivity of the intermediate product. α lies between zero and one. Introducing capital does not change the model so it is omitted.

Value added is given by

$$Y_t - x_t \tag{2}$$

We assume that the intermediate inputs cost 1 unit of final good to produce. Adding prices does not alter the intuition from the model.

The final good is produced in a perfectly competitive market, however, monopoly profits exist in the intermediate product sector. Growth results from innovations that raise the productivity parameter A_t by improving the quality of the intermediate product. If the entrepreneur successfully innovates at time t, she will become the intermediate market monopolist in that period. Otherwise, the monopoly will pass to a random firm.

Innovation

Each producer in the intermediate product market can invest in innovation, but whether the outcome of the effort for innovation is successful is probabilistic in nature. If the innovator succeeds, productivity goes up based on:

$$A_t = \gamma A_{t-1} \tag{3}$$

where $\gamma > 1$. If the innovator fails, then there will be no innovation at time t and $A_t = A_{t-1}$.

The probability μ_t that an innovation occurs in period t depends positively on the amount of R&D expenditure (R_t) through the innovation function, θ, according to

$$\mu_t = \theta\left(\frac{R_t}{A_t}\right) \tag{4}$$

The probability of innovation depends inversely on A_t, because as technology advances it becomes

more complex and thus harder to improve upon. For concreteness, we assume that the innovation function takes the following form (similar to Aghion and Howitt (2009)):

$$\theta(\mathbf{C}, R, A) = (\delta \mathbf{C}) \left(\frac{R_t}{A_t} \right)^{\sigma} \tag{5}$$

$\mathbf{C}$ is a vector of firm related variables that affect the probability of successfully introducing innovation. This vector includes information such as scientific skills, collaboration, and exporting, foreign ownership and business focus. δ is a parameter that reflects the productivity of research effort and the elasticity σ lies between zero and one.

5 Methodology

Empirical model

Given equation (5) and vector $\mathbf{C}$ of variables associated with innovation, the paper uses the empirical model given in equation (6), where I^* is the level of innovation novelty. I^* is not observed, but ordered innovation outcomes, I, in the BCS survey are observed. I can take values no innovation ($I = 0$), new-to-firm innovation ($I = 1$), new-to-industry innovation ($I = 2$), innovations new-to-Australia ($I = 3$), and new-to-the-world innovation ($I = 4$).

Innovation novelty for firm j in industry i at time t is modelled as

$$\begin{aligned} I^*_{jit} =& \beta_1 \ln\left(TO_{ji,t-2}\right) + \beta_2 \ln\left(K_{ji,t-2}\right) + \beta_3 exp_{ji,t-2} + \beta_4 GSInnov_{ji,t-2} \\ &+ \beta_5 R\&Dji, t-2 + \beta_6 FTE_{ji,t-2} + \beta_7 \mathbf{X}_{ji,t-2} + \beta_8 \mathbf{Y}_{ji,t-2} + \mu_i + \mu_t + \varepsilon_{jit} \end{aligned} \tag{6}$$

We include the natural log of firm turnover (TO) and capital stock (K) and a dummy variable equal to one if a firm exports (exp). Previous goods and services innovation ($GSInnov$) has been found to be a good proxy for sustained innovation effort and a strong predictor of firm growth (Hecker and Ganter, 2013; Majeed et al., 2021). Other literature points out that product innovation is most highly correlated with other forms of innovation (Guarascio and Tamagni, 2019).

We include a dummy variable equal to one if the firm engaged in research and development activity ($R\&D$) and we control for full-time equivalent employees (FTE).

X is a vector of other firm level variables which includes foreign ownership, an indicator for firm age (if the firm is more than five years old), whether the firm collaborated with other businesses to develop or introduce new goods, measures of the focus of the firm's business in the past year and the types of skills used by the business in the past year. Business focus variables include whether firms had a business focus, to at least some extent (see Appendix Table A2), on financial measures, cost measures, operational measures, quality measures, innovation measures, human resources measures and environmental measures. Skills variables, which measure the specific skillset used by the business in undertaking core business activities, include engineering, science and research, IT professional, IT technical support, project management and business management.

Y is a vector of industry-level variables which include Lerner index (included as a quadratic), log of total industry turnover and log of total industry profit.[3]. We also include an interaction between the industry-level Lerner Index and firm-level FTE.[4] Appendix Table A2 has a detailed list of all the variables and their exact definitions. μ_i and μ_t are industry and time fixed effects. The ε_{jit} capture unobservable, firm-specific characteristics.

Estimation method

Given that we observe I but not I^*, a standard way to estimate models such as equation (6) is by using an ordered response model (Cameron and Trivedi, 2005). We use an ordered probit estimation method, which assumes that the unobserved variables have a normal distribution. Ordered response models account for the discrete categories of the dependent variable, which for this paper are the levels of novelty of innovation.

As I^* crosses a series of increasing, but unknown and unobserved thresholds, we move up the ordering of alternatives. Due to the increasing nature of ordered classes, the interpretation of

[3]In early versions of the models we also included mean industry age, total number of firms in the industry and the three-year compound average growth in turnover for the industry were also included. None of these were ever significant and are thus dropped in our preferred specification.

[4]Aghion et al. (2005) show a quadratic relationship between the Lerner index and innovation–see above. We also wanted to verify whether this relationship might depend upon firm size, hence the interaction.

this model's primary parameters set, β, is simple: positive signs indicate increased probability of higher levels of innovation novelty, while a negative sign indicates the opposite. In general, for M alternatives (indexed by m) we define

$$I_{jit} = m \text{ if } \kappa_{m-1} < I^*_{jit} < \kappa_m$$

$$\text{where } \kappa_0 = -\infty \text{ and } \kappa_M = \infty$$

$$\text{then}$$

$$\begin{aligned} Prob\left[I_{jit} = m\right] &= Prob\left[\kappa_{m-1} < I^*_{jit} \leq \kappa_m\right] \\ &= Prob\left[\kappa_{m-1} < \Phi' \mathbf{Z}_{jit} + \varepsilon_{jit} \leq \kappa_m\right] \\ &= Prob\left[\kappa_{m-1} - \Phi' \mathbf{Z}_{jit} < \varepsilon_{jit} \leq \kappa_m - \Phi' \mathbf{Z}_{jit}\right] \\ &= F\left(\kappa_m - \Phi' \mathbf{Z}_{jit}\right) - F\left(\kappa_{m-1} - \Phi' \mathbf{Z}_{jit}\right) \end{aligned} \tag{7}$$

F is the cumulative distribution function of ε (a normal distribution in our implementation). The regression parameters which capture the response of the variables are represented by the vector Φ, the variables from equation (6) are assembled in $\mathbf{Z}$ and the $(M-1)$ threshold parameters are $\kappa_1 \ldots \kappa_{m-1}$.

Further, we expect there to be reverse causality between innovation and the right-hand side variables. For example, variables such as turnover or R&D are likely to increase innovation, but simultaneously, successful innovations are likely to increase turnover and encourage firms to invest more in R&D. This will create endogeneity problems. To deal with this problem we lag all the variables on the right-hand side. Recall that our panel is constructed from annual snapshots that are two years apart, so the appropriate lag is two.

Skills and collaboration for innovation variables are not lagged. This is because when we use lags for these variables they turn out to be non–significant. However, contemporaneous variables seem to have a significant effect, signalling that skills and collaboration for innovation might have a more current impact on innovation. However, using contemporaneous variables means that there might be simultaneity with these variables and hence the coefficient on skill variables should be

interpreted with caution.

Once we estimate equation (7), we can transform the coefficient estimates into marginal effects. This allows us to evaluate how a change in a variable affects the probability of moving from one innovation category to another. For each variable, we can produce 5 marginal effects—one for the change in probability of being in each of the five categories as the variable changes. Note that these 5 marginal effects must sum to one. In what follows, we present and discuss marginal effects. Coefficient estimates are provided in the appendix.

6 Results

This section presents some of the main findings of our analysis. Table 4 shows the marginal effects for each category of innovation novelty from our estimates of equation (7).[5] The first column present results for all firms, while the next two columns splits the firms into two groups: those that are manufacturing and professional, scientific and technical services industries (MNF PST) and all others (non-MNF PST).[6]

[Table 4]

All firms

Firm-specific factors play an important role in determining innovation output. The results suggest that R&D, persistence of innovation, openness, collaboration, and employing people with business management skills are associated with higher levels of innovation novelty. The results suggest that firm-specific factors are important for higher levels of innovation novelty. The rest of this section elaborates on these points.

Undertaking R&D is positively associated with firms' ability to innovate. For the average firm, undertaking R&D increases the ability to introduce new-to-Australia and new-to-world innovations

[5] Appendix Table A5 contains the coefficient estimates.

[6] Manufacturing (MNF) and professional, scientific and technical services industries (PST) are the sectors that have invested the most in R&D in Australia in recent years (Australian Bureau of Statistics, 2017, 2019) and had the highest proportion of firms that have shown high growth in R&D activity (Department of Industry, Science, Energy and Resources, 2017).

by 1.4 per cent and 1.3 per cent, respectively. In the manufacturing and professional, scientific and technical services (PST) industries, the probability increases are even higher, at 1.9 per cent for new-to-Australia innovations and 2.4 per cent for new-to-world innovations.

Firms introducing product innovation in one period increase their chances of higher-level innovations in subsequent periods, suggesting that the persistence in innovation (i.e. whether innovation is an ongoing business practice) affects higher-level innovations. Having previously introduced goods and services innovation increases a firm's chances of subsequent new-to-Australia and new-to-world innovation by around 2.3 per cent and 2.1 per cent, respectively. The results are again stronger for the manufacturing and PST industries.

Foreign ownership is an important source of technological growth and innovation novelty for the average firm. Having foreign ownership increases the probability of introducing new-to-Australia and new-to-world innovation by around 1.2 per cent and 1.1 per cent, respectively.

Collaboration is positively related to higher levels of innovation novelty. Collaboration for the average firm is associated with increasing the probability of new-to-industry, new-to-Australia and new-to-world innovations by around 1.9 per cent, 2.7 per cent and 2.5 per cent, respectively.[7] This effect is stronger for the manufacturing and PST industries, where collaboration on innovation increases the probability of new-to-Australia and new-to-world innovations by around 2.9 per cent and 3.6 per cent, respectively. Collaboration for innovation by firms in the non-manufacturing and non-PST industries increases the probability of new-to-firm, new-to-industry, new-to-Australia and new-to-world innovations by around 1.2 per cent, 2.1 per cent, 2.7 per cent and 2.0 per cent, respectively.

Results further show that a business focus on innovation is strongly and significantly related to higher levels of novelty. There is also evidence that skills in business management contemporaneously raise the chances of higher levels of innovation novelty in all firms. The strong and positive association of variables like business focus on innovation and skills in business management show

[7] Variables such as collaboration for innovation and science, technology, engineering and mathematics (STEM) skills have a contemporaneous effect on the probability of undertaking any type of innovation. When we included lags of collaboration for innovation and STEM skills in the regressions they were always statistically insignificant.

the importance of management capability within a firm. Results also show that there is a contemporaneous and positive association between skills in science and research and the likelihood of higher levels of novelty. On the other hand, we find no direct effect of capital expenditure affecting innovation for the average firm, nor do we find any effect of market power.[8]

Analysing the effects by firm size and industry reveals some interesting differences between the two groups. In particular, we find that R&D and foreign ownership are more important for large firms than for SMEs. We separately estimate the model for large and small firms—marginal effects for large firms are presented in Appendix Table A3 while Appendix Table A4 presents the marginal effects for SMEs.[9]

Large firms

For large firms, undertaking R&D increases the probability of new-to-industry, new-to-country and new-to-world innovations by around 1.0 per cent, 1.6 per cent, and 1.5 per cent, respectively. This effect is larger for manufacturing and PST industries, though less precisely estimated.

Based on firm size, the effect of foreign ownership is similar to the effect of R&D. Across all industries, foreign ownership increases the probability of large firms to introducing new-to-industry, new-to-country and new-to-world innovations by around 1.0 percent, 1.6 per cent and 1.5 per cent, respectively.

Collaboration on innovation allows large firms across all industries to introduce innovations at higher levels of novelty. For large firms in the manufacturing and PST industries, collaboration on innovation increases the probability to introduce new-to-industry, new-to-country and new-to-world innovations by 1.2 per cent, 3.0 per cent and 3.7 per cent, respectively. A similar positive impact is found in other industries, where collaboration on innovation lifts the probability of new-to-industry, new-to-country and new-to-world innovations by 1.9 per cent, 2.5 per cent and 1.9 per cent, respectively.

Small and medium firms

[8]Lerner Index, which is widely used to measure market power, is included in the regressions. Once we control for total industry turnover and profit, Lerner index was only found to be statistically significant for MNF and PST sectors.

[9]Appendix Tables A6 and A7 show the coefficient estimates for the models estimated for large and small firms, respectively.

For exports, R&D, foreign ownership and capital investment, there are some important differences for SMEs. In the manufacturing and PST industries, exporting by SMEs is associated with an increased the probability of introducing higher levels of innovation novelty compared to non-exporting SMEs. Exporting decreases the probability of not innovating by around 11 per cent, and it increases the probability of innovating at the new-to-firm, new-to-industry, new-to-Australia and new-to-world level by 4.8 per cent, 1.5 per cent, 1.7 per cent and 2.7 per cent, respectively (Table A4). The results suggest that exporting is an important impetus for innovation in these industries.

Larger firms benefit more from undertaking R&D with respect to introducing higher levels of innovation novelty. This is partly due to the fact that small firms, for the most part, do not undertake much R&D. Further, prior innovation in goods and services is only associated with higher levels of innovation novelty for SMEs in the non-manufacturing and non-PST industries. This stands in contrast to large firms, where prior goods and services innovations are found to be linked to higher levels of innovation novelty across all industries. The paper found no statistical evidence of a relationship between foreign ownership and higher levels of innovation novelty amongst SMEs, possibly reflecting an inclination of foreign investors to buy into larger firms.

Across all industries, SMEs that collaborate on innovation are more likely to be introducing higher levels of innovation novelty, compared to SMEs that do not collaborate. For the typical SME, collaboration on innovation increases the probability of introducing new-to-industry, new-to-country and new-to-world innovations by 1.8 per cent, 2.2 per cent and 1.9 per cent, respectively.

Surprisingly, in the manufacturing and PST industries, capital investment is found to reduce the likelihood of SMEs to introduce innovations with higher degrees of novelty. One possible interpretation could be that many SMEs are trading off introducing more novel kinds of innovation for capital investment. In the presence of such a trade-off, capital investment may be crowding out innovation expenditures. This finding may warrant further research to improve understanding of the mechanisms.

6.1 Robustness checks

We undertook a few simple robustness checks with respect to our results. First, we re-estimated all of the models with a simpler, three item classification of innovation novelty: no innovation, incremental innovation (new-to-firm and new-to-industry innovations) and high levels of innovation novelty (new-to-country and new-to-world innovations). None of the substantive results change.

We re-estimated the models using a linear regression model and treating the five values of innovation novelty as being a continuous variable. Unsurprisingly, the basic flavor of the results doesn't change. Variables that we found to have a positive impact on innovation novelty are generally positive and significant and similarly for those that act against innovation novelty. The patterns of significance and insignificance were the same in the ordered probit models and the linear regressions.

Finally, because we have panel data, we can control for unobservable firm-specific characteristics in a linear regression context. In equation (6), the ε_{ijt} capture both time-varying and time-invariant firm characteristics. If we separate these into time invariant (α_j) and time-variant elements (u_jit), we can use fixed effects to eliminate the time invariant components. There are two drawbacks of this approach. The first is that the ordered probit model is not identified with fixed effects. The second is that many of the variables that are the focus of our study do not vary much over time and by using only within-firm variation we eliminate the variation across firms that we use to distinguish between innovating and non-innovating firms. We estimate all of the models using linear fixed effects and the results do not lead us to conclude that our analysis is incorrect. Many of the variables become insignificant in the fixed effects regressions, particularly the categorical variables. For the continuous variables, however, the direction of effects is the same as what we report for the main model. We thus conclude that endogeneity from time-invariant, firm-specific characteristics is not an important influence on our results .

7 Concluding Remarks

Higher levels of innovation novelty, which include new-to-country and new-to-world innovation, are expected to impact firm growth and generate positive externalities. This means higher levels of innovation novelty are important from a policy perspective. Our paper is the first to examine the determinants of innovation novelty in Australia. This paper presents findings from analysis based on survey data for businesses linked with unit record administrative data from the Australian Taxation Office and the Australian Bureau of Statistics.

Firm-specific factors such as undertaking R&D, persistence of innovation, a focus on innovation and collaborating to produce innovation are associated with higher levels of innovation novelty. Foreign ownership, particularly for larger firms, is also associated with higher levels of innovation novelty. Businesses which report IT and management skills as being amongst their core competencies are also more likely to engage in higher levels of innovation novelty.

Firm-specific factors are more important for higher levels of innovation novelty than industry characteristics (such as the intensity of competition). There are notable differences between firms of different sizes. For larger firms, R&D and foreign ownership are associated with higher levels of innovation novelty across all industries. For SMEs, higher levels of innovation novelty are closely related to exports, but only for firms in the manufacturing and PTS industries. Somewhat surprisingly, capital investment by SMEs in the manufacturing and PST industries is associated with reduced introduction of higher levels of innovation novelty. This may suggest that for smaller firms, capital expenditure is potentially crowding out innovation expenditure.

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Figures and Tables

Table 1: *Summary statistics*

Variable	Count	Mean	Standard Deviation	p1	Median	p99
Firm-level variables						
Log of real turnover	250128	15.12	2.25	11.05	14.75	21.14
Log of real capital expenditure	172533	11.67	2.73	6.05	11.46	18.71
Exporting Firm*	252681	0.21				
Goods and services innovation*	88207	0.26				
Firm undertook R&D*	13072	0.21				
Foreign ownership*	87589	0.15				
Firm age	271769	11.48	7.57	0	10	33
Full-time Equivalent Employment	252681	140.44	966.18	1.03	11.15	2132.72
Innovation Collaboration*	65989	0.17				
Business focus variables						
Financial focus	83111	0.94				
Cost focus	82774	0.92				
Operational focus	82224	0.86				
Quality focus	82492	0.92				
Innovation focus	82178	0.82				
Human resource focus	82427	0.88				
Use of skillsets in core business activities						
Engineering*	73654	0.24				
Science and research*	73654	0.11				
IT professionals*	73654	0.35				
IT technical support*	73654	0.41				
Project Management*	73654	0.29				
Business management*	73654	0.4				
Industry variables						
Industry variables						
Lerner index	208123	22.33	216.43	0.85	3.02	288.23
Log total industry turnover	252681	24.54	1.15	21	24.65	27.17
3 year compound growth rate of total industry turnover	196129	22.08	1.24	18.71	22.14	25.95
Average industry age	252681	9	2.15	5.09	8.87	14.66
Total number of firms in industry	252681	14896.45	16401.35	152	6845	56459

Notes: Industries are specified at 2-digit Australia and New Zealand Standard Industrial Classification (ANZSIC) level. The extent to which businesses focus on each measure is ranked between 0 (not at all) to 3 (a major extent).
*denotes indicator variable
Source: ABS Business Longitudinal Analysis Data Environment, 2019

Table 2: *Innovating firms in Australia, 2016-2017*

	Firms and innovation:			
	introduced or implemented innovation (innovating)	**still in development**	**abandoned**	**any innovative activity (innovation-active)**
Total	38.3	20.9	7.1	44.5
	By employment size			
0-4 employees	30.6	17.0	6.0	36.3
5-19 employees	50.0	25.1	9.2	56.9
20-199 employees	52.2	34.4	8.1	60.6
200 or more employees	62.8	43.3	6.6	69.8

Notes: Numbers in table are percentages. Data include firms that are non-employing

Source: Australian Bureau of Statistics (2018)

Table 3: *Innovating novelty by type of innovation among Australian firms, 2016-2017*

Number of employees	New to the world	New to Australia	New to the industry	New to the business	Any innovation
Goods and services innovation					
0-4	8.8	8.3	14.1	75.2	15.4
5-19	6.6	7.3	13.3	77.1	20.1
20-199	12.7	12.5	15.3	68.3	22.4
200 or more	6.9	15.6	26.3	73.3	27.1
Total	8.4	8.4	14	75.2	17.4
Operational processes					
0-4	3	4.6	8.3	87.2	13
5-19	2.4	2.8	7.2	89.1	21.7
20-199	7	3.3	16.2	81	25.9
200 or more	0.8	2.7	14.1	86.3	38.5
Total	3.1	3.7	8.8	87.3	16.7
Organisational/managerial processes					
0-4	1.7	2.4	8.2	88.9	12.6
5-19	0.4	1	5.9	94.2	23.9
20-199	N/A	0.3	9.9	90.9	27.2
200 or more	0.6	1.9	10.4	89.6	44.8
Total	1	1.6	7.4	91.4	17.3
Marketing methods					
0-4	1.4	1.3	3.5	94.3	12.6
5-19	4.2	1.2	4.2	91.4	22.1
20-199	0.9	N/A	14.9	85.5	24.6
200 or more	1.6	2.5	6.8	93	23.5
Total	2.5	1.2	5.1	92.2	16.4

Notes: Numbers in table are percentages. Data include firms that are non-employing

Source: Australian Bureau of Statistics (2018)

Table 4: *Marginal effects from ordered probit regression of factors determining novelty of innovation–firms of all sizes, 2005-06 to 2015-16*

Independent Variable: Innovation Novelty	(1) All Industries dy/dx	(2) Non-MNF PST dy/dx	(3) MNF PST dy/dx
		ln(real turnover)[t-2]	
1	−0.0137***	−0.0135***	−0.0159***
	(0.0031)	(0.0038)	(0.0059)
2	0.0002	0.0021***	−0.0069**
	(0.0005)	(0.0007)	(0.0028)
3	0.0036***	0.0036***	0.0040***
	(0.0008)	(0.0010)	(0.0015)
4	0.0053***	0.0045***	0.0083***
	(0.0012)	(0.0013)	(0.0032)
5	0.0047***	0.0034***	0.0105***
	(0.0011)	(0.0010)	(0.0040)
		ln(real capital expenditure)[t-2]	
1	0.0014	−0.0002	0.0057
	(0.0023)	(0.0028)	(0.0042)
2	−0.0000	0.0000	0.0024
	(0.0001)	(0.0004)	(0.0018)
3	−0.0004	0.0000	−0.0014
	(0.0006)	(0.0007)	(0.0011)
4	−0.0005	0.0001	−0.0030
	(0.0009)	(0.0009)	(0.0022)
5	−0.0005	0.0000	−0.0037
	(0.0008)	(0.0007)	(0.0028)
		Exporting firm[t-2]	
1	−0.0133	−0.0039	−0.0309*
	(0.0091)	(0.0111)	(0.0159)
2	0.0002	0.0006	−0.0134*
	(0.0005)	(0.0017)	(0.0075)
3	0.0035	0.0010	0.0078*
	(0.0024)	(0.0029)	(0.0042)
4	0.0051	0.0013	0.0162*
	(0.0035)	(0.0037)	(0.0085)
5	0.0046	0.0010	0.0203*
	(0.0032)	(0.0028)	(0.0107)
		Goods and services innovation[t-2]	
1	−0.0599***	−0.0615***	−0.0518***
	(0.0078)	(0.0095)	(0.0139)
2	0.0007	0.0094***	−0.0224***
	(0.0020)	(0.0027)	(0.0068)
3	0.0155***	0.0161***	0.0130***
	(0.0022)	(0.0027)	(0.0037)
4	0.0230***	0.0206***	0.0271***
	(0.0032)	(0.0035)	(0.0075)
5	0.0207***	0.0153***	0.0340***
	(0.0029)	(0.0027)	(0.0092)
		Firm undertook R&D[t-2]	
1	−0.0363***	−0.0320***	−0.0361***
	(0.0091)	(0.0118)	(0.0138)
2	0.0004	0.0049**	−0.0156**
	(0.0012)	(0.0022)	(0.0068)
3	0.0094***	0.0084***	0.0091**
	(0.0024)	(0.0031)	(0.0036)
4	0.0139***	0.0107***	0.0189**
	(0.0036)	(0.0041)	(0.0074)
5	0.0125***	0.0080***	0.0237**
	(0.0033)	(0.0030)	(0.0095)

Table 4 (continued)

Independent Variable: Innovation Novelty	(1) All Industries dy/dx	(2) Non-MNF PST dy/dx	(3) MNF PST dy/dx
		Foreign ownership[t-2]	
1	−0.0316***	−0.0367***	−0.0222
	(0.0096)	(0.0122)	(0.0149)
2	0.0004	0.0056**	−0.0096
	(0.0011)	(0.0023)	(0.0067)
3	0.0082***	0.0096***	0.0056
	(0.0025)	(0.0033)	(0.0038)
4	0.0121***	0.0123***	0.01116
	(0.0038)	(0.0042)	(0.0079)
5	0.0109***	0.0091***	0.0146
	(0.0034)	(0.0031)	(0.0098)
		Business focus on financial measures[t-2]	
1	−0.0395	−0.0430	0.0108
	(0.0345)	(0.0397)	(0.0791)
2	0.0005	0.0066	0.0047
	(0.0014)	(0.0063)	(0.0342)
3	0.0102	0.0113	−0.0027
	(0.0089)	(0.0104)	(0.0199)
4	0.0151	0.0144	−0.0057
	(0.0132)	(0.0134)	(0.0414)
5	0.0136	0.0107	−0.0071
	(0.0120)	(0.0100)	(0.0520)
		Business focus on cost measures[t-2]	
1	0.0071	0.0148	−0.0022
	(0.0276)	(0.0340)	(0.0461)
2	−0.0001	−0.0023	−0.0010
	(0.0004)	(0.0052)	(0.0199)
3	−0.0018	−0.0039	0.0006
	(0.0072)	(0.0089)	(0.0116)
4	−0.0027	−0.0050	0.0012
	(0.0106)	(0.0114)	(0.0241)
5	−0.0024	−0.0037	0.0015
	(0.0095)	(0.0085)	(0.0303)
		Business focus on operational measures[t-2]	
1	0.0087	−0.0058	0.0671
	(0.0204)	(0.0227)	(0.0547)
2	−0.0001	0.0009	0.0290
	(0.0004)	(0.0035)	(0.0241)
3	−0.0023	0.0015	−0.0169
	(0.0053)	(0.0060)	(0.0138)
4	−0.0034	0.0020	−0.0351
	(0.0078)	(0.0076)	(0.0287)
5	−0.0030	0.0015	−0.0441
	(0.0071)	(0.0056)	(0.0362)
		Business focus on quality measures[t-2]	
1	−0.0418	0.0016	−0.1809***
	(0.0301)	(0.0344)	(0.0501)
2	0.0005	−0.0002	−0.0782***
	(0.0015)	(0.0053)	(0.0267)
3	0.0108	−0.0004	0.0455***
	(0.0078)	(0.0090)	(0.0135)
4	0.0160	−0.0005	0.0947***
	(0.0116)	(0.0115)	(0.0275)
5	0.0144	−0.0004	0.1190***
	(0.0104)	(0.0085)	(0.0351)

Table 4 (continued)

Independent Variable: Innovation Novelty	(1) All Industries dy/dx	(2) Non-MNF PST dy/dx	(3) MNF PST dy/dx
	Business focus on innovation measures[t-2]		
1	−0.0433**	−0.0490**	−0.0250
	(0.0187)	(0.0213)	(0.0431)
2	0.0005	0.0075**	−0.0108
	(0.0015)	(0.0037)	(0.0188)
3	0.0112**	0.0129**	0.0063
	(0.0049)	(0.0057)	(0.0109)
4	0.0166**	0.0165**	0.0131
	(0.0072)	(0.0072)	(0.0225)
5	0.0149**	0.0122**	0.0165
	(0.0066)	(0.0055)	(0.0284)
	Business focus on human resource measures[t-2]		
1	−0.0000	−0.0194	0.0528
	(0.0257)	(0.0266)	(0.0666)
2	0.0000	0.0030	0.0228
	(0.0003)	(0.0041)	(0.0293)
3	0.0000	0.0051	−0.0133
	(0.0066)	(0.0070)	(0.0168)
4	0.0000	0.0065	−0.0276
	(0.0098)	(0.0089)	(0.0350)
5	0.0000	0.0048	−0.0347
	(0.0089)	(0.0066)	(0.0441)
	Lerner Index[t-2]		
1	0.0000	0.0000	−0.0056**
	(0.0001)	(0.0001)	(0.0022)
2	0.0000	0.0000	−0.0019
	(0.0000)	(0.0000)	(0.0012)
3	−0.0000	−0.0000	0.0014**
	(0.0000)	(0.0000)	(0.0006)
4	−0.0000	−0.0000	0.0028**
	(0.0000)	(0.0000)	(0.0012)
5	−0.0000	−0.0000	0.0033**
	(0.0000)	(0.0000)	(0.0015)
	Full-time equivalent employment[t-2]		
1	−0.0000	−0.0000	0.0000
	(0.0000)	(0.0000)	(0.0000)
2	−0.0000	−0.0000	0.0000
	(0.0000)	(0.0000)	(0.0000)
3	0.0000	0.0000	−0.0000
	(0.0000)	(0.0000)	(0.0000)
4	0.0000	0.0000	−0.0000
	(0.0000)	(0.0000)	(0.0000)
5	0.0000	0.0000	−0.0000
	(0.0000)	(0.0000)	(0.0000)
	ln(total industry turnover)[t-2]		
1	−0.0044	−0.0208	0.0208
	(0.0187)	(0.0120)	(0.0156)
2	0.0001	0.0032	0.0090
	(0.0015)	(0.0020)	(0.0069)
3	0.0011	0.0055	−0.0052
	(0.0049)	(0.0032)	(0.0039)
4	0.0017	0.0070	−0.0109
	(0.0072)	(0.0041)	(0.0081)
5	0.0015	0.0052	−0.0137
	(0.0066)	(0.0030)	(0.0104)

Table 4 (continued)

Independent Variable: Innovation Novelty	(1) All Industries dy/dx	(2) Non-MNF PST dy/dx	(3) MNF PST dy/dx
		ln(total industry profit)[t-2]	
1	0.0158**	0.0234**	0.0078
	(0.0078)	(0.0094)	(0.0147)
2	−0.0002	−0.0036**	0.0034
	(0.0005)	(0.0017)	(0.0064)
3	−0.0041**	−0.0062**	−0.0020
	(0.0020)	(0.0025)	(0.0037)
4	−0.0061**	−0.0079**	−0.0041
	(0.0030)	(0.0032)	(0.0077)
5	−0.0055**	−0.0058**	−0.0051
	(0.0027)	(0.0024)	(0.0097)
		Collaboration on innovation	
1	−0.0714***	−0.0805***	−0.0551***
	(0.0088)	(0.0108)	(0.0146)
2	0.0009	0.0123***	−0.0238***
	(0.0024)	(0.0035)	(0.0070)
3	0.0185***	0.0211***	0.0138***
	(0.0025)	(0.0032)	(0.0039)
4	0.0274***	0.0270***	0.0288***
	(0.0037)	(0.0041)	(0.0078)
5	0.0247***	0.0200***	0.0362***
	(0.0033)	(0.0031)	(0.0096)
		Engineering skills used in core business activities	
1	−0.0023	−0.0041	0.0080
	(0.0103)	(0.0127)	(0.0170)
2	0.0000	0.0006	0.0034
	(0.0001)	(0.0019)	(0.0073)
3	0.0006	0.0011	−0.0020
	(0.0027)	(0.0033)	(0.0043)
4	0.0009	0.0014	−0.0042
	(0.0036)	(0.0043)	(0.0089)
5	0.0008	0.0010	−0.0052
	(0.0036)	(0.0032)	(0.0112)
		Science and research skills used in core business activities	
1	−0.0297***	−0.0376**	−0.0193
	(0.0114)	(0.0161)	(0.0155)
2	0.0004	0.0057**	−0.0083
	(0.0010)	(0.0028)	(0.0068)
3	0.0077***	0.0099**	0.0048
	(0.0030)	(0.0043)	(0.0039)
4	0.0114***	0.0126**	0.0101
	(0.0044)	(0.0055)	(0.0081)
5	0.0103***	0.0094**	0.0127
	(0.0040)	(0.0042)	(0.0103)
		IT Professional skills used in core business activities	
1	−0.0274***	−0.0351***	−0.0129
	(0.0095)	(0.0113)	(0.0169)
2	0.0003	0.0054**	−0.0056
	(0.0009)	(0.0022)	(0.0075)
3	0.0071***	0.0092***	0.0033
	(0.0025)	(0.0030)	(0.0043)
4	0.0105***	0.0118***	0.0068
	(0.0037)	(0.0038)	(0.0089)
5	0.0095***	0.0087***	0.0085
	(0.0033)	(0.0029)	(0.0112)

Table 4 (continued)

Independent Variable: Innovation Novelty	(1) All Industries dy/dx	(2) Non-MNF PST dy/dx	(3) MNF PST dy/dx
	IT technical support skills used in core business activities		
1	0.0070	0.0109	−0.0038
	(0.0096)	(0.0115)	(0.0180)
2	−0.0001	−0.0017	−0.0016
	(0.0001)	(0.0018)	(0.0077)
3	−0.0018	−0.0029	0.0010
	(0.0025)	(0.0030)	(0.0045)
4	−0.0027	−0.0037	0.0020
	(0.0037)	(0.0039)	(0.0094)
5	−0.0024	−0.0027	0.025
	(0.0033)	(0.0029)	(0.0118)
	Project management skills used in core business activities		
1	−0.0078	−0.0071	−0.0064
	(0.0100)	(0.0117)	(0.0187)
2	0.0001	0.0011	−0.0028
	(0.0003)	(0.0018)	(0.0080)
3	0.0020	0.0019	0.0016
	(0.0026)	(0.0031)	(0.0047)
4	0.0030	0.0024	0.0033
	(0.0038)	(0.0039)	(0.0097)
5	0.0027	0.0018	0.0042
	(0.0035)	(0.0029)	(0.0122)
	Business management skills used in core business activities		
1	−0.0289***	−0.0269**	−0.0334**
	(0.0093)	(0.0112)	(0.0165)
2	0.0003	0.0041**	−0.0144*
	(0.0010)	(0.0020)	(0.0074)
3	0.0075***	0.0071**	0.0084**
	(0.0024)	(0.0030)	(0.0043)
4	0.0111***	0.0090**	0.0175**
	(0.0036)	(0.0038)	(0.0087)
5	0.0100***	0.0067**	0.0219**
	(0.0032)	(0.0028)	(0.0108)
		Firm age > 5 years	
1	0.0142	0.0140	0.0232
	(0.0159)	(0.0180)	(0.0301)
2	0.0007	−0.0014	0.0137
	(0.0019)	(0.0010)	(0.0231)
3	−0.0038	−0.0038	−0.0061
	(0.0044)	(0.0051)	(0.0082)
4	−0.0058	−0.0050	−0.0132
	(0.0068)	(0.0068)	(0.0184)
5	−0.0053	−0.0038	−0.0177
	(0.0065)	(0.0053)	(0.0266)
Year fixed effects	Y	Y	Y
Industry fixed effects	Y	Y	Y
Observations	4,908	3,659	1,249

Notes: Results reported from firms in (1) all industries; (2) non-manufacturing and non-professional, scientific and technical services industries; and (3) manufacturing and professional, scientific and technical services industries only.
Novelty of innovation is categorised into 1 (no innovation), 2 (new to the business), 3 (new to the industry), 4 (new to Australia), 5 (new to the world).
*** indicates significance at the 1 per cent, ** 5 per cent and * 10 per cent level.
[t-2] indicates second lag of variable.

Source: BLADE 2019

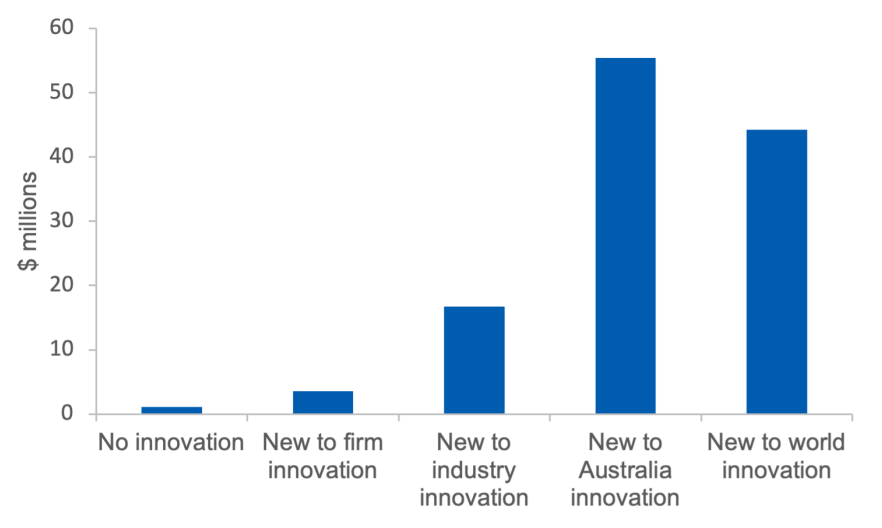

FIGURE 1: **Median turnover amounts in real terms by levels of innovation novelty, 2005–06 to 2015–16 (Source: BLADE)**

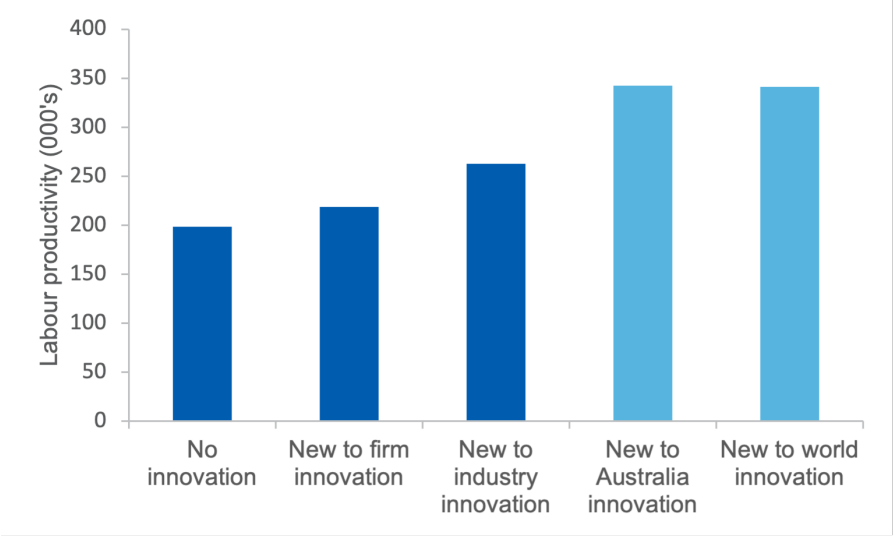

FIGURE 2: **Median Labour productivity by levels of innovation novelty, 2005–06 to 2015–16 (Source: BLADE)**

APPENDIX

Table A1: *Levels of innovation novelty as defined in the paper*

Order of Novelty	Description	Definition
1	No innovation	No introduction of significantly improved goods or services, operational processes, organisational/ managerial processes or marketing methods
2	New to firm	Introduced at least one type of innovation which was new to the firm but not 'new to the industry', 'new to Australia' or 'new to the world'.
3	New to the industry	Introduced at least one type of innovation which was new to the industry but not 'new to Australia' or 'new to the world'.
4	New to Australia	Introduced at least one type of innovation which was new to Australia but not 'new to the world'.
5	New to the world	Introduced new to the world innovation in at least one area (goods or services, operational processes, organisational/ managerial processes or marketing methods)

Notes: If a business had introduced multiple innovations with different degrees of novelty, the novelty variable for that firm will reflect its most novel innovation.
Source: ABS (2019) Business Longitudinal Analysis Data Environment

Any business that reports introducing a new-to-the-world innovation, regardless of the type of innovation, is included in the new–to–the–world category. A business is said to have introduced a new-to-Australia innovation if it introduces at least one type of innovation that was new to Australia but not new-to-the-world innovation. A business is said to have introduced a new-to-industry innovation if it introduces at least one type of innovation that was new to its respective industry but not new-to-Australia. New-to-firm innovation is innovation that is only new to that firm. A firm is categorised as not innovating if it does not introduce any significantly improved goods or services, operational processes, organisational/ managerial processes, or marketing methods within the period of study.

Table A2: *Variable descriptions*

Variable	Description	Values
Firm-level variables		
Turnover	Natural log of real turnover	continuous
Capital expenditure	Natural log of real capital expenditure	continuous
Export	Indicator if firm exports	0 No 1 Yes
Foreign Ownership	Indicator if firm is more than 50 per cent foreign owned	0 No 1 Yes
Firm size	Firm's full time equivalent employment size (FTE)	continuous
Collaboration on Innovation	Indicator of whether the firm collaborated with other businesses to develop or introduce any new goods, services process or methods	0 No 1 Yes
R&D	Indicator if firm undertook R&D	0 No 1 Yes
Goods and Services Innovation	Indicator of whether the firm introduced any new or significantly improved goods or services that were new to the business during the past financial year	0 No 1 Yes
Measures of firm's self-assessed business focus over the past financial year		
Financial measures	The extent that the firm focused on financial measures, e.g. profits, sales growth, returns on investment.	0 Not at all 1 Small extent 2 Moderate extent 3 Major extent
Cost measures	The extent that the firm focused on cost measures, e.g. budget, cost per unit of output, inventory cost.	as above
Operational measures	The extent that the firm focused on operational measures, e.g. asset utilisation, on-time delivery.	as above
Quality measures	The extent that the firm focused on quality measures, e.g. customer satisfaction, defect rates.	as above
Innovation measures	The extent that the firm focused on innovation measures, e.g. new processes, new value added products.	as above
Human resource measures	The extent that the firm focused on human resources, e.g. job satisfaction, skills development.	as above
Environmental measures	The extent that the firm focused on environmental measures, e.g. recycling, adherence to environmental regulations, sustainability, carbon footprint analysis.	as above

Table A2 (continued): *Variable descriptions*

Variable	Description	Values
Skills used by the business in undertaking core business activity during the past financial year		
Engineering	Firm used engineering skills for its core business activities	0 No 1 Yes
Science and research	Firm used science and research skills for its core business activities	0 No 1 Yes
IT professional	Firm used IT professional skills for its core business activities	0 No 1 Yes
IT technical support	Firm used IT technical support skills for its core business activities	0 No 1 Yes
Project management	Firm used project management skills for its core business activities	0 No 1 Yes
Business management	Firm used business management skills for its core business activities	0 No 1 Yes
Industry-level variables		
Industry turnover	Natural log of total turnover within the industry	continuous
Industry profit	Natural log of total profit within the industry	continuous
Competitiveness	Lerner Index	continuous

The measures of firm's self-assessed business focus over the past financial year are recoded to an indicator variable which takes value one if the firm responded 'Small extent', 'Moderate extent' or 'Major extent'. It is this indicator variable that is used in the regressions.

Table A3: *Marginal effects from ordered probit regression of factors determining novelty of innovation–firms with more than 200 full-time employees, 2005-06 to 2015-16*

Independent Variable: Innovation Novelty	(1) All Industries dy/dx	(2) Non-MNF PST dy/dx	(3) MNF PST dy/dx
		ln(real turnover)[t-2]	
1	−0.0067*	−0.0100**	0.0019
	(0.0039)	(0.0048)	(0.0086)
2	−0.0040*	−0.0039*	0.0021
	(0.0023)	(0.0020)	(0.0093)
3	0.0026*	0.0041**	−0.0006
	(0.0015)	(0.0020)	(0.0027)
4	0.0042*	0.0055**	−0.0015
	(0.0025)	(0.0027)	(0.0068)
5	0.0039*	0.0042**	−0.0019
	(0.0023)	(0.0021)	(0.0084)
		ln(real capital expenditure)[t-2]	
1	0.0033	0.0028	0.0051
	(0.0026)	(0.0032)	(0.0047)
2	0.0020	0.0011	0.0054
	(0.0015)	(0.0013)	(0.0050)
3	−0.0013	−0.0012	−0.0016
	(0.0010)	(0.0013)	(0.0015)
4	−0.0021	−0.0015	−0.0040
	(0.0016)	(0.0018)	(0.0037)
5	−0.0019	−0.0012	−0.0049
	(0.0015)	(0.0014)	(0.0045)
		Exporting firm[t-2]	
1	0.0010	0.0020	−0.0029
	(0.0090)	(0.0108)	(0.0163)
2	0.0006	0.0008	−0.0031
	(0.0053)	(0.0042)	(0.0177)
3	−0.0004	−0.0008	0.0009
	(0.0035)	(0.0045)	(0.0052)
4	−0.0006	−0.0011	0.0023
	(0.0056)	(0.0059)	(0.0129)
5	−0.0006	−0.0009	0.0028
	(0.0052)	(0.0046)	(0.0159)
		Goods and services innovation[t-2]	
1	−0.0536***	−0.0543***	−0.0498***
	(0.0083)	(0.0101)	(0.0144)
2	−0.0314***	−0.0210***	−0.0536***
	(0.0055)	(0.0054)	(0.0151)
3	0.0207***	0.0225***	0.0158***
	(0.0033)	(0.0044)	(0.0047)
4	0.0335***	0.0298***	0.0392***
	(0.0053)	(0.0059)	(0.0113)
5	0.0308***	0.0231***	0.0484***
	(0.0050)	(0.0048)	(0.0136)
		Firm undertook R&D[t-2]	
1	−0.0263***	−0.0256**	−0.0239*
	(0.0088)	(0.0117)	(0.0130)
2	−0.0154***	−0.0099**	−0.0258*
	(0.0054)	(0.0048)	(0.0143)
3	0.0102***	0.0106**	0.0076*
	(0.0035)	(0.0049)	(0.0042)
4	0.0164***	0.0140**	0.0188*
	(0.0056)	(0.0065)	(0.0102)
5	0.0151***	0.0109**	0.0233*
	(0.0051)	(0.0050)	(0.0129)

Table A3 (continued)

Independent Variable: Innovation Novelty	(1) All Industries dy/dx	(2) Non-MNF PST dy/dx	(3) MNF PST dy/dx
		Foreign ownership[t-2]	
1	−0.0258***	−0.0283***	−0.0263**
	(0.0083)	(0.0107)	(0.0130)
2	−0.0151***	−0.0110**	−0.0283**
	(0.0051)	(0.0045)	(0.0144)
3	0.0100***	0.0117***	0.0083**
	(0.0033)	(0.0045)	(0.0042)
4	0.0161***	0.0155***	0.0207**
	(0.0053)	(0.0060)	(0.0104)
5	0.0148***	0.0120***	0.0256**
	(0.0048)	(0.0046)	(0.0129)
		Business focus on financial measures[t-2]	
1	0.0034	0.0118	.
	(0.0901)	(0.0987)	(.)
2	0.0020	0.0046	.
	(0.0528)	(0.0382)	(.)
3	−0.0013	−0.0049	.
	(0.0349)	(0.0409)	(.)
4	−0.0021	−0.0065	.
	(0.0563)	(0.0541)	(.)
5	−0.0020	−0.0050	.
	(0.0518)	(0.0419)	(.)
		Business focus on cost measures[t-2]	
1	0.0579	0.0774*	−0.0655**
	(0.0401)	(0.0435)	(0.0331)
2	0.0339	0.0299*	−0.0706*
	(0.0236)	(0.0174)	(0.0369)
3	−0.0224	−0.0321*	0.0208*
	(0.0156)	(0.0182)	(0.0107)
4	−0.0362	−0.0424*	0.0516**
	(0.0250)	(0.0238)	(0.0263)
5	−0.0332	−0.0329*	0.0637*
	(0.0231)	(0.0185)	(0.0330)
		Business focus on operational measures[t-2]	
1	0.0092	−0.0019	0.1086
	(0.0288)	(0.0319)	(0.0935)
2	0.0054	−0.0007	0.1170
	(0.0169)	(0.0123)	(0.0996)
3	−0.0036	0.0008	−0.0345
	(0.0111)	(0.0132)	(0.0297)
4	−0.0058	0.0010	−0.0856
	(0.0180)	(0.0175)	(0.0733)
5	−0.0053	0.0008	−0.1057
	(0.0166)	(0.0135)	(0.0902)
		Business focus on quality measures[t-2]	
1	−0.0154	0.0131	−0.1114**
	(0.0344)	(0.0389)	(0.0500)
2	−0.0090	0.0051	−0.1200**
	(0.0202)	(0.0150)	(0.0563)
3	0.0060	−0.0054	0.0353**
	(0.0133)	(0.0161)	(0.0163)
4	0.0096	−0.0072	0.0878**
	(0.0215)	(0.0213)	(0.0397)
5	0.0088	−0.0056	0.1084**
	(0.0198)	(0.0165)	(0.0505)

Table A3 (continued)

Independent Variable: Innovation Novelty	(1) All Industries dy/dx	(2) Non-MNF PST dy/dx	(3) MNF PST dy/dx
	Business focus on innovation measures[t-2]		
1	−0.0134	−0.0205	0.0157
	(0.0204)	(0.0229)	(0.0547)
2	−0.0078	−0.0079	0.0169
	(0.0121)	(0.0091)	(0.0587)
3	0.0052	0.0085	−0.0050
	(0.0079)	(0.0095)	(0.0174)
4	0.0083	0.0112	−0.0124
	(0.0128)	(0.0126)	(0.0430)
5	0.0077	0.0087	−0.0153
	(0.0118)	(0.0099)	(0.0530)
	Business focus on human resource measures[t-2]		
1	−0.0325	−0.0324	−0.0580
	(0.0354)	(0.0362)	(0.0967)
2	−0.0190	−0.0125	−0.0625
	(0.0208)	(0.0142)	(0.1033)
3	0.0126	0.0134	0.0184
	(0.0137)	(0.0150)	(0.0307)
4	0.0203	0.0177	0.0457
	(0.0222)	(0.0199)	(0.0760)
5	0.0187	0.0137	0.0564
	(0.0203)	(0.0154)	(0.0933)
	Lerner Index[t-2]		
1	0.0000	0.0000	−0.0035
	(0.0001)	(0.0001)	(0.0024)
2	0.0000	0.0000	−0.0033
	(0.0000)	(0.0000)	(0.0024)
3	0.0000	0.0000	0.0011
	(0.0000)	(0.0000)	(0.0008)
4	0.0000	0.0000	0.0026
	(0.0000)	(0.0000)	(0.0018)
5	0.0000	0.0000	0.0031
	(0.0000)	(0.0000)	(0.0022)
	Full-time equivalent employment[t-2]		
1	0.0000	0.0000	0.0000
	(0.0000)	(0.0000)	(0.0000)
2	0.0000	0.0000	0.0000
	(0.0000)	(0.0000)	(0.0000)
3	0.0000	0.0000	0.0000
	(0.0000)	(0.0000)	(0.0000)
4	0.0000	0.0000	0.0000
	(0.0000)	(0.0000)	(0.0000)
5	0.0000	0.0000	0.0000
	(0.0000)	(0.0000)	(0.0000)
	ln(total industry turnover)[t-2]		
1	−0.0096	−0.0195	0.0178
	(0.0097)	(0.0119)	(0.0174)
2	−0.0056	−0.0076	0.0191
	(0.0057)	(0.0048)	(0.0185)
3	0.0037	0.0081	−0.0056
	(0.0038)	(0.0050)	(0.0054)
4	0.0060	0.0107	−0.0140
	(0.0061)	(0.0065)	(0.0135)
5	0.0055	0.0083	−0.0173
	(0.0056)	(0.0051)	(0.0171)

Table A3 (continued)

Independent Variable: Innovation Novelty	(1) All Industries dy/dx	(2) Non-MNF PST dy/dx	(3) MNF PST dy/dx
		ln(total industry profit)[t-2]	
1	0.0175**	0.0254***	−0.0045
	(0.0077)	(0.0091)	(0.0158)
2	0.0103**	0.0098**	−0.0048
	(0.0046)	(0.0039)	(0.0170)
3	−0.0068**	−0.0105***	0.0014
	(0.0030)	(0.0038)	(0.0050)
4	−0.0110**	−0.0139***	0.0035
	(0.0048)	(0.0050)	(0.0124)
5	−0.0101**	−0.0108***	0.0044
	(0.0044)	(0.0040)	(0.0154)
		Collaboration on innovation	
1	−0.0427***	−0.0452***	−0.0377***
	(0.0085)	(0.0106)	(0.0141)
2	−0.0250***	−0.0175***	−0.0406***
	(0.0057)	(0.0053)	(0.0152)
3	0.0165***	0.0187***	0.0120***
	(0.0035)	(0.0046)	(0.0047)
4	0.0267***	0.0247***	0.0297***
	(0.0056)	(0.0063)	(0.0111)
5	0.0245***	0.0192***	0.0367***
	(0.0051)	(0.0048)	(0.0135)
		Engineering skills used in core business activities	
1	0.0080	0.0027	0.0217
	(0.0107)	(0.0129)	(0.0193)
2	0.0047	0.0010	0.0234
	(0.0063)	(0.0050)	(0.0208)
3	−0.0031	−0.0011	−0.0069
	(0.0041)	(0.0053)	(0.0061)
4	−0.0050	−0.0015	−0.0171
	(0.0067)	(0.0070)	(0.0152)
5	−0.0046	−0.0011	−0.0211
	(0.0062)	(0.0055)	(0.0188)
		Science and research skills used in core business activities	
1	−0.0271***	−0.0330**	−0.0192
	(0.0103)	(0.0141)	(0.0148)
2	−0.0159***	−0.0128**	−0.0207
	(0.0062)	(0.0060)	(0.0159)
3	0.0105***	0.0137**	0.0061
	(0.0040)	(0.0059)	(0.0047)
4	0.0169***	0.0181**	0.0151
	(0.0064)	(0.0078)	(0.0115)
5	0.0156***	0.0140**	0.0187
	(0.0060)	(0.0062)	(0.0145)
		IT Professional skills used in core business activities	
1	−0.0137	−0.0144	−0.0144
	(0.0104)	(0.0126)	(0.0181)
2	−0.0080	−0.0056	−0.0155
	(0.0062)	(0.0049)	(0.0198)
3	0.0053	0.0060	0.0046
	(0.0040)	(0.0052)	(0.0058)
4	0.0086	0.0079	0.0113
	(0.0065)	(0.0069)	(0.0143)
5	0.0079	0.0061	0.0140
	(0.0060)	(0.0054)	(0.0177)

Table A3 (continued)

Independent Variable: Innovation Novelty	(1) All Industries dy/dx	(2) Non-MNF PST dy/dx	(3) MNF PST dy/dx
	IT technical support skills used in core business activities		
1	0.0090	0.0089	0.0099
	(0.0113)	(0.0134)	(0.0208)
2	0.0053	0.0035	0.0106
	(0.0066)	(0.0052)	(0.0225)
3	−0.0035	−0.0037	−0.0031
	(0.0044)	(0.0055)	(0.0067)
4	−0.0056	−0.0049	−0.0078
	(0.0070)	(0.0073)	(0.0164)
5	−0.0052	−0.0038	−0.0096
	(0.0065)	(0.0057)	(0.0203)
	Project management skills used in core business activities		
1	0.0032	0.0005	0.0045
	(0.0103)	(0.0118)	(0.0194)
2	0.0019	0.0002	0.0049
	(0.0060)	(0.0046)	(0.0210)
3	−0.0012	−0.0002	−0.0014
	(0.0040)	(0.0049)	(0.0062)
4	−0.0020	−0.0003	−0.0035
	(0.0064)	(0.0065)	(0.0153)
5	−0.0018	−0.0002	−0.0044
	(0.0059)	(0.0050)	(0.0190)
	Business management skills used in core business activities		
1	−0.0084	−0.0064	−0.0189
	(0.0105)	(0.0129)	(0.0184)
2	−0.0049	−0.0025	−0.0204
	(0.0062)	(0.0050)	(0.0199)
3	0.0033	0.0026	0.0060
	(0.0041)	(0.0054)	(0.0059)
4	0.0053	0.0035	0.0149
	(0.0066)	(0.0071)	(0.0146)
5	0.0048	0.0027	0.0184
	(0.0060)	(0.0055)	(0.0178)
		Firm age > 5 years	
1	0.0505*	0.0093	0.0817***
	(0.0289)	(0.0442)	(0.0159)
2	0.0660	0.0044	0.3167
	(0.0698)	(0.0247)	(0.1942)
3	−0.0236	−0.0040	−0.0154
	(0.0161)	(0.0198)	(0.0177)
4	−0.0436	−0.0054	−0.0952***
	(0.0348)	(0.0271)	(0.0139)
5	−0.0493	−0.0043	−0.2878
	(0.0479)	(0.0220)	(0.2175)
Year fixed effects	Y	Y	Y
Industry fixed effects	Y	Y	Y
Observations	3,002	2,165	837

Notes: Results reported from firms with more than 200 full-time employees in (1) all industries; (2) non-manufacturing and non-professional, scientific and technical services industries; and (3) manufacturing and professional, scientific and technical services industries only.
Novelty of innovation is categorised into 1 (no innovation), 2 (new to the business), 3 (new to the industry), 4 (new to Australia), 5 (new to the world).
*** indicates significance at the 1 per cent, ** 5 per cent and * 10 per cent level.
[t-2] indicates second lag of variable.

Source: BLADE 2019

Table A4: *Marginal effects from ordered probit regression of factors determining novelty of innovation–firms with less than 200 full-time employees, 2005-06 to 2015-16*

Independent Variable: Innovation Novelty	(1) All Industries dy/dx	(2) Non-MNF PST dy/dx	(3) MNF PST dy/dx
		ln(real turnover)[t-2]	
1	−0.0039	−0.0044	−0.0002
	(0.0071)	(0.0078)	(0.0163)
2	0.0023	0.0028	0.0001
	(0.0042)	(0.0050)	(0.0074)
3	0.0005	0.0005	0.0000
	(0.0009)	(0.0009)	(0.0022)
4	0.0006	0.0007	0.0000
	(0.0011)	(0.0012)	(0.0026)
5	0.0005	0.0004	0.0001
	(0.0009)	(0.0008)	(0.0041)
		ln(real capital expenditure)[t-2]	
1	0.0024	−0.0009	0.0136
	(0.0044)	(0.0050)	(0.0089)
2	−0.0014	0.0006	−0.0062
	(0.0026)	(0.0032)	(0.0043)
3	−0.0003	0.0001	−0.0019
	(0.0005)	(0.0006)	(0.0012)
4	−0.0004	0.0001	−0.0022
	(0.0007)	(0.0008)	(0.0015)
5	−0.0003	0.0001	−0.0034
	(0.0006)	(0.0005)	(0.0023)
		Exporting firm[t-2]	
1	−0.0501**	−0.0110	−0.1061***
	(0.0211)	(0.0254)	(0.0355)
2	0.0298**	0.0070	0.0482***
	(0.0126)	(0.0162)	(0.0177)
3	0.0060**	0.0013	0.0145**
	(0.0027)	(0.0029)	(0.0064)
4	0.0076**	0.0017	0.0168**
	(0.0033)	(0.0038)	(0.0068)
5	0.0066**	0.0011	0.0267**
	(0.0030)	(0.0025)	(0.0107)
		Goods and services innovation[t-2]	
1	−0.0571***	−0.0575***	−0.0163
	(0.0162)	(0.0188)	(0.0318)
2	0.0340***	0.0367***	0.0074
	(0.0099)	(0.0122)	(0.0145)
3	0.0069***	0.0066***	0.0022
	(0.0022)	(0.0024)	(0.0045)
4	0.0086***	0.0086***	0.0026
	(0.0027)	(0.0031)	(0.0050)
5	0.0076***	0.0056***	0.0041
	(0.0023)	(0.0020)	(0.0080)
		Firm undertook R&D[t-2]	
1	−0.0369*	−0.0316	−0.0273
	(0.0220)	(0.0260)	(0.0370)
2	0.0220*	0.0202	0.0124
	(0.0131)	(0.0167)	(0.0169)
3	0.0044*	0.0037	0.0037
	(0.0027)	(0.0031)	(0.0051)
4	0.0056*	0.0047	0.0043
	(0.0033)	(0.0039)	(0.0059)
5	0.0049	0.0031	0.0069
	(0.0031)	(0.0026)	(0.0096)

Table A4 (continued)

Independent Variable: Innovation Novelty	(1) All Industries dy/dx	(2) Non-MNF PST dy/dx	(3) MNF PST dy/dx
		Foreign ownership[t-2]	
1	0.0156	0.0027	0.0086
	(0.0303)	(0.0378)	(0.0430)
2	−0.0093	−0.0017	−0.0039
	(0.0181)	(0.0241)	(0.0194)
3	−0.0019	−0.0003	−0.0012
	(0.0037)	(0.0044)	(0.0059)
4	−0.0024	−0.0004	−0.0014
	(0.0046)	(0.0057)	(0.0067)
5	−0.0021	−0.0003	−0.0022
	(0.0040)	(0.0036)	(0.0109)
		Business focus on financial measures[t-2]	
1	−0.0409	−0.0440	0.0414
	(0.0489)	(0.0539)	(0.1194)
2	0.0243	0.0280	−0.0188
	(0.0291)	(0.0344)	(0.0543)
3	0.0049	0.0051	−0.0057
	(0.0059)	(0.0063)	(0.0164)
4	0.0062	0.0066	−0.0065
	(0.0075)	(0.0082)	(0.0190)
5	0.0054	0.0042	−0.0104
	(0.0066)	(0.0053)	(0.0300)
		Business focus on cost measures[t-2]	
1	0.0022	0.0046	−0.0017
	(0.0444)	(0.0530)	(0.0816)
2	−0.0013	−0.0029	0.0008
	(0.0265)	(0.0338)	(0.0370)
3	−0.0003	−0.0005	0.0002
	(0.0054)	(0.0061)	(0.0112)
4	−0.0003	−0.0007	0.0003
	(0.0067)	(0.0080)	(0.0129)
5	−0.0003	−0.0004	0.0004
	(0.0059)	(0.0051)	(0.0205)
		Business focus on operational measures[t-2]	
1	0.0097	−0.0155	0.1317
	(0.0324)	(0.0345)	(0.0855)
2	−0.0058	0.0099	−0.0598
	(0.0193)	(0.0219)	(0.0400)
3	−0.0012	0.0018	−0.0180
	(0.0039)	(0.0040)	(0.0127)
4	−0.0015	0.0023	−0.0208
	(0.0049)	(0.0052)	(0.0144)
5	−0.0013	0.0015	−0.0331
	(0.0043)	(0.0033)	(0.0227)
		Business focus on quality measures[t-2]	
1	−0.1034**	−0.0362	−0.3371***
	(0.0504)	(0.0545)	(0.0991)
2	0.0616**	0.0231	0.1530***
	(0.0300)	(0.0347)	(0.0501)
3	0.0125**	0.0042	0.0461**
	(0.0064)	(0.0064)	(0.0193)
4	0.0157**	0.0054	0.0533**
	(0.0080)	(0.0083)	(0.0216)
5	0.0137**	0.0035	0.0847***
	(0.0070)	(0.0053)	(0.0295)

Table A4 (continued)

Independent Variable: Innovation Novelty	(1) All Industries dy/dx	(2) Non-MNF PST dy/dx	(3) MNF PST dy/dx
	Business focus on innovation measures[t-2]		
1	−0.0872**	−0.0873**	−0.1250*
	(0.0353)	(0.0404)	(0.0702)
2	0.0519**	0.0557**	0.0567*
	(0.0213)	(0.0261)	(0.0327)
3	0.0105**	0.0101**	0.0171
	(0.0045)	(0.0049)	(0.0108)
4	0.0132**	0.0131**	0.0198
	(0.0055)	(0.0063)	(0.0125)
5	0.0116**	0.0084**	0.0314*
	(0.0050)	(0.0042)	(0.0188)
	Business focus on human resource measures[t-2]		
1	0.0562	0.0206	0.2385**
	(0.0414)	(0.0420)	(0.0989)
2	−0.0335	−0.0131	−0.1082**
	(0.0247)	(0.0268)	(0.0481)
3	−0.0068	−0.0024	−0.0326**
	(0.0051)	(0.0049)	(0.0163)
4	−0.0085	−0.0031	−0.0377*
	(0.0064)	(0.0063)	(0.0200)
5	−0.0075	−0.0020	−0.0599**
	(0.0055)	(0.0041)	(0.0258)
	Lerner Index[t-2]		
1	−0.0014*	−0.0010	−0.0161***
	(0.0008)	(0.0009)	(0.0057)
2	0.0010*	0.0008	0.0084**
	(0.0005)	(0.0006)	(0.0040)
3	0.0001	0.0001	0.0023**
	(0.0001)	(0.0001)	(0.0011)
4	0.0002	0.0001	0.0026**
	(0.0001)	(0.0001)	(0.0012)
5	0.0001	0.0000	0.0028
	(0.0001)	(0.0001)	(0.0023)
	Full-time equivalent employment[t-2]		
1	−0.0002	−0.0001	−0.0004
	(0.0001)	(0.0001)	(0.0003)
2	0.0001	0.0001	0.0002
	(0.0001)	(0.0001)	(0.0001)
3	0.0000*	0.0000	0.0001
	(0.0000)	(0.0000)	(0.0000)
4	0.0000*	0.0000	0.0001
	(0.0000)	(0.0000)	(0.0000)
5	0.0000*	0.0000	0.0001
	(0.0000)	(0.0000)	(0.0001)
	ln(total industry turnover)[t-2]		
1	0.0245	0.0033	0.0139
	(0.0206)	(0.0271)	(0.0297)
2	−0.0146	−0.0021	−0.0063
	(0.0123)	(0.0173)	(0.0136)
3	−0.0030	−0.0004	−0.0019
	(0.0025)	(0.0031)	(0.0040)
4	−0.0037	−0.0005	−0.0022
	(0.0031)	(0.0041)	(0.0048)
5	−0.0032	−0.0003	−0.0035
	(0.0028)	(0.0026)	(0.0075)

Table A4 (continued)

Independent Variable: Innovation Novelty	(1) All Industries dy/dx	(2) Non-MNF PST dy/dx	(3) MNF PST dy/dx
		ln(total industry profit)[t-2]	
1	−0.0046	−0.0050	0.0692**
	(0.0173)	(0.0216)	(0.0327)
2	0.0027	0.0032	−0.0314**
	(0.0103)	(0.0138)	(0.0154)
3	0.0006	0.0006	−0.0095*
	(0.0021)	(0.0025)	(0.0054)
4	0.0007	0.0007	−0.0109*
	(0.0026)	(0.0032)	(0.0058)
5	0.0006	0.0005	−0.0174*
	(0.0023)	(0.0021)	(0.0090)
		Collaboration on innovation	
1	−0.1459***	−0.1611***	−0.1193***
	(0.0188)	(0.0230)	(0.0325)
2	0.0868***	0.1027***	0.0542***
	(0.0126)	(0.0163)	(0.0186)
3	0.0176***	0.0186***	0.0163***
	(0.0033)	(0.0039)	(0.0057)
4	0.0221***	0.0242***	0.0189**
	(0.0040)	(0.0048)	(0.0075)
5	0.0193***	0.0156***	0.0300***
	(0.0034)	(0.0035)	(0.0087)
		Engineering skills used in core business activities	
1	−0.0206	−0.0260	−0.0007
	(0.0214)	(0.0265)	(0.0342)
2	0.0123	0.0166	0.0003
	(0.0127)	(0.0169)	(0.0155)
3	0.0025	0.0030	0.0001
	(0.0026)	(0.0031)	(0.0047)
4	0.0031	0.0039	0.0001
	(0.0033)	(0.0040)	(0.0054)
5	0.0027	0.0025	0.0002
	(0.0029)	(0.0026)	(0.0086)
		Science and research skills used in core business activities	
1	−0.0711**	−0.0801*	−0.0604
	(0.0319)	(0.0440)	(0.0452)
2	0.0423**	0.0511*	0.0274
	(0.0189)	(0.0280)	(0.0205)
3	0.0086**	0.0092*	0.0083
	(0.0041)	(0.0054)	(0.0067)
4	0.0108**	0.0120*	0.0096
	(0.0049)	(0.0067)	(0.0076)
5	0.0094**	0.0077	0.0152
	(0.0046)	(0.0047)	(0.0121)
		IT Professional skills used in core business activities	
1	−0.0448**	−0.0605***	0.0052
	(0.0183)	(0.0208)	(0.0366)
2	0.0266**	0.0386***	−0.0024
	(0.0109)	(0.0134)	(0.0166)
3	0.0054**	0.0070***	−0.0007
	(0.0023)	(0.0026)	(0.0050)
4	0.0068**	0.0091***	−0.0008
	(0.0029)	(0.0034)	(0.0058)
5	0.0059**	0.0058**	−0.0013
	(0.0026)	(0.0023)	(0.0092)

Table A4 (continued)

Independent Variable: Innovation Novelty	(1) All Industries dy/dx	(2) Non-MNF PST dy/dx	(3) MNF PST dy/dx
	IT technical support skills used in core business activities		
1	−0.0084	0.0032	−0.0419
	(0.0176)	(0.0205)	(0.0347)
2	0.0050	−0.0020	0.0190
	(0.0105)	(0.0131)	(0.0162)
3	0.0010	−0.0004	0.0057
	(0.0021)	(0.0024)	(0.0050)
4	0.0013	−0.0005	0.0066
	(0.0027)	(0.0031)	(0.0059)
5	0.0011	−0.0003	0.0105
	(0.0023)	(0.0020)	(0.0086)
	Project management skills used in core business activities		
1	−0.0487**	−0.0352	−0.0556
	(0.0208)	(0.0246)	(0.0394)
2	0.0290**	0.0225	0.0253
	(0.0125)	(0.0157)	(0.0185)
3	0.0059**	0.0041	0.0076
	(0.0026)	(0.0029)	(0.0057)
4	0.0074**	0.0053	0.0088
	(0.0033)	(0.0038)	(0.0066)
5	0.0065**	0.0034	0.0140
	(0.0029)	(0.0025)	(0.0102)
	Business management skills used in core business activities		
1	−0.0640***	−0.0577***	−0.0760**
	(0.0174)	(0.0201)	(0.0346)
2	0.0381***	0.0368***	0.0345**
	(0.0106)	(0.0130)	(0.0169)
3	0.0077***	0.0067***	0.0104*
	(0.0024)	(0.0026)	(0.0057)
4	0.0097***	0.0087***	0.0120**
	(0.0029)	(0.0033)	(0.0061)
5	0.0085***	0.0056***	0.0191**
	(0.0025)	(0.0022)	(0.0092)
		Firm age > 5 years	
1	0.0031	0.0063	−0.0009
	(0.0243)	(0.0280)	(0.0461)
2	−0.0019	−0.0040	0.0004
	(0.0143)	(0.0175)	(0.0211)
3	−0.0004	−0.0007	0.0001
	(0.0030)	(0.0033)	(0.0063)
4	−0.0005	−0.0010	0.0001
	(0.0037)	(0.0044)	(0.0073)
5	−0.0004	−0.0006	0.0002
	(0.0033)	(0.0028)	(0.0115)
Year fixed effects	Y	Y	Y
Industry fixed effects	Y	Y	Y
Observations	1,906	1,494	412

Notes: Results reported from firms with less than 200 FTE in (1) all industries; (2) non-manufacturing and non-professional, scientific and technical services industries; and (3) manufacturing and professional, scientific and technical services industries only.
Novelty of innovation is categorised into 1 (no innovation), 2 (new to the business), 3 (new to the industry), 4 (new to Australia), 5 (new to the world).
*** indicates significance at the 1 per cent, ** 5 per cent and * 10 per cent level.
[t-2] indicates second lag of variable.

Source: BLADE 2019

Table A5: *Coefficient estimates from ordered probit regression of factors determining novelty of innovation–all firms, 2005-06 to 2015-16*

Independent Variable: Innovation Novelty	(1) All Industries	(2) Non-MNF PST	(3) MNF PST
ln(real turnover)[t-2]	0.0655*** (0.0149)	0.0625*** (0.0176)	0.0856*** (0.0319)
ln(real capital expenditure)[t-2]	−0.0066 (0.0110)	0.0007 (0.0127)	−0.0304 (0.0227)
Exporting firm[t-2]	0.0637 (0.0435)	0.0182 (0.0512)	0.166** (0.0863)
Goods and services innovation[t-2]	0.286*** (0.0370)	0.283*** (0.0435)	0.278*** (0.0731)
Firm undertook R&D[t-2]	0.173*** (0.0439)	0.147*** (0.0545)	0.194*** (0.0741)
Foreign ownership[t-2]	0.151*** (0.0460)	0.169*** (0.0561)	0.119 (0.0800)
Business focus on financial measures[t-2]	0.188 (0.165)	0.198 (0.183)	−0.0584 (0.426)
Business focus on cost measures[t-2]	−0.0338 (0.132)	−0.0682 (0.157)	0.0120 (0.248)
Business focus on operational measures[t-2]	−0.0417 (0.0973)	0.0269 (0.104)	−0.361 (0.294)
Business focus on quality measures[t-2]	0.199 (0.144)	−0.0072 (0.158)	0.973*** (0.271)
Business focus on innovation measures[t-2]	0.206** (0.0893)	0.226** (0.0985)	0.135 (0.232)
Business focus on human resource measures[t-2]	0.0002 (0.122)	0.0894 (0.123)	−0.284 (0.359)
Lerner Index	−0.0001 (0.0005)	−0.0000 (0.0005)	0.0485** (0.0202)
(Lerner Index)^2	0.0000 (0.0000)	0.0000 (0.0000)	−0.0010* (0.0006)

Table A5 (continued): *Coefficient estimates from ordered probit regression of factors determining novelty of innovation–all firms, 2005-06 to 2015-16*

Independent Variable: Innovation Novelty	(1) All Industries	(2) Non-MNF PST	(3) MNF PST
Full-time equivalent employment (FTE) [t-2]	0.0000 (0.0000)	0.0000 (0.0000)	0.0000 (0.0000)
Lerner Index × FTE	0.0000 (0.0000)	−0.0000 (0.0000)	−0.0000 (0.0000)
(Lerner Index)^2× FTE	. (.)	. (.)	0.0000 (0.0000)
ln(total industry turnover)[t-2]	0.0208 (0.0457)	0.0961* (0.0555)	−0.112 (0.0831)
ln(total industry profit)[t-2]	−0.0754** (0.0371)	−0.108** (0.0432)	−0.0417 (0.0793)
Collaboration on innovation	0.341*** (0.0418)	0.371*** (0.0498)	0.296*** (0.0775)
Engineering skills used in core business	0.0108 (0.0492)	0.0189 (0.0586)	−0.0428 (0.0913)
Science and research skills used in core business	0.142*** (0.0546)	0.173** (0.0743)	0.104 (0.0831)
IT Professional skills used in core business	0.131*** (0.0453)	0.162*** (0.0520)	0.0696 (0.0912)
IT technical support skills used in core business	−0.0335 (0.0461)	−0.0502 (0.0530)	0.0204 (0.0965)
Project management skills used in core business activities	0.0373 (0.0477)	0.0326 (0.0538)	0.0344 (0.100)
Business management skills used in core business activities	0.138*** (0.0442)	0.124** (0.0515)	0.18** (0.0885)
Firm age > 5 years	−0.0701 (0.0806)	−0.0666 (0.0878)	−0.133 (0.184)
Year fixed effects	Y	Y	Y
Industry fixed effects	Y	Y	Y
Observations	4,908	3,659	1,249

Notes: See Table 4 for marginal effects.
Results reported from firms in (1) all industries; (2) non-manufacturing and non-professional, scientific and technical services industries; and (3) manufacturing and professional, scientific and technical services industries only.
Novelty of innovation is categorised into 1 (no innovation), 2 (new to the business), 3 (new to the industry), 4 (new to Australia), 5 (new to the world).
*** indicates significance at the 1 per cent, ** 5 per cent and * 10 per cent level.
[t-2] indicates second lag of variable

Source: BLADE 2019

Table A6: *Coefficient estimates from ordered probit regression of factors determining novelty of innovation–firms with 200 or more full-time employees, 2005-06 to 2015-16*

Independent Variable: Innovation Novelty	(1) All Industries	(2) Non-MNF PST	(3) MNF PST
ln(real turnover)[t-2]	0.0407*	0.0586**	−0.0124
	(0.0238)	(0.0281)	(0.0561)
ln(real capital expenditure)[t-2]	−0.0201	−0.0164	−0.0329
	(0.0158)	(0.0188)	(0.0304)
Exporting firm[t-2]	−0.00608	−0.0118	0.0189
	(0.0541)	(0.0636)	(0.107)
Goods and services innovation[t-2]	0.323***	0.319***	0.324***
	(0.0477)	(0.0573)	(0.0891)
Firm undertook R&D[t-2]	0.158***	0.150**	0.156*
	(0.0528)	(0.0683)	(0.0839)
Foreign ownership[t-2]	0.155***	0.166***	0.171**
	(0.0500)	(0.0625)	(0.0844)
Business focus on financial measures[t-2]	−0.0206	−0.0693	.
	(0.543)	(0.579)	(.)
Business focus on cost measures[t-2]	−0.349	−0.454*	0.427**
	(0.241)	(0.254)	(0.215)
Business focus on operational measures[t-2]	−0.0555	0.0110	−0.708
	(0.174)	(0.187)	(0.605)
Business focus on quality measures[t-2]	0.0928	−0.0768	0.726**
	(0.207)	(0.228)	(0.325)
Business focus on innovation measures[t-2]	0.0805	0.120	−0.103
	(0.123)	(0.134)	(0.356)
Business focus on human resource measures[t-2]	0.196	0.190	0.378
	(0.213)	(0.212)	(0.627)
Lerner Index	−0.0002	−0.0002	0.0453*
	(0.0005)	(0.0006)	(0.0256)
(Lerner Index)^2	0.0000	0.0000	−0.0007
	(0.0000)	(0.0000)	(0.0008)

Table A6 (continued): *Coefficient estimates from ordered probit regression of factors determining novelty of innovation–firms with 200 or more full-time employees, 2005-06 to 2015-16*

Independent Variable: Innovation Novelty	(1) All Industries	(2) Non-MNF PST	(3) MNF PST
Full-time equivalent employment (FTE) [t-2]	0.0000	0.0000	0.0010
	(0.0000)	(0.0000)	(0.0007)
Lerner Index × FTE	−0.0000	−0.0000	−0.0002
	(0.0000)	(0.0000)	(0.0001)
(Lerner Index)^2× FTE	.	.	0.0000
	(.)	(.)	(0.0000)
ln(total industry turnover)[t-2]	0.0578	0.115	−0.116
	(0.0585)	(0.0697)	(0.112)
ln(total industry profit)[t-2]	−0.106**	−0.149***	0.0293
	(0.0461)	(0.0529)	(0.103)
Collaboration on innovation	0.257***	0.265***	0.246***
	(0.0516)	(0.0625)	(0.0906)
Engineering skills used in core business	−0.0480	−0.0156	−0.141
	(0.0645)	(0.0754)	(0.125)
Science and research skills used in core business	0.163***	0.194**	0.125
	(0.0619)	(0.0830)	(0.0958)
IT Professional skills used in core business	0.0827	0.0842	0.0936
	(0.0626)	(0.0737)	(0.118)
IT technical support skills used in core business	−0.0544	−0.0524	−0.0644
	(0.0680)	(0.0784)	(0.136)
Project management skills used in core business activities	−0.0191	−0.00277	−0.0294
	(0.0619)	(0.0694)	(0.127)
Business management skills used in core business activities	0.0509	0.0374	0.123
	(0.0636)	(0.0760)	(0.120)
Firm age > 5 years	−0.388	−0.0564	−1.103*
	(0.295)	(0.277)	(0.608)
Year fixed effects	Y	Y	Y
Industry fixed effects	Y	Y	Y
Observations	3,002	2,165	837

Notes: See Table A3 for marginal effects.
Results reported from all firms with 200 or more full-time employees in (1) all industries; (2) non-manufacturing and non-professional, scientific and technical services industries; and (3) manufacturing and professional, scientific and technical services industries only.
Novelty of innovation is categorised into 1 (no innovation), 2 (new to the business), 3 (new to the industry), 4 (new to Australia), 5 (new to the world).
*** indicates significance at the 1 per cent, ** 5 per cent and * 10 per cent level.
[t-2] indicates second lag of variable

Source: BLADE 2019

Table A7: *Coefficient estimates from ordered probit regression of factors determining novelty of innovation–firms with less than 200 full-time employees, 2005-06 to 2015-16*

Independent Variable: Innovation Novelty	(1) All Industries	(2) Non-MNF PST	(3) MNF PST
ln(real turnover)[t-2]	0.0147	0.0160	0.0009
	(0.0264)	(0.0287)	(0.0699)
ln(real capital expenditure)[t-2]	−0.0090	0.0035	−0.0584
	(0.0164)	(0.0183)	(0.0377)
Exporting firm[t-2]	0.187**	0.0403	0.454***
	(0.0790)	(0.0930)	(0.154)
Goods and services innovation[t-2]	0.213***	0.211***	0.0698
	(0.0608)	(0.0692)	(0.136)
Firm undertook R&D[t-2]	0.138*	0.116	0.117
	(0.0821)	(0.0953)	(0.159)
Foreign ownership[t-2]	−0.0585	−0.0098	−0.0369
	(0.113)	(0.138)	(0.184)
Business focus on financial measures[t-2]	0.153	0.161	−0.177
	(0.183)	(0.198)	(0.511)
Business focus on cost measures[t-2]	−0.0083	−0.0168	0.0074
	(0.166)	(0.194)	(0.349)
Business focus on operational measures[t-2]	−0.0363	0.0568	−0.563
	(0.121)	(0.126)	(0.366)
Business focus on quality measures[t-2]	0.387**	0.132	1.442***
	(0.189)	(0.200)	(0.431)
Business focus on innovation measures[t-2]	0.326**	0.320**	0.535*
	(0.132)	(0.149)	(0.302)
Business focus on human resource measures[t-2]	−0.210	−0.0754	−1.020**
	(0.155)	(0.154)	(0.422)
Lerner Index	0.0069*	0.0053	0.137***
	(0.0036)	(0.0038)	(0.0485)
(Lerner Index)^2	−0.0002	−0.0002	−0.0036**
	(0.0002)	(1.0.0002)	(0.00140)

Table A7 (continued): *Coefficient estimates from ordered probit regression of factors determining novelty of innovation–firms with less than 200 full-time employees, 2005-06 to 2015-16*

Independent Variable: Innovation Novelty	(1) All Industries	(2) Non-MNF PST	(3) MNF PST
Full-time equivalent employment (FTE) [t-2]	0.0009**	0.0007**	0.0036
	(0.0004)	(0.0003)	(0.0024)
Lerner Index × FTE	−0.0004*	−0.0004*	−0.0006
	(0.0002)	(0.0002)	(0.0006)
(Lerner Index)^2× FTE	0.0000	0.0000	0.0000
	(0.0000)	(0.0000)	(0.0000)
ln(total industry turnover)[t-2]	−0.0915	−0.0120	−0.0595
	(0.0768)	(0.0993)	(0.127)
ln(total industry profit)[t-2]	0.0172	0.0182	−0.296**
	(0.0646)	(0.0791)	(0.142)
Collaboration on innovation	0.545***	0.590***	0.510***
	(0.0697)	(0.0838)	(0.135)
Engineering skills used in core business	0.0770	0.0955	0.00317
	(0.0800)	(0.0972)	(0.146)
Science and research skills used in core business	0.266**	0.293*	0.259
	(0.120)	(0.162)	(0.196)
IT Professional skills used in core business	0.167**	0.222***	−0.0222
	(0.0687)	(0.0765)	(0.157)
IT technical support skills used in core business	0.0315	−0.0116	0.179
	(0.0656)	(0.0751)	(0.147)
Project management skills used in core business activities	0.182**	0.129	0.238
	(0.0779)	(0.0902)	(0.169)
Business management skills used in core business activities	0.239***	0.212***	0.325**
	(0.0653)	(0.0736)	(0.150)
Firm age > 5 years	−0.0118	−0.0233	0.00398
	(0.0915)	(0.104)	(0.197)
Year fixed effects	Y	Y	Y
Industry fixed effects	Y	Y	Y
Observations	1,906	1,494	412

Notes: See Table A4 for marginal effects.
Results reported from all firms with less than 200 full-time employees in (1) all industries; (2) non-manufacturing and non-professional, scientific and technical services industries; and (3) manufacturing and professional, scientific and technical services industries only.
Novelty of innovation is categorised into 1 (no innovation), 2 (new to the business), 3 (new to the industry), 4 (new to Australia), 5 (new to the world).
*** indicates significance at the 1 per cent, ** 5 per cent and * 10 per cent level.
[t-2] indicates second lag of variable

Source: BLADE 2019