INNOVATION IN MANUFACTURED FOOD AND INFANT FORMULA SECTORS

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Executive summary

The OECD (2005, p.46) defines innovation as 'the implementation of a new or significantly improved product (good or service), or process, a new marketing method, or a new organisational method in business practices, workplace organisation or external relations'.

Innovation is important for the success of individual firms in creating and maintaining market share. However, as each innovation proliferates through the market they lose their profit generation ability; firms must continue to innovate to maintain competitiveness.

The ultimate beneficiaries of innovation are consumers. If ideas and innovation were frozen at circa 1800, there would be no electricity, plumbing and sanitation, aeroplanes, birth control, antibiotics, TV or the Internet. Not only is our lifestyle enhanced through purchase of these more desirable products; we are often able to purchase these superior products with comparatively less work inputs than our forebears. Innovations that create new products and improve worker productivity have made us considerably wealthier than our ancestors.

Today this means that our well-being will fall below potential if we fail to innovate and exploit the best new ideas.

Expanding exports is also a key Government strategy to growing the wealth of Australia and New Zealand. Encouraging innovative businesses environments in Australia and New Zealand is critical to being competitive in the world market.

The infant formula industry represents the premium and research-intensive extreme of the processed food industry and is a prime example of continued innovation improving the standard of living of citizens by closing the health and development gap between breast fed and infant formula fed infants. According to infant formula industry representatives, new ingredients requiring regulatory approval appear every 12-20 months. Europe and the USA consider this industry a national priority and have considerably faster regulatory systems than New Zealand and Australia. In order to remain competitive in the international infant formula market, Australia New Zealand must foster an innovative industry.

Our simulations of exports from the Australian dairy industry reveal that a one standard deviation fall in innovation is associated with a A$27.5 million decline in dairy exports which equates to approximately 1.4 percent of annual dairy exports in Australia. If the magnitude is similar in New Zealand, we would expect New Zealand annual dairy exports to fall by NZ$234.6 million a year.

New Zealand and Australia infant formula firms have positioned themselves well to take advantage of major importing markets, especially China (including Hong Kong), Vietnam, and South Korea. Most of the companies interviewed for this report claimed that over 90% of their infant formula was exported.

Contents

1. Introduction

This report explores some of the economic benefits of an innovative manufactured food sector.

The report has been commissioned by Food Standards Australia New Zealand (FSANZ) to build understanding of the importance of product innovation to achieving an efficient and internationally competitive food industry, and how this supports Australian and New Zealand's exports.

The OECD (2005, p.46) defines innovation as 'the implementation of a new or significantly improved product (good or service), or process, a new marketing method, or a new organisational method in business practices, workplace organisation or external relations'.

Innovations have led to significant improvements in the lives of humans as a collective. This has been through the creation of more desirable products and an increase in the purchasing power of consumers in capitalist societies.

At the individual firm level, innovation plays an important role in obtaining and maintaining market share. Australia and New Zealand are also focused on increasing exports to attract new income to their economies and grow the wealth of their citizens. Encouraging an innovative food sector will enable Australia and New Zealand to compete on the world stage.

Although strict regulatory regimes are an important protectant of consumers, they should not be overly restrictive such that it limits the innovation of safe and suitable ideas. We consider infant formula to demonstrate the tension between regulation and innovation.

The report is structured as follows. Chapter two considers of the role of innovation for firm's performance. Innovation can be either for the creation of new products or for driving down production costs for businesses that wish to stay in the growth phase of the business lifecycle; although innovation does come with business risk. Chapter three turns to the importance of innovation to build the wealth of nations; innovations are shown to improve the standard of living for citizens through two mechanisms being the creation of more desirable products and by increasing citizens' purchasing power. Chapter four outlines the role of innovation to driving exports. Chapter five depicts simulations of the cost of falling behind the innovation frontier. Two Case studies of the manufactured food industry and the Australia and New Zealand infant formula products are then outlined.

2. The role of innovation in driving firm performance

In competitive markets where businesses compete for market share on either lower prices or by producing a more desirable product, innovation is the key factor to maintaining or obtaining market share in the longer term. Innovation may either be improvements to product line-ups or the production process.

Firm growth cannot be sustained through investments in the other factors of productivity as they run up against diminishing returns (Solow 1956). This means that holding technology or knowledge constant, investments in physical capital, such as plant and equipment, are subject to returns which eventually diminish to zero. Even investment in marketing and workforce training is also subject to diminishing returns. A firm cannot keep cutting prices without making production methods more efficient and there is little point in forever increasing staff training and marketing if products and production methods are static.

The ability of people to generate new ideas is endless. Over the long run, businesses must change their product line-up or mode of production to remain competitive. Similarly, these things are requisite for sustained increase in output per worker over time, which is linked to incomes. Investment in new products, new knowledge and new processes are required to arrest the decline in returns from investments in tangible capital, education and training. The process by which knowledge is converted

to productivity is called 'innovation'.[1] More successful innovation leads to improvements in productivity. A productive firm can afford to pay its staff more, reduce prices, and overcome the financial barriers to be able to export as we demonstrate later.

In many ways, innovation is at the core of the transformation process since—almost by definition—it is *the* way firms metamorphosise to compete with rivals. To the extent that it is positively correlated with profitability, those firms that are not innovative are more likely to wither and die. For Australian studies see Bickerdyke, Lattimore and Madge (2000), Parham (2002); Breunig and Wong (2007); Jensen, Webster and Buddelmeyer (2008); Buddelmeyer, Jensen and Webster (2010). There is also a considerable body of evidence on what makes some firms more productive than others (see Bartelsman and Doms 2000; Bloom and Van Reenen 2010; Dedrick and Kraemer 2015; Lane and Lubatkin 1998; Lichtenberg and Siegel 1991; Parham 2002)

The threat of competition induces firms to develop, that is, to make decisions about investment in innovation, advertising, brands and skill development. There is strong evidence that current productivity is an important selection filter: the literature consistently finds a positive relationship between survival and proxy variables for current productivity, such as business age and size (for example, see Dunne, Roberts and Samuelson 1988; Geroski 1995; Audretsch and Mahmood 1995; Mata, Portugal and Guimaraes 1995; Agarwal and Gort 1996; Segarra and Callejon 2002; Thompson 2005; Klepper and Thompson 2007).

The finding of a strong positive correlation between innovation and subsequent firm productivity is common but not universal. Janz, Loof and Peters (2004), Crepon, Dugent and Mairesse (1998), Loof and Heshmati (2006), Van Leeuwena and Klompb (2006), Huergo and Jaumandreu (2004) and Cainelli, Evangelista and Savona (2006) all find a positive lagged effect of innovation on productivity. However, other studies such as Griffith et al. (2006) find mixed effects.

To the extent this effect holds for nascent firms, there is some evidence that some innovators move from being potential stars to superstars. Cefis and Marsili (2005) find evidence of an innovation premium—the increase in survival time due to successful innovation—of approximately 11 per cent. However, other studies were less sanguine finding either no relationship between innovative activity and survival or a negative one (see Audretsch and Mahmood 1995; Segarra and Callejon 2002; Buddelmeyer, Jensen and Webster 2010). Audretsch (1991), Cockburn and Wagner (2006) and Bayus and Agarwal (2006) found that positive effects of innovative activity were only achieved for small (new) firms or were conditional on the maturity of the technology. Thus, the relationship between innovation and survival is complex: ultimately, some firms may successfully innovate and become superstars, while others will be less successful and perhaps move into the 'deficient' quadrant (from where exit is most likely).

So, what do we know from these studies? Beyond case studies, anecdotes and quantitative analysis on small ad hoc and biased datasets, the stylised facts are that R&D and innovation do result, on average, in higher productivity. There is a large volume of evidence at the country, industry and firm level to support this (See the reviews by Cohen 2010 and Hall, Mairesse and Mohnen 2010).

3. The role of innovation in creating national wealth[2]

[1] The OECD (2005, p.46) defines innovation as 'the implementation of a new or significantly improved product (good or service), or process, a new marketing method, or a new organisational method in business practices, workplace organisation or external relations'.

[2] This and the next section includes extracts from Webster (2017); Palangkaraya and Webster (2015); Palangkaraya, Spurling, and Webster (2016).

Successful new-to-the-world and new-to-the-firm innovations are one of the key outputs from societies that have well-developed social, institutional and intangible capital.[3] Successful new-to-the-world innovations are the standard bearer that all others follow. As competitors emulate—via new-to-the-firm innovation—productivity improvements spread, prices fall, and profits are eroded. While innovations may assist firms to obtain market share in short to medium term, continual innovations are needed to maintain competitiveness. The ultimate beneficiary of innovation is the consumer, who can buy either a larger or superior bundle of goods and services for a given hour of labour. These represent the perpetual gains to the standard of living of all parties other than the originator of an idea and his or her immediate consumers. That is, much of the benefit from product innovation is only captured by the business in the short term. Over the longer run, the beneficiary is the consumer.

In developed countries, we work in relatively comfortable jobs in safe surrounds, yet somehow contribute to an economy that provides goods, services and life comforts that are beyond the imagination of even our recent ancestors. We consume complex and varied foods – on demand; we have more clothes than we could possibly wear out in a year; we have entertainments and sophisticated pleasure goods that would have been unimaginable to even our grandparents. We look forward to a long life and expect all our children to reach adulthood and reproduce.

On most measures, albeit subjective, our jobs are easier and more pleasant than the typical job at any point in history. Our ancestors worked considerably harder than most of us, but had limited food, clothing and shelter – often within the envelope of a short and painful life.

So how do we account for the difference? It's not capital accumulation. Capital goods are a mere re-arrangement of natural resources. The amount of matter in the world is the same now as it always has been – it is just that we have moved and re-assembled some of it into manufactured items. If we think about the world being one large integrated business, then plant, equipment and infrastructure are just intermediate inputs.

Knowledge, combined with our acts of labour, accounts for the difference between our lifestyle today and the lifestyles experienced at any point in the past. As pointed out by Francis Bacon nearly half a millennium ago, man (sic) does not create material things, he only creates ideas. Knowledge is the only original factor of production that truly accumulates and is therefore the only factor that can cause a continual growth in output per worker.

The mention of knowledge immediately turns the spotlight on education and formal skill acquisition. It would be hard to argue that education and training do not matter. A correlation between years of education and productivity (or income) is a well-established stylised fact in both country and person-level studies. However, formal skill acquisition or years of education only explain a small part of the gap in incomes or productivity. As aptly shown by Ricardo Hausmann,[4] it is not the full story.

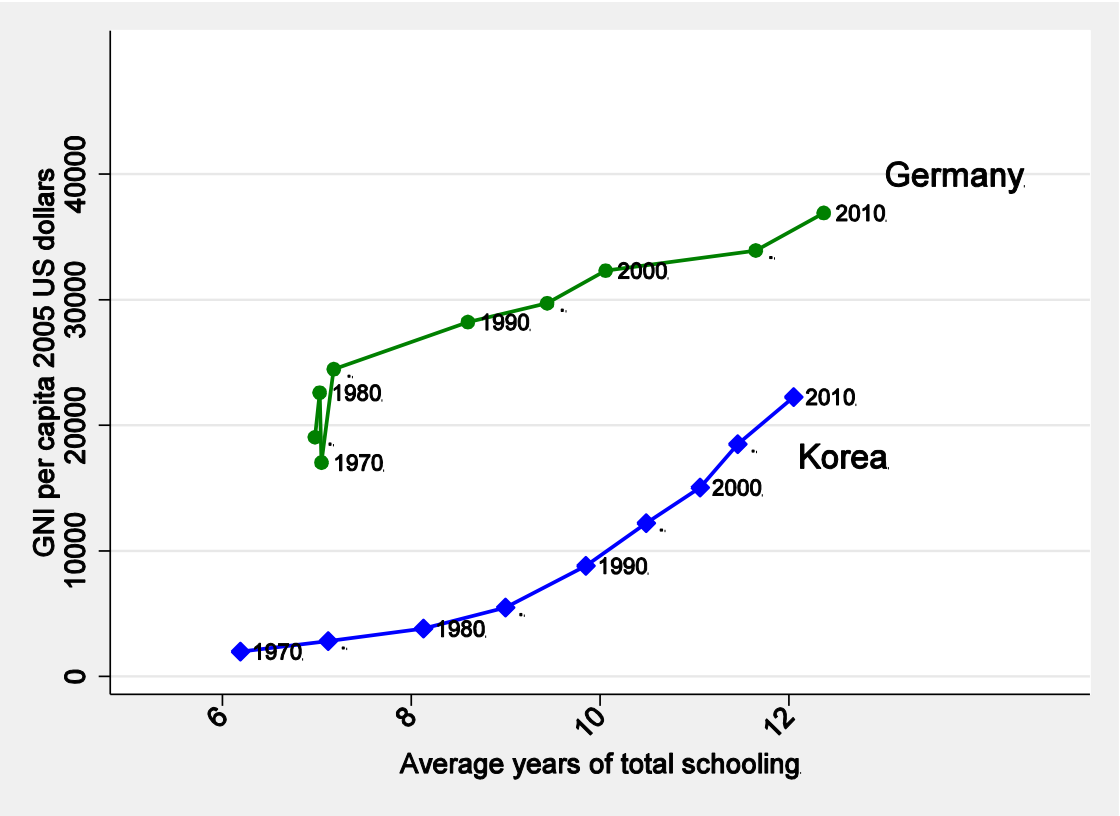
For illustrative purposes we present, in Figure 1, two countries, South Korea and Germany, with approximately the same population, geographic size and endowment of natural resources. It shows that at every level of average schooling, German Gross National Income is considerably above that for South Korea. In the 1970s and 1980s, not shown in Figure 1, Germany had more (tangible) capital

[3] New-to-the-world innovations represent the frontiers of science and novelty but their expected successes are both highly uncertain and highly rewarding. New-to-the-firm innovations, on the other hand, are less risky and largely involve imitation and copying. New-to-the-firm changes are more pervasive than the new-to-the-world varieties.

[4] https://www.youtube.com/watch?v=F3qd-A1acGU.

stock, that is plant, equipment and infrastructure, per capita than South Korea and this may account for some of the gap. But by 2010, the stock was about $100,000 (2005 US prices) per person in both countries.[5] Yet the gap in per capita income is still large.

Gross National Income (GNI) per capita and Average years of total schooling, Germany and Korea, 1970 to 2010



What explains this productivity gap? Different disciplines have their own nomenclature for it and it is variously called culture (trust, rule of law), learning-by-doing, the ability to innovate, know-how or collective know-how, R&D, institutions, systems, networks and intangible capital. The central theme is that an economy or society is more than just the sum of its parts. There is something between organisations and people that make single units more (or less) productive. Some economies have it and others don't (Syverson 2011; Thompson 2007; Shearmur and Doloreux 2013; Sahal 1983; Rosenberg 1979; Palangkaraya, Stierwald and Yong 2009; Nelson 1995; Miguélez and Moreno 2015; Lederman and Maloney 2003; Lichtenberg 1992; Jones and Williams 1998; Kendrick 1972; Frantzen 2000; Fagerberg and Godinho 2005; Della Malva and Carree 2013; Coe and Helpman 1995; Bresnahan and Trajtenberg 1995; Whitehead 1925).

It is easy to see how our lifestyle would have been curtailed if ideas and the development of new products were frozen at circa 1800. There would be no electricity, plumbing and sanitation, aeroplanes, birth control, antibiotics, TV or the Internet. We could keep educating our citizens and training our workforce, but there is a limit to how far this will take us without new ideas to carry us

[5] Sources: World Bank national accounts data, and OECD National Accounts data files. GNI per capita is gross national income divided by midyear population. Barro-Lee: Average years of total schooling, age 15+, total Robert J. Barro and Jong-Wha Lee: http://www.barrolee.com/. Federal Reserve Economic Data. Capital Stock at Constant National Prices for Germany, Korea, Millions of 2005 U.S. Dollars, Annual, Link: https://research.stlouisfed.org/fred2.

forward. Ultimately, people would have to curtail the time spent in education in order to participate in the production process. We could keep improving coordination, information sharing and economic incentives within the economy, but without new ways to make these operate efficiently, there is a limit to the additional productivity gains we can achieve. We will end up with beautifully efficient horse transport, wooden ships and craft manufactures. We can keep building more infrastructure and adding more physical equipment, but it is very easy to see that the value of another road, bridge, dam and building quickly hits diminishing and then zero returns. We are richer now in terms of the lifestyle we can purchase, and often, from less working hours.

Having better or cheaper products allows a nation is to expand exports thus bringing new income into the country. There are several current Australian and New Zealand Government strategies to grow food and agricultural exports. Without increasing productivity and remaining competitive, Australia and New Zealand will not be able to access export markets. Undertaking innovation to develop cost-effective and differentiated offerings that meet the demands of consumers is essential to obtaining and maintaining market share.[6]

4. The role of innovation in driving exports

Companies that export are more likely to be high-performing, innovative and have stronger job growth potential, all other things considered.[7] Theoretical and empirical evidence has shown a close interlink between businesses' decision to innovate and their export performance. As only the most productive businesses can bear the high entry cost of exporting, and it is only through innovation that businesses can gain higher level of productivity to reduce operational costs, innovation is in many respects a pre-condition for international market share. In addition, product innovation in terms of the development of new products of higher quality or better fit with different preferences of international consumers can help businesses in assessing foreign markets.

Viewed at the country level, innovation can lead to new products and expands the range of products that businesses can export and thus increasing the extensive margins of exports (Krugman 1979; Dollar 1986; Grossman and Helpman 1989). On the other hand, innovation can result in improved quality of the same type of products and thus increase the intensive margins of exports as businesses can charge a higher price (Flam and Helpman 1987; Grossman and Helpman 1991). Aggregate studies have shown empirical evidence which supports both hypotheses (Chen 2013).

However, the empirical evidence at the business level on whether innovation is required for obtaining and sustaining market share is more nuanced. Vernon (1966; 1979) argued that business decisions to enter the export market is closely related to the interaction between the product life cycle and the initial innovation outcomes of the business. If the internationalisation process is sequential as argued by Vernon, where businesses aim to take their domestic successes overseas after their initial innovation, we may see innovation affects export across different margins differently.

There is evidence that the link between innovation and export varies by industry and the type of innovation (Becker and Egger 2013; Palangkaraya 2011; Van Beveren and Vandenbussche). Hallak (2006, 2010) argued that businesses may adopt different innovation and market entry strategies depending on differences in terms of the preferences for quality and production costs. For example, there is evidence that innovation can lead to a higher international market share through higher export market participation (Becker and Egger 2013; Cassiman and Golovko 2011), but the increase

[6] https://fial.com.au/Attachment?Action=Download&Attachment_id=37

[7] https://www.industry.gov.au/sites/default/files/May%202018/document/pdf/australia-2030-prosperity-through-innovation-full-report.pdf?acsf_files_redirect

may not necessarily come from entry into new export markets (Lo Turco and Maggioni 2015 and Damijan et al. 2010).

Innovation can influence export performance through various channels. Innovative activities can lead to the development of a new product, either brand new or modified from existing products, that is of a higher value to foreign customers due to its higher quality or its being closer to what the foreign customers demand. In this case, innovation can potentially increase market share in both the existing export markets in which the business operate and in totally new export markets.

Theoretical models of business export decisions of Costantini and Melitz (2008), Atkeson and Burstein (2010) and Long, Raff and Stähler (2011) show changes in international trade costs can lead to a larger international market share through innovation induced by the higher potential profits from export market activities. Other studies such as Bustos (2010) and Sala and Navas-Ruiz (2007), which examined business decisions to innovate through increased R&D spending and advanced technology adoption, also found the importance of innovation for export market participation as market competition changes both in domestic and international markets.

Hallak and Sivadsan (2013) stressed the importance of 'product productivity', the ability to produce quality, in addition to 'process productivity', the ability to produce output at a lower cost, in explaining exporter premia. Firms vary in terms of these two abilities. As a result, large businesses may fail to respond to trade liberalisation by entering the export markets not because they are not cost-efficient (as they might be so through economies of scale), but because they are not willing to invest in product quality upgrading (that is, they are not willing to pay the required costs for innovation). In contrast, there may be small businesses which invest enough in 'product productivity' that they can gain international market share.

A most recent and detailed analysis on the relationship between innovation and export shows that innovation influences different export margins differently (Elliot, Jabbour and Vanino 2020). Based on French data, the study found that, on the intensive margin, innovation leads to an increase in market share in the existing product-market space. However, on the extensive margin, innovation may not drive exports in terms of new products or new export destinations. In other words, innovation appears to be associated more with the ability of innovators, relative to non-innovators, in increasing their international market share through replacing their obsolete products with new ones (which plausibly command a higher premium). The authors of the study concluded that it is critical for exporting firms to innovate to gain and protect their international market share. A failure to do so will see their export market share falling significantly.

Table 1 summarises the estimated coefficients of innovation status of business i at year t on export performance from a panel data regression of the following general form:

$$export_{it} = \alpha_i + \gamma_t + \beta innov_{it} + \varepsilon_{it} \quad (1)$$

where $export_{it}$ is either export status or export value (total and a subset of high price export) and $innov_{it}$ is whether the business has any patent, trademark or design right application filed in a given year t.[8] As specified in equation (1), the estimates of β can be interpreted as how much, on average, innovation can affect export performance. The estimates presented in Table 1 are based on data of all businesses in Australian food manufacturing industry (ANZSIC 11) over the period of 2004–2017.

[8] We use multiple measures of innovation to account for the different degree of innovation. For example, some process or organisational innovation may not be patentable but lead to newly developed businesses that are protected by new trademark.

Table 1: The relationship between innovation and export, Australia food manufacturing, 2004-2017

Dependent variable	Innovation measure			Sample	
	Patent	Trademark	Design	Number of business	Average Dep. Var
Export value (A$000)	n.s.	1,572.6***	5,022.7***	27,578	1,085.6
Export value (log)	n.s.	0.284***	n.s.	27,578	
Export status (0|1), OLS	n.s.	0.046***	0.053***	39,878	0.021
Export status (0|1), LOGIT	n.s.	0.180***	n.s.	2,659	0.209

Note: "n.s." denotes no statistically significant relationship at 10 per cent significant level or lower. */**/*** denotes statistical significance at 10/5/1 per cent level.

Source: Estimated based on BLADE-Business Activity Statement data

From Table 1, there is a clear evidence of a positive and economically and statistically significant relationship between innovation status and export performance of Australian businesses in the food manufacturing industry (ANZSIC 11), especially when innovation status is measured based on trademark and design right filing activity. The lack of statistical significance from patent filing activity reflects the low-technology and therefore low rate of patenting nature of the industry.[9] For example, on average, businesses with a new trademark filing have on average A$1,572,600 higher exports. This is an economically significant relationship given the overall average export value of the industry is around A$1,085,600. The average relative increase in export as shown by the log value estimate in the second row of Table 1 for trademark measure is around 28 per cent.[10] There is also evidence that innovation is associated with export participation. If we consider all businesses including those which never export and those which always export, the average export participation is around 2.1 per cent.[11] Looking at the trademark measure, innovation is associated with an increase of 4.6 percentage points in export participation rates. Even among the subset of businesses which have been in and out of the export market, innovation is associated with around 18 percentage point higher export participation rate.[12]

We now look at the variation in the relationship between innovation and export across select subsectors of the food manufacturing industry. Table 2 summarises the estimated β-coefficients of innovation status in equation (1) above for four different subsectors with the largest average export: 111 Meat and meat product manufacturing, 112 Seafood processing, 113 Dairy product manufacturing, 116 Grains mill and cereal product manufacturing, and 118 Sugar and confectionary manufacturing. The first point of interest in Table 2 is that while patentable innovation does not appear to be associated with export performance for the aggregate food manufacturing industry, it is not necessarily the case when we look at each subsector. Patentable innovation is associated with higher export performance for Meat and meat product manufacturing, Dairy product manufacturing, and Sugar and confectionary manufacturing. For the first subsector, patent is associated with higher

[9] However, the extent of patenting activity may vary significantly between subsectors within the industry.

[10] The relationship between export value and innovation is much stronger if we use design right filing as a measure of innovation. However, because design right filing activity is much less frequent, this estimate may not be as robust as the estimates based on trademark, as confirmed by the lack of significance when log export value is used.

[11] See Table 1's estimates with the dependent variable "Export status (0|1), OLS".

[12] See Table 1's estimates with the dependent variable "Export status (0|1), LOGIT".

export at both the intensive (average export value) and extensive (export participation) margins. For the dairy product manufacturing subsector, patenting status is associated with $20.7m higher average exports.[13] Consistent with Table 1, the estimates in Table 2 show that trademark appears as the most reliable measure of innovation for food manufacturing subsectors with many of the β-coefficient estimates supporting the hypothesis of a positive relationship between innovation and export performance in all of the four subsectors with the highest export share.

[13] The effect of patent in relative term (when the dependent variable is logged) is not statistically significant indicating that while the effect is statistically significant in absolute term, the estimate of the effect is less precise when expressed in relative term.

Table 2: The relationship of innovation and export status, subsectors of food manufacturing, 2004-2017, Australia

Dependent variable	Innovation measure			Sample	
	Patent	Trademark	Design	Number of business	Average Dep. Var
111 Meat and Meat Product Manufacturing					
Export value (A$000)	n.s.	13,400.0***	n.s.	2,966	5,328.6
Export value (log)	1.655**	n.s.	3.146**		
Export status (0|1)	0.137***	0.026***	0.193***	4840	0.027
113 Dairy Product Manufacturing					
Export value (A$000)	20,700.0***	n.s.	13,800.0***	1,169	4,345.0
Export value (log)	n.s.	0.491***	n.s.		
Export status (0|1)	n.s.	0.064***	0.091***	1580	0.038
116 Grain Mill and Cereal Product Manufacturing					
Export value (A$000)	n.s.	n.s.	n.s.	765	3,113.7
Export value (log)	n.s.	1.144***	n.s.		
Export status (0|1)	n.s.	0.107***	n.a.	1054	0.058
118 Sugar and Confectionary Manufacturing					
Export value (A$000)	n.s.	n.s.	n.s.	958	2,012.8
Export value (log)	n.s.	0.373*	n.s.		
Export status (0|1)	0.091*	0.062***	n.s.	1352	0.055

Source: Estimated based on BLADE-Business Activity Statement data

Note: "n.s." denotes no statistically significant relationship at 10 per cent significant level or lower. */**/*** denotes statistical significance at 10/5/1 per cent level. n.a. denotes not enough observation to obtain any estimate.

5. Simulations of the economic costs of falling behind the international innovation frontier

To simulate the economic impact of innovation in the food industry, we will integrate the results from Section 4 with the Australian Business Register and Intellectual Property Longitudinal Research Data. Table 3 provides the average share of firms in the given industry that file for either a patent, trademark, or design right in a single year.

Table 3: Average share of firms Innovating in a given year, subsectors of food manufacturing, 2004-2017, Australia

ANZSIC Classification	Patents	Trademarks	Designs	Firms
11 – Food Product Manufacturing	0.41%	11.61%	0.23%	2,238
111 – Meat and Meat Product Manufacturing	0.26%	10.03%	0.11%	210
113 – Dairy Product Manufacturing	0.73%	12.60%	0.16%	243
116 – Grain Mill and Cereal Product Manufacturing	0.23%	11.91%	0.00%	133
118 – Sugar and Confectionary Manufacturing	0.46%	11.61%	0.09%	167

Note: Only firms which have filed either a patent, trademark, or design are included.
Source: Intellectual Property Longitudinal Research Data; Australian Business Register.

From the table, we can see that firms within the food product manufacturing industry as well as the subdivisions within the industry are more likely to file for trademarks in a given year when compared to the other primary forms of intellectual property protection. Interestingly though, firms are nearly 1.8 times more likely to patent in the dairy industry than the food product division as a whole. Not all firms in our regression sample developed a new product or innovated in our sample period. When compared to the number of firms used to calibrate the impacts of innovation on exports, slightly more than 10 per cent of all firms in the industry have filed for a trademark within our sample period.[14]

Falling behind in the international innovation frontier will not necessarily lead to the complete cessation of new products or innovations being developed in Australia and New Zealand, yet our discussions with the industry manufacturers have all noted that new products and changes within existing products help propel export growth within the industry. To simulate the likely impact, we assume that the higher regulatory hurdles will result in a one-standard deviation reduction in the number of firms innovating in a given year. To calculate, we use the following formula:

$$OSD = np * (1 - p)$$

Where n is the number of firms in a given industry and p is the probability that a given firm will innovate in a year. For example, at the Food Product Manufacturing level, we would expect around 3 fewer firms to patent, 15 fewer firms to issue a trademark and 2 fewer firms to issue a design right each year.

Table 4: Estimated Annual Impact of a One Standard Deviation Decline in Innovation on Australia Food Manufacturing

Dependent variable	**Innovation measure**		
	Patent	**Trademark**	**Design**

[14] While the source of the Australian Business Register and BLADE have a similar source, the population frames are not directly comparable, so this comparison is an estimate of the true share.

11 – Food Product Manufacturing			
Change Export value (A$000)	n.s.	-23,832.3	-11,382.3
Change in Export status (0|1), OLS	n.s.	-0.70	n.s.
Change in Export (0|1), LOGIT	n.s.	-2.73	-0.12
111 – Meat and Meat Product Manufacturing			
Change Export value (A$000)	n.s.	-58,332.9	n.s.
Change in Export status (0|1), OLS	-0.10	-0.11	-0.09
113 – Dairy Product Manufacturing			
Change Export value (A$000)	-27,469.1	n.s.	-8,597.9
Change in Export status (0|1), OLS	n.s.	-0.33	n.s.
116 – Grain Mill and Cereal Product Manufacturing			
Change Export value (A$000)	n.s.	n.s.	n.s.
Change in Export status (0|1), OLS	n.s.	-0.40	n.s.
118 – Sugar and Confectionary Manufacturing			
Change Export value (A$000)	n.s.	n.s.	n.s.
Change in Export status (0|1), OLS	n.s.	-0.26	n.s.

Source: Calculations based on results from Tables 1 through 3.

Table 4 presents the estimated impact of falling behind due to a one standard deviation decrease in the number of firms innovating in a given year. Due to the reduction of new products being introduced, we estimate that the annual value of exports in food manufacturing would decrease by about A$23.8 million dollars with a further A$11.3 million due to fewer design rights being filed by firms. In addition, we estimate that 1 to 3 fewer firms would export in a given year, thereby shrinking the global profile of Australian firms.

However, the table also breaks down the results by the top exporting subsector. As noted in Table 2, differences in statistical significance can be driven by different industry dynamics, thus the results may reflect more homogenous economic conditions. Within the dairy industry, patents are relatively important and thus a one standard deviation fall in innovation is associated with a A$27.5 million decline in dairy exports, while the fall in design rights will contribute a further $8.6 million loss in exports. This equates to approximately 1.4 percent of annual dairy exports in Australia.[15] If the magnitude is similar within New Zealand, we would expect New Zealand annual dairy exports to fall by NZ$234.6 million a year.[16]

6. Case study - Food manufacturing industry

The food industry has traditionally been viewed as a relatively low-tech industry which relied on innovations on the supply-side of food production (Christensen, Rama and von Tunzelmann, 1996). Martinez and Briz (2000) claim that the food and beverage industry is generally noted to have amongst the lowest R&D to sales ratio relative to all other industrial sectors. Yet, the innovations based on R&D accounts for only part of the innovation story within the industry (see Christensen, Rama and von Tunzelmann, 1996; Menrad, 2004). Menrad (2004) for example, found that over 75 per cent of SMEs

[15] This figure excludes re-exports of dairy products.

[16] Total Export figures in the dairy industry based on 2018-19 gross exports found within Table 5.

in the food industry within Germany employs either no one within research or development or only one or two employees on a part-time basis.

However, innovation does not always need formal R&D. It is increasingly acknowledged that product development, process innovation and new services assist food and beverage firms to differentiate themselves within the industry. Omar (1995) further notes that food retailers have also driven innovation in product differentiation through the creation of own-brand products that compete on price compared to national brands.

Freeman (1994) divides innovation and knowledge creation styles into either widening and deepening. The former is akin to the classic creative destruction discussed by Schumpeter (1934). Schumpeter (1942) nonetheless discusses how older, established firms are more likely to innovate through deepening their existing knowledge base.

There is evidence that within the food and beverage industry, much of the innovation is occurring through deepening of existing knowledge bases held by older firms as opposed to new firms entering the market. Alfranca, Rama and von Tunzelmann (2002) explore the predominant mode of innovation within the food and beverage industry in the United States between 1977 and 1994 and find evidence that the number of granted patents are a function of the previous patents granted to the firm. This result holds true both for utility patents as well as design patents. Multinational firms are the most likely to have a major impact within the food sector. Martinez and Rama (2012) examined 59 large food and beverage firms headquartered in Europe and found that since the late 1970s, the home country was the main location of food-related R&D activities.

It is likely that the record on innovation for SMEs is more variable. Survey data of small firms within Belgium has found that smaller firms believe innovation is critical to success and strive to innovate through new products, processes, markets and organisational structures (Avermaete, Viaene, Morgan and Crawford, 2003).

Whereas the technological-side of food innovation by global manufacturers appears to be focused within home countries, globalisation has allowed multinational firms to supply their products around the globe. To accommodate this, Menrad (2004) and Christensen et al. (2004) found that multinational firms employ local teams to develop products that adapt to local preferences. These local development teams are also important for maintaining compliance with the local regulatory environment (Christensen et al., 2004). On the flip side, Hermann (2009) argues that local food regulations can inhibit innovations in products that may be traditionally consumed in foreign markets but are exotic from the point of the local market. As a case study, Hermann looks at traditional foods eaten within the Andean region of South America and their status in relation to the EU Novel Food Regulations. He finds that several traditional foods require regulatory approval to be consumed within the European Union. He argues that this discourages investment within export supply chains, reduces innovation within tropical biomes, and limits investment opportunities within developing countries due to the costs of regulatory compliance for these products. Hermann shows that regulatory regimes can be a hindrance to innovation.

Food and beverage firms are not constrained to innovating within the food and beverage sector. Martinze and Rama (2012) find that non-food sector innovations by global food manufacturers are prevalent, and unlike their innovations within the food sector, are often located outside of their global home countries. This suggests that food companies rely on outside knowledge to continue to innovate within the industry. These industries that are tied to food production appear to be increasingly high tech. Alfranca, Rama and von Tunzelmann (2003) sampled over 18,000 utility patents to explore the associations between patents of food technology and other non-food technology patents by the same

multinationals. They found that food patenting is strongly associated with research in biotechnology, chemistry, machinery, and other technology fields.

Although food processing firms can innovate through the development of new products, ultimately the innovation is reliant on consumer acceptance (Del Giudice, Nebbia, and Pascucci, 2009). To demonstrate this, Del Giudice, Nebbia, and Pascucci (2009) explore consumer acceptance of functional foods, products which are 'foods intended to be consumed as part of the normal diet and that contain biologically active components which offer the potential of enhanced health or reduced risk of disease.' They found that, in the case of young adults in Italy, cultural education was a key driver of consumer acceptance. Although consumer acceptance is a critical component to innovation, firms which engage with consumers directly in the development of products typically rely on manufacturer-active paradigms in developing products (Busse and Siebert, 2018). In other words, manufacturers primarily take the responsibility to assess the needs of the customers when designing a product (Von Hippel, 1978).

Research finds that firms which analyse these innovations as part of a larger system benefit the most. Looking at industry innovation in general, Jensen, Johnson, Lorenz and Lundvall (2007) find that firms that integrate both supply-driven innovations as well as implementing demand-driven product development experience more innovations than those firms implementing just one of those strategies. Isaksen and Nilsson (2013) explored this through two cases studies within Norway and Sweden to note that regional policies can be implemented to assist the food industry to better link these two modes of innovative research.

Regional policy can also be implemented to provide a stronger and clearer framework to promote a technological advantage within an industry. Levidow, Birch and Papaioannou (2012) note that within the food industry, the European Union has developed a Knowledge-Based Bio-Economy framework. This framework seeks to develop and promote life sciences and biotechnology research to achieve a more sustainable and competitive food industry.

The regulatory environment is an important influencer of the innovation appetite for firms. Thus, Government have a role to play in the creation of cheaper and better targeted products.

7. Case study - Australia New Zealand infant formula industry

The infant formula industry represents the premium and research-intensive extreme of the Processed food industry. In New Zealand and Australia, subsidiaries of established international companies (e.g. Nestle, Danone, Mead Johnson Nutrition, Abbott) exist but there are also national champions (e.g. Fonterra) and emerging challengers (e.g. Synlait, Bellamys, Dairy Goat Co-operative and NIG Nutritionals and A2). For these smaller New Zealand and Australian companies, infant formula constitutes most of their sales. Research is conducted through partnerships with universities and in their own standalone research centres.

Innovation in infant formula has been a key theme throughout the food and beverage industry development. Early substitutes often involved milk from cows, sheep or goats, but infants that did not have access to breast milk suffered from higher mortality rates. As late as the 1850s, infant formula was generally derived from evaporated milk with sugar added. Significant innovations began in the 1860s with the development of the 'soup for infants' by Justus von Liebig which was based on a chemical analysis of human milk. Further developments have occurred such as using vegetable oil, iron fortification, changing the whey to casein ratio, and the introduction of hydrolysed protein.

According to industry experts, new ingredients needing regulatory approval come along every 12-20 months especially for Human Milk Oligosaccharides (HMOs). The launch of a new ingredient rests on

many years of intensive research. Europe and the USA consider this industry a national priority and have considerably faster regulatory approval processes than Australia and New Zealand. There are about 130 different HMOs in breast milk which represents a strong pipeline of research in discovery and understanding. HMOs may play a key role in aiding brain and gut development. Many past innovative additions, such as Vitamin C, are now the norm and are in fact a mandatory addition. Innovations in this sector is crucial to help further reduce the gap in growth and development outcomes of formula-fed infants with the outcome of breast-fed infants. Yet it is nonetheless important to note the role that food standards have on ensuring quality products within the industry. This will help minimise reoccurrences such as the alleged misleading marketing of infant formula products in developing countries (Ims and Zsolnai, 2014) or the use of melamine within infant formula in China (Marano, 2018).

The socioeconomic benefits of continued innovation are also clear. A study by Mahon, Claxton and Wood (2016) estimates that reduced health outcomes for pre-term babies being fed formula currently cost the UK National Health Service A$55.9 million in their first year of life due to increased incidence rates of necrotising enterocolitis, sepsis, sudden infant death syndrome, delayed cognitive development and other diseases relative to breast-fed babies. A related study, Straub, Grunert, Northstone and Emmett (2019), examined how these diseases and cognitive delays may impact long-term outcomes for formula-fed infants in the United Kingdom. Using a decision model within a longitudinal study, they estimated that breast-feeding a child for more than six months is associated with an increased economic benefit of A$16,330 per child. Extrapolated to the population, a 1 per cent increase in the 800,000 children born a year in the UK that are breast-fed is associated with an economic benefit of more than A$62.5 million. Innovation to better align the composition of infant formula to breastmilk may reduce the economic burden associated with the formula feeding.

According to industry experts, and as is seen in other industries, innovation is very important for market share retention and most international players are well-established companies. Through extensive research, the composition of infant formula has changed considerably over the years. This research endeavours to make the composition of formula closer to breast milk in terms of proteins, fats, minerals, vitamins, probiotics and oligosaccharides. The Netherlands, which is the leading exporter of infant formula, works under a tight regulatory framework and has been able to launch innovative products. They first market in their domestic country and then export. This enables them to innovate at speed.

Not all innovation involves ingredients. Changes to establish the provenance of goods is important as counterfeiting is an issue, particularly in China. The creation of QR codes on packaging and micro-dots have been important.

Although the papers are framed as the economic benefits of breast-feeding, they nonetheless provide evidence in which further innovations within the infant formula industry to make the formulae is closer to breast milk, can lead to widespread societal benefits for parents and babies who have difficulty feeding.

Food product manufacturing are significant industries for both New Zealand and Australia. In the 2017-18 financial year, manufactured food sales in New Zealand exceeded NZ$43.4 billion and the industry employed more than 93,000 workers. For the same financial year, food sales within Australia was A$90.1 billion, and the industry employed 218,000 people. Annual growth in real sales have climbed 1.2 and 1.4 per cent since 2013, respectively. (Note, these are gross sales and therefore include the cumulative value along the supply chain from agriculture to manufacture).

However, the growth rate of the food product manufacturing, as a whole, masks the large growth within milk formula product manufacturing for Australia. Within the same period (i.e. since 2013), real

sales have seen a growth of 108.8 per cent, climbing to A$802.7 million in 2018 (Euromonitor, 2018a). New Zealand has not experienced the same growth in infant formula sales; sales rose only 8.0 per cent during the same period. Euromonitor (2018b) notes that the baby food industry within New Zealand is subject to falling birth rates but is supplemented through immigration and grey market sales.

Table 5: Gross Exports of Dairy Products from New Zealand and Australia, millions of dollars

	New Zealand		Australia		
	Exports	China	Exports	Re-Exports	China
2008-09	NZ$5,511	NZ$775	AU$2,581	AU$9	AU$261
2009-10	NZ$9,682	NZ$1,779	AU$1,965	AU$3	AU$204
2010-11	NZ$12,023	NZ$2,370	AU$2,236	AU$5	AU$232
2011-12	NZ$12,522	NZ$2,602	AU$2,178	AU$11	AU$236
2012-13	NZ$11,875	NZ$3,240	AU$2,140	AU$7	AU$293
2013-14	NZ$16,445	NZ$6,350	AU$2,672	AU$12	AU$520
2014-15	NZ$12,607	NZ$2,624	AU$2,451	AU$24	AU$374
2015-16	NZ$11,963	NZ$3,058	AU$2,538	AU$47	AU$760
2016-17	NZ$13,926	NZ$4,089	AU$2,525	AU$49	AU$865
2017-18	NZ$15,847	NZ$4,973	AU$2,804	AU$89	AU$1,110
2018-19	NZ$16,758	NZ$5,872	AU$2,654	AU$896	AU$1,751

Note: Reported in millions of dollars. Australian export figures are gross exports and exclude re-exports which are reported separately. China exports for Australia include re-exports. Export figures for China include Hong Kong and Macau.
Source: Statistics New Zealand, Australian Bureau of Statistics

Exports play a substantial role within the dairy industry but is a critically important component within New Zealand. In the latest figures available, 30 per cent of milk produced in Australia is exported, whereas 95 per cent of milk produced in New Zealand is exported (DCANZ 2020; Dairy Australia 2020). As reported in Table 5 above, gross exports of dairy products in New Zealand are valued at over NZ$16.8 billion in the latest financial year, significantly larger than the AU$2.7 billion of exports within Australia. China, including Hong Kong and Macau, remains the largest markets for both New Zealand and Australia. Yet as a share of exports, Australia remains much more dependent on China, with 49.3 per cent of exports and re-exports destined for the Chinese market.

Table 6 looks at gross exports specifically for infant formula products exported by New Zealand and Australia. Infant formula products are increasingly important for the dairy industry. In the 2008-09 financial years, infant formula product exports as a share of dairy exports was around 3 per cent for New Zealand and just under 5 per cent for Australia. By 2018-19, these shares increased to 10 per cent and 8.7 per cent respectively.

Changes in the distribution of exports within Table 6 also suggest a change in the business model in how infant formula products are exported from the New Zealand and Australian market. Whereas New Zealand exports direct to China have been increasing, the last financial year in Australia has seen more than a ten-fold increase, AU$885 million, in re-exports of infant formula from Australia, much of it destined to China. As Australia remains the second largest destination of infant formula products from New Zealand, a large proportion is likely re-directed to China.

An interviewee noted that while the Daigou market remains important for exporting products to the Chinese market, the use of Cross-border Ecommerce[17] using bonded warehouses is an emerging market for infant formula products. We speculate that the re-export figures are reflective of the changing trends.

Table 6: Gross Exports of Infant Formula Products from New Zealand and Australia, millions of dollars

	New Zealand		Australia		
	Exports	China	Exports	Re-Exports	China
2008-09	NZ$161	NZ$66	AU$125	AU$1	AU$56
2009-10	NZ$255	NZ$84	AU$82	AU$1	AU$30
2010-11	NZ$254	NZ$95	AU$62	AU$2	AU$19
2011-12	NZ$352	NZ$193	AU$51	AU$7	AU$22
2012-13	NZ$582	NZ$353	AU$69	AU$5	AU$34
2013-14	NZ$379	NZ$176	AU$75	AU$5	AU$44
2014-15	NZ$421	NZ$204	AU$68	AU$6	AU$45
2015-16	NZ$723	NZ$296	AU$337	AU$20	AU$314
2016-17	NZ$812	NZ$425	AU$410	AU$37	AU$408
2017-18	NZ$1,253	NZ$701	AU$493	AU$75	AU$525
2018-19	NZ$1,663	NZ$1,079	AU$230	AU$885	AU$1,028

Note: Reported in millions of dollars. Australian export figures are gross exports and exclude re-exports which are reported separately. China exports for Australia include re-exports. Export figures for China include Hong Kong and Macau.
Source: Statistics New Zealand, Australian Bureau of Statistics

Beyond China, Asian countries are the primary destinations for Australian produced infant formula products and excluding New Zealand, include Taiwan, Vietnam, South Korea, and Bangladesh. New Zealand's largest markets excluding China and Australia include Thailand, Taiwan, Malaysia, and South Korea. However, New Zealand also exports large quantities of formulas into the Middle East as well as Russia and the United Kingdom.

Infant formula is the premium or highest value end of the processed dairy market and New Zealand and Australia have positioned themselves well to take advantage of major importing markets, especially China (including Hong Kong) and to a lesser extent Vietnam and South Korea. Most of the companies interviewed for this report claimed that over 90% of their infant formula was exported.

According to industry experts, the routes through which new innovations appeal to consumers varies by the country. In New Zealand and Australia and other Western countries, the recommendation by health care professionals, who are the key opinion leaders, is very important for parents. Health care professionals are regarded as objective scientific people who monitor global paediatric recommendations. In addition, consumers do their own research, and rely on recommendations from peers, the internet and families. Established brands have an advantage introducing new ingredients on to the market as they can leverage their reputation. The market is global and there are many options for buying online.

[17] Austrade (2016) details the cross-border ecommerce model.

Understandably, this market is cautious and careful about accepting new product ingredients. It can take 10 to 15 years for new ingredients to become mainstream in this market. For example, the HMO which was introduced into Europe 4 years ago (but now allowed in over 60 countries around the world) has achieved a market share of between 0.5 and 1 % according to industry experts.

The role of health care professions in China is less than in New Zealand and Australia possibly because parents are concerned that official information sources have been corrupted. According to industry experts, the average Chinese consumer conduct their own extensive research into formula labels and individual ingredients, much more so than a Western parent. They use the internet and confer among their peers. It is known that one paediatrician in China has become such a trusted source for advice on baby food that he has over 50 million followers. If parents cannot get the latest and best product from official sources in China, they will use cross-border and daigou routes. For example, demand for the latest premium-product formula with HMOs, is so strong that cross-border trade from Australia to China has been quadrupling each year in the last few years.

Government-to-government relationships matter for access to export markets, especially in the last few years. In this respect the State, Australia and New Zealand Governments manage the relationship differently.

Marano (2018) list the following factors in driving export success for infant formula industry firms:

- Pre-market success revolves around quality assurance aspects of the products. This, as noted above, is critical as Chinese consumers have a lack of trust in the quality of the domestic food market.
- Continued commitment to scaling up within China to provide a better product awareness.
- Regulations within China can change quickly and are not uniform across the country. Regulators further require strong traceability of product supplies.
- A local partner is critical to understanding the regulatory environment.
- Branding the products as safe and reliable is critical through country-of-origin marketing.
- Sustainability of distribution.
- Catering to multiple market segments.
- Importance of online retail channels.
- Use of social media.

At the firm level, Marano (2018) further notes that advanced manufacturing techniques available in Australia have been the key to successful exports to China, although scale has further helped promote firms' exports. As infant formula is a high value-added product, successful firms partner with Chinese companies that understand the market to whom these products are targeted. Developing and maintaining these relationships are critical in China and help offset the challenging regulatory environment. Branding through country-of-origin is further important as both Australia and New Zealand can market the year-round availability of green grass.

8. Conclusions

Improvement in product quality via innovation is a key to maintaining strong exports in all countries. The global market place is highly competitive, and producers need to respond in a timely manner to changing consumer expectations.

The infant formulae industry is a key, high value-added sector of the both the Australian and New Zealand economies. However, without keeping abreast of the international frontier for product quality, we will become known for belonging to the cheap, low-quality end of the market. A reputation lost will be hard to recover.

9. References

Abramovitz, M. 1956, 'Resource and output trends in the United States since 1870', *American Economic Review: Papers and Proceedings*, 46, 5–23.

Agarwal, R. and Gort, M. 1996, 'The evolution of markets and entry, exit and survival for firms', *Review of Economics and Statistics*, 78, 489–498.

Alfranca, O., Rama, R., and von Tunzelmann, N. (2002), 'A Patent Analysis of Global Food and Beverage Firms: The Persistence of Innovation', *Agribusiness*, 18(3), 349-368.

Alfranca, O., Rama, R., and von Tunzelmann, N. (2003), 'Technological Fields and Concentration of Innovation Among Food and Beverage Multinationals', *International Food and Agribusiness Management Review*, 5(2).

Atkeson, A. and Burstein, A., (2010) 'Innovation, firm dynamics, and international trade', *Journal of Political Economy*, 118, 433–484.

Audretsch, D. B. 1991, 'New firm survival and the technological regime', *Review of Economics and Statistics*, 73, 441– 450.

Audretsch, D. B. and Mahmood, T. 1995, 'New firm survival: New results using a hazard function', *Review of Economics and Statistics*, 77, 97–103.

Austrade (2016) 'e-Commerce in China', Austrade Business Update – 26 July 2016. URL: https://www.austrade.gov.au/ArticleDocuments/1418/Webinar-eCommerce-in-China-Business-update-July-2016.pdf.aspx. Last accessed: 19 June 2020.

Avermaete, T., Viaene, J., Morgan, E., and Crawford, N. (2003), 'Determinants of Innovation in small food firms', *European Journal of Innovation Management*, 6(1), 8-17.

Bartelsman, E.J. and Doms, M., (2000) 'Understanding productivity: Lessons from longitudinal microdata', *Journal of Economic literature*, 38(3), 569-594.

Bayus, B. L. and Agarwal, R. 2006, 'Product strategies and firm survival in technologically dynamic industries', unpublished paper, Kenan-Flagler Business School, University of North Carolina.

Becker, S. O. and Egger, P. (2013). 'Endogenous product versus process innovation and a firm's propensity to export', *Empirical Economics*, 44, 329–354.

Bickerdyke, I., Lattimore, R. and Madge, A. 2000, 'Business Failure and Change: An Australian Perspective', Productivity Commission Staff Research Paper, AusInfo, Canberra.

Bloom, N. and Van Reenen, J. (2010) 'Why Do Management Practices Differ across Firms and Countries?', *Journal of Economic Perspectives*, 24, 203–224.

Bresnahan, T. and Trajtenberg, M. (1995) 'General purpose technologies 'Engines of growth'?', *Journal of Econometrics*, 65, 83–108.

Breunig, R. and Wong, M.-H. (2007) 'The role of firm dynamics in Australia's productivity growth', *Australian Economic Review*, 40, 90–96.

Buddelmeyer, H., Jensen, P. H and Webster, E. (2010) 'Innovation and the Determinants of Company Survival', *Oxford Economic Papers*, 62 (2), 261–285.

Busse, M., and Siebert, R. (2018), 'The Role of consumers in food innovation processes', *European Journal of Innovation Management*, 21(1), 20-43.

Bustos, P. (2010) 'Trade liberalization, exports and technology upgrading: evidence on the impact of MERCOSUR on Argentinian firms, *American Economic Review*, 101, 304–340.

Cainelli, G., Evangelista, R. and Savona, M. (2006) 'Innovation and economic performance in services: A firm-level analysis', *Cambridge Journal of Economics*, 30, 435–458.

Cassiman, B. and Golovko, E. (2011) 'Innovation and internationalization through exports', *Journal of International Business Studies*, 42, 56–75.

Cefis, E. and Marsili, O. (2005) 'A matter of life and death: Innovation and firm survival'*, Industrial and Corporate Change*, 14, 1167–1192.

Chen, W.-C. (2013) 'The extensive and intensive margins of exports: The role of innovation', *The World Economy*, 36 (5), 607–635.

Christensen, J., von Tunzelmann, N., and Rama, R. (1996), 'Innovation in the European Food Products and Beverages Industry', *Report for the European Commission*.

Cockburn, I. and Wagner, S. (2006) 'Patents and the survival of internet-related IPOs', unpublished paper, School of Management, Boston University.

Coe, D. T. and Helpman, E. (1995) 'International R-and-D spillovers', *European Economic Review*, 39, 859–887.

Cohen, W. (2010) 'Fifty years of empirical studies on innovative activity and performance', in *Handbook of the Economics of Innovation*, B. Hall and N. Rosenberg (eds), North Holland Elsevier, Amsterdam, 129-213.

Costantini, J. A. and Melitz, M. J. (2008) 'The dynamics of firm-level adjustment to trade liberalization', in *The Organization of Firms in a Global Economy*, Helpman, E., Marin, D. and Verdier, T. (eds), Harvard University Press, Cambridge, MA, pp. 107–141.

Crepon, B., Dugent, E. and Mairesse, J. (1998), 'Research, innovation and productivity: An econometric analysis at the firm level', *Economics of Innovation and New Technologies*, 7, 115–158.

Dairy Australia (2018). "October 2018, Market brief China". Report.

Damijan, J. P., Kostevc, C. and Polanec, S. (2010). 'From innovation to exporting or vice versa?', *World Economy*, 33, 374–398.

Dedrick, J. and Kraemer, K. (2015) 'Who captures value from science-based innovation? The distribution of benefits from GMR in the hard disk drive industry', *Research Policy*, 44, 1615–1628.

Del Giudice, T., Nebbia, S., and Pascucci, S. (2009), 'The Role of Consumer Acceptance in the Food Innovation Process: Young Consumer Perception of Functional Food in Italy', *Proceedings of the 3rd International European Forum on System Dyna ics and Innovation in Food Networks*. Edited by Fritz, M., Rickert, U., and Schiefer, G.

Della Malva, A. and Carree, M. (2013) 'The spatial distribution of innovation: evidence on the role of academic quality for seven European countries', *Economics of Innovation and New Technology*, 22, 601-618.

Dollar, D. (1986), 'Technological innovation, capital mobility, and the product cycle in North-South trade', *American Economic Review*, 76 (1), 177–190.

Dunne, T., Roberts, M. J. and Samuelson, L. (1988) 'Patterns of firm entry and exit in U.S. manufacturing industries', *RAND Journal of Economics*, 19, 495–515.

Elliott, R. J. R., Jabbour, L. and Vanino, E. (2020). 'Innovation and the creative destruction of trade: A study of the intensive and extensive margins of trade for French firms', *Oxford Bulletin of Economics and Statistics*, 82 (1), 180–208.

Euromonitor International (2018a), "Baby Food in Australia", Passport Report.

Euromonitor International (2018b), "Baby Food in New Zealand", Passport Report.

Fabricant, S. (1954), *Economic Progress and Economic Change*, National Bureau of Economic Research, New York.

Fagerberg, J. and Godinho, M. (2005) 'Innovation and catching-up', in *The Oxford Handbook of Innovation*, eds J. Fagerberg, D. Mowery and R. Nelson, Oxford University Press, Oxford.

Flam, H. and Helpman, E. (1987) 'Vertical product differentiation and North-South trade', *American Economic Review*, 77 (5), 810–822.

Frantzen, D. (2000) 'R&D, human capital and international technology spillovers: A cross-country analysis', *Scandinavian Journal of Economics*, 102, 57–75.

Freeman, C. (1994), 'The economics of technical change: a critical survey article'. *Cambridge Journal of Economics,* 18(5), 463-514.

Geroski, P. A. (1995) 'What do we know about entry?', *International Journal of Industrial Organization*, 13, 421–440.

Griffith, R., Huergo, E., Mairesse, J. and Peters, B. (2006) 'Innovation and productivity across four European countries', *Oxford Review of Economic Policy*, 22, 483–498.

Griliches, Z. (1995) 'The discovery of the residual. An historical note', National Bureau of Economic Research Working Paper no. 5348, Cambridge, Massachusetts.

Grossman, G. M. and Helpman, E. (1991) 'Quality ladders and product cycles', *Quarterly Journal of Economics*, 106 (2), 557–586.

Hall, B., Mairesse, J. and Mohnen, P. (2010) 'Measuring the returns to R&D', in *Handbook of the Economics of Innovation*, B. Hall and N. Rosenberg (eds) North Holland Elsevier, Amsterdam , 1033-1082.

Hallak, J. C. (2006), 'Product quality and the direction of trade', *Journal of International Economics*, 68 (1), 238–265.

Hallak, J. C. (2010) 'A product-quality view of the Linder hypothesis', *Review of Economics and Statistics*, 92 (3), 453–466.

Hallak, J. C. and Sivadasan, J. (2013) ' Product and process productivity: Implications for quality choice and conditional exporter premia', *Journal of International Economics*, 91, 53–67.

Hermann, M. (2009), 'The impact of the European Novel Food Regulation on trade and food innovation based on traditional plant foods from developing countries', *Food Policy*, 34, 499-507.

Huergo, E. and Jaumandreu, J. (2004), 'Firms' age, process innovation and productivity growth', 22, 541–559.

Ims, K. and Zsolnai, L. (2014), 'Ethics of social innovation'. *Society and Business Review*, 9(2), 186-194.

Isaksen, A. and Nilsson, M. (2013), 'Combined Innovation Policy: Linking Scientific and Practical Knowledge in Innovation Systems', *European Planning Studies*, 21(12), 1919-1936.

Janz, N., Loof, H. and Peters, B. (2004), 'Firm level innovation and productivity: Is there a common story across countries?', *Problems and Perspectives in Management*, 2, 184–204.

Jensen, M., Johnson, B., Lorenz, E., and Lundvall, B. (2007), 'Forms of knowledge and modes of innovation'. *Research Policy*, 36, 680-693.

Jensen, P. H, Webster, E. and Buddelmeyer, H. (2008) 'Innovation, technological conditions and new firm survival', *Economic Record*, 84, 434–448.

Jones, C. I. and Williams, J. C. (1998) 'Measuring the social return to R&D', *Quarterly Journal of Economics*, 113, 119–135.

Kendrick J. W. (1972), 'The treatment of intangible resources as capital', *Review of Economic Studies*, 18 (1), 109–125.

Kendrick J.W. (1994) 'Total capital and economic growth', *Atlantic Economic Journal*, 22, 1−18.

Klepper, S. and Thompson, P. (2007) 'Submarkets and the evolution of market structure', *RAND Journal of Economics*, 37 (4), 861–886 .

Krugman, P. (1979) 'A model of innovation, technology transfer, and the world distribution of income', *Journal of Political Economy*, 87 (2), 253–266.

Lane, P. and Lubatkin, M. (1998) 'Relative absorptive capacity and interorganizational learning' *Strategic Management Journal*, 19, 461–477.

Lederman, D. and Maloney, W. F. (2003), 'R&D and development', World Bank Policy Research Working Paper no. 3024.

Levidow, L., Birtch, K., and Papaioannou, T. (2012). 'Divergent Paradigms of European Agro-Food Innovation: The Knowledge-Based Bio-Economy (KBBE) as an R&D Agenda'. *Science, Technology, & Human Values*, 38(1), 94-125.

Lichtenberg, F. R. (1992), 'R&D investment and international productivity differences', National Bureau of Economic Research Working Paper no. 4161, Cambridge, Massachusetts.

Lichtenberg, F. R. and D. Siegel (1991) 'The impact of R&D investment on productivity:- New evidence using linked R&D-LRD data', *Economic Inquiry*, 29 (2), 203–229.

Lo Turco, A. and Maggioni, D. (2015) 'Dissecting the impact of innovation on exporting in Turkey', *Economics of Innovation and New Technology*, 24, 309–338.

Long, N. V., Raff, H. and Stähler, F. (2011) 'Innovation and trade with heterogeneous firms', *Journal of International Economics*, 84, 149–159.

Loof, H. and Heshmati, A. (2006) 'On the relationship between innovation and performance: A sensitivity analysis', *Economics of Innovation and New Technologies*, 15, 317–44.

Mahon, J., Claxton, L., and Wood, H. (2016). 'Modelling the cost-effectiveness of human milk and breastfeeding in preterm infants in the United Kingdom'. *Health Economics Review* 6(54).

Marano, S. (2018). "Australian infant formula exports to China: Factors for Success". *PhD Thesis.*

Marshall A. ([1890], 1920), *Principles of Economics*, 8th edition, London: Macmillan.

Martinez, C. and Rama, R. (2012). 'Home or next door? Patenting by European food and beverage multinationals'. *Technology Analysis & Strategic Management*, 24(7), 647-661.

Martinez, M. and Briz, J. (2000). 'Innovation in the Spanish food & drink industry'. *The International Food and Agribusiness Management Review*, 3(2), 155-176.

Mata, J., Portugal, P. and Guimaraes, P. 1995, 'The survival of new plants: Start-up conditions and post-entry evolution', International Journal of Industrial Organization , vol. 13, pp. 459–81.

Menrad, K. (2004). 'Innovations in the food industry in Germany'. *Research Policy*, 33, 845-878.

Miguélez, E. and Moreno, R. (2015) 'Knowledge flows and the absorptive capacity of regions', Research Policy, 44, 833–848.

Nelson, R. R. (1995) 'Recent evolutionary theorizing about economic change', *Journal of Economic Literature*, 33, 48–90.

OECD (2005) 'Guidelines for Collecting and Interpreting Innovation Data', Organisation for Economic Co-operation and Development and Eurostat, Paris.

Omar, O. 'Retail influence on food technology and innovation'. *International Journal of Retail and Distribution Management*, 23(3), 11-16.

Palangkaraya, A,. Thomas Spurling, Elizabeth Webster (2016) What drives firm innovation? A review of the economics literature, Centre for Transformative Innovation, Swinburne University of Technology.

Palangkaraya, A. (2011) 'The link between innovation and export, in *Globalization and Innovation in East Asia*, Hahn, C. H. and Nardjoko D. A. (eds), ERIA Research Project Report 2010-4, Chapter 4, 103 D. A. 140.

Palangkaraya, A. and Elizabeth Webster (2015) Estimating the impact of the VicStart and ICT – Trade Events and Exports Assistance program participation on firm performance, A report prepared for State of Victoria Department of Economic Development, Jobs, Transport and Resources, Centre for Transformative Innovation Swinburne University of Technology.

Palangkaraya, A., Stierwald, A. and Yong, J. (2009) 'Is firm productivity related to size and age? The case of large Australian firms', *Journal of Industry, Competition and Trade*, 9, 167–195.

Parham, D. 2002, 'The role of exit and entry in Australian productivity growth', Organisation for Economic Co-operation and Development STI Working Paper 2002/6, Paris.

Patel, P., and Pavitt, K. (1991). 'Large firms in the Production of the World's Technology: An Important Case of 'Non Globalisation'', *Journal of International Business Studies*, 22, 1-21.

Rosenberg, N. (1979) 'Technological interdependence in the American economy', *Technology and Culture*, 20, 25–50.

Sala and Navas-Ruiz (2007)

Sala, D and Navas-Ruiz, A. (2007), 'Technology adoption and the selection effect of trade', UC3M Working papers. Economics we076737, Universidad Carlos III de Madrid. Departamento de Economía.

Schumpeter, J. (1934). *The theory of economic development*. Harvard University Press, Cambridge, MA.

Schumpeter, J. (1942). *Capitalism, socialism and democracy*. Harper, New York, NY.

Segarra and Callejon 2002

Segarra, A. and Callejon, M. (2002), 'New firms' survival and market turbulence: New evidence from Spain', *Review of Industrial Organization*, 20, 1–14.

Shearmur, R. and Doloreux, D. (2013) 'Innovation and knowledge intensive business service: the contribution of knowledge-intensive business service to innovation in manufacturing establishments, *Economics of Innovation and New Technology*, 22, 751–774.

Solow, R. M. (1957), 'Technical change and the aggregate production function', *Review of Economics and Statistics*, 39, 312–320.

Solow, R. M. (1987), 'We'd better watch out', *New York Times Book Review*, 12 July, 36.

Straub, N., Grunert, P., Northstone, K., and Emmett, P. (2019). 'Economic impact of breast-feeding-associated improvements of childhood cognitive development, based on data from the ALSPAC'. *British Journal of Nutrition*, 122(S1), S16-S21.

Syverson, C. (2011), 'What determines productivity?', *Journal of Economic Literature,* 49, 326–65.

Thompson, P. (2005) 'Selection and firm survival: Evidence from the shipbuilding industry, 1825–1914', *Review of Economics and Statistics*, 87, 26–36.

Thompson, P. (2007) 'Founder quality and firm performance: Implications for local development strategies', *Australian Economic Review*, 40, 97–105.

Van Beveren, I., and H. Vandenbussche (2010) 'Product and Process Innovation and Firms' Decision to Export', *Journal of Economic Policy Reform*, 13 (1), 3–24.

Van Leeuwena, G. and Klompb, L. (2006) 'On the contribution of innovation to multi-factor productivity growth', *Economics of Innovation and New Technologies*, 15, 367–390.

Vernon, R. (1966) 'International investment and international trade in the product cycle', *Quarterly Journal of Economics*, 80 (2). 190–207.

Vernon, R. (1979), 'The product cycle hypothesis in a new international environment', *Oxford Bulletin of Economics and Statistics*, 41 (4), 255–267.

Von Hippel, E. (1978), 'a customer-active paradigm for industrial product idea generation'. *Research Policy,* 7, 240-266.

Webster, E. (2017) 'The source of wealth', *New Zealand Economic Papers*. 51, 79-85

Whitehead, A., (1925) *Science and the modern world*. New York: New American Library.