Conference Name: Australian Centre for Entrepreneurship Research Exchange Conference 2013
Conference Location: Queensland University of Technology, Gardens Point
Conference Date: 6 – 8 February, 2013
ISBN: 978-1-921897-55-9
Editor: Per Davidsson

Paper Title: Firm innovation, industry innovativeness and performance: A study of new manufacturing ventures in Australia

Authors: Alex Tan, University of Western Australia, Terence Fan, Singapore Management University

Submitting Author Contact Information:
Alex Tan
University of Western Australia, Australia
a.tan@uwa.edu.au

Firm innovation, industry innovativeness and performance: A study of new manufacturing ventures in Australia

Abstract

The causal relation between innovations developed by a focal firm and its performance has for some time been inconclusive. In this paper, we focus on the Australian manufacturing industries of the 1990s as a relatively efficient context and functional institutional environment, to hypothesize potentially confounding effects of the state of innovation in an industry sub-sector, as well as an innovating new venture embedded within that sub-sector. Our results show that in general, new ventures commercializing an innovation enjoy higher sales growth and returns on assets. In addition, while an average new venture enjoys significant positive growth in sales in an industry sub-sector where innovativeness is high—capturing a 'rising-tide-raises-all-boats' effect, however, for new ventures themselves developing innovations, high industry innovativeness also presents as a high barrier to overcome, limiting sales growth and returns on assets. In particular, the interaction effect can be so large in magnitude so as to overwhelm the main effect of innovation on performance.

Keywords: *Innovation; new ventures; industry innovativeness*

Introduction

Innovation is important for effective firm performance in today's competitive markets (Cooper, 2000, Zahra and Nielsen, 2002), yet the link between innovation and firm performance has not always been conclusive. In a number of studies, technological innovations have been found to positively influence firm performance in a number of industries for both internationally and domestically oriented firms (Kotha and Nair, 1995; Han, Kim and Srivastava, 1998; Zahra, Hitt and Ireland, 2000). Meanwhile, a number of studies reported weak or no significant link between innovations and performance (Capon, Farley and Hoenig, 1990; Montoya-Weiss and Calantone, 1994; Lin and Chen, 2007).

Over the years, two major advances have helped resolve these inconsistencies. First, Zahra and his colleagues' studies in U.S. manufacturing and software firms highlighted how investment in innovations (i.e., research and development, or R&D, spending) *per se* was generally not directly linked to performance changes in the focal organization, because such investment may take a long time to reach a state where the appropriate new knowledge can be properly integrated and resultant innovation commercialized (e.g., Zahra, 1996; Zahra and Bogner, 2000; Zahra, Hitt and Ireland, 2000). In other words, technological innovations that were ready to be commercialized have a much stronger impact on firm performance than investments in innovations in general.

Second, the institutional environment in which a focal firm is embedded has been found to impact the link between innovations and performance. Focusing on new technology ventures based in China as a transition economy, Li and Atuahene-Gima (2001) showed that innovations require adequate institutional support to result in improved firm performance. In fact, in certain 'dysfunctional' institutional environments, more relevant experience among managers of technology-based ventures may even be associated with poorer performance (Li and Zhang, 2007).

On top these two major advances, a third perspective has emerged in the study of established industries. In a series of recent studies, a significant level of innovation spillovers has been demonstrated: given everything else equal, a focal firm produces more if its competitors in the same industry spend more on R&D (e.g., Knott and Posen, 2009; Knott, Posen and Wu, 2009). In other words, the innovation investment of industry rivals has been shown to improve, not worsen, performance of the focal firm. This provides a fresh contingency perspective to unpack the inconclusive link between innovations and firm performance for the focal firm.

The recent studies on innovation spillovers counted in their R&D expenditures by firms to adopt rivals' technological innovations in an isomorphic manner to regain lost competitiveness (Knott, Posen and Wu, 2009; Aghion *et al*., 2001). The effect on investment on new-to-the-industry innovations can be more complicated, as innovations developed by one firm can cut into the performance of another, triggering the latter firm to in turn respond in a more powerful innovation – leading to what some claim as the ‘Red Queen Effect’ in competition (D’Aveni, 1994; Derfus *et al.*, 2008). In these instances, the net effect on firm performance can be more difficult to predict.

Moreover, the recent studies on innovation spillovers have focused on relatively mature industries. The picture for new ventures – which often rely on technological innovations to offer a differentiated product to the marketplace (instead of playing ‘catch-up’ to rivals as in established firms) – can be significantly different, and warrants closer attention (Hawawinin, Subramanian and Verdin, 2003; Short *et al.*, 2009). In fact, new ventures are significantly related to economic growth, accounting for up to 15% of all new jobs created across dozens of countries (Reynolds, Bygrave and Autio, 2003). In view of the relatively slow rate of economic growth in many parts of the world in the wake of the global financial crisis, there has been a renewed focus on studying new ventures. That new ventures have been known to face high failure odds (Song *et al.*, 2008; Geroski, Mata and Portugal, 2010), and that a vast majority simply persist without significant growth (Gimeno *et al.*, 1997; Wiklund, Davidsson and Delmar, 2003) provide additional impetus to examine the link between a focal firm’s innovations and its performance as moderated by innovation investment by rivals. This gap in the literature (Gilbert, McDougall and Audretsch, 2006) is the focus of this paper.

In line with our intention, we chose an industry setting that was generally competitive internationally (i.e., far from being ‘dysfunctional’), as illustrated by the fact that many constituent firms – including new ventures – can derive a significant portion of their sales from outside their home country. A search at the international business literature shows that the Australian manufacturing industry in the 1990’s fits this description very well – in fact, data from this industry spawned the international new ventures, or the notion of ‘born-global’ firms that became an important new stream of research specialization. Examining how firm-specific innovation investment resulted in actual innovations, our analyses showed that while innovations in general led to significant subsequent growth in sales, this link is significantly modified by the innovation characteristics in the industry, such that much of this performance improvement may be eroded in more innovation-intensive industries.

Theory Development and Hypotheses

In this study, we therefore follow the overall logic that R&D spending impacts the development and commercialization of innovations, which in turn impacts firm performance, subject to industry innovation conditions. We describe our hypotheses in the ensuing sections.

Innovative Capability and its Link to New Venture Performance

Developing innovative capability has become a *sine qua non* of competition, in particular, for new ventures. While scholars and practitioners traditionally acknowledge the importance of innovations on firm performance, the link between the two has been inconclusive for many years. For instance, in Capon, Farley and Hoenig’s (1990) literature review found a positive relation between innovation and firm performance in two-thirds of the studies, but a negative or no significant relation in the rest. Li and Chen’s (2007) recent survey of new ventures in Taiwan similarly showed only a weak link between innovation and performance. After controlling for other variables such as strategic orientation and industry environment, a few studies have shown a positive link between innovation and performance in the Japanese machine tool industry and in retail banking, among others (Kotha and Nair, 1995; Han, Kim and Srivastava, 1998; Zahra, Hitt and Ireland, 2000). However, the importance of strategy depends on how it is implemented in the specific study. While Zahra and colleagues’ (Zahra, 1996; Zahra and Bogner, 2000) study on U.S.-based firms noted that specific technology strategy such as pioneering versus following impacts performance, a wider study on non-diversified manufacturing firms in 75 countries by Covin, Slevin and Heeley (2000) showed that pioneers and followers actually grew at an indistinguishable pace.

Proponents of the positive link between innovation and performance in new ventures generally argue how innovations help these ventures more easily win over customers otherwise less satisfied with established incumbents, and in so doing, help acquire new(-to-industry) customers (Desphande, Farley and Webster, 1993; Han *et al.*, 1998). As a result, innovations have been linked to performance improvements for the innovating firm and even dethronement of industry leaders (Kotha and Nair, 1995; Ferrier, Smith and Grimm, 1999). Scholars focusing on linking innovation strategy to firm performance however consistently found that performance is generally not affected by the size or proportion of R&D spending, but is rather directly impacted by innovations developed and implemented by a focal firm (Zahra, 1996; Zahra and Bogner, 2000). The size of R&D spending impacts only the extent or likelihood that an innovation can be successfully developed in a competitive manner (e.g., relatively short period of time to commercialization, see e.g., Mu and Bernadetto, 2011). As a result, we conceptualize that spending on R&D, as well as other important functional activities related to innovation development, such as marketing and manufacturing (Christensen, 1995; Guan and Ma, 2003; Lumpkin and Dess, 1996) increases innovative capability, which in turn impacts performance, contingent upon industry conditions.

Recently, studies on innovation spillovers have informed how the R&D spending of competitors impacts the performance of a focal firm. For instance, the output of a focal firm is enhanced when the R&D expenditure of other industry peers increases, given everything else constant (Knott, Posen and Wu, 2009). Moreover, a focal firm tended to benefit from the entire set of knowledge held by a number of firms, not only from the industry cost leader. Further, examining R&D spending from publicly listed firms across multiple industries, Knott and Posen (2009) found that firms increased their expenditure on R&D when their production could benefit more from their competitors' R&D expenditure. These findings paint a broad picture that R&D spending by competitors in the same industry can contribute to the development of technological innovation in a focal firm. Many studies on new ventures link the entrepreneurs' or managers' perception of industry as well as their other attitudes to innovations to their tendency to generate or adopt innovations (e.g., Pérez-Luño, Wiklund and Valle-Cabrera, 2011), but none so far had examined how investments in innovations from competitors in the same industry can impact the innovative capability development in a focal firm.

The preceding discussion leads to our predictions that:

Hypothesis 1a: Greater investment in innovation, including R&D and product marketing from a focal new venture increases its innovative capability.

Hypothesis 1b: Greater pooled investment in innovation, including R&D and product marketing from a focal new venture's industry competitors increases its innovative capability.

Hypothesis 2: A focal new venture's innovative capability increases its subsequent performance.

State of Industry Innovativeness on New Venture Performance

Scholars have tended to argue how the high variability within the new venture population dramatically reduces industry-level impacts on their performance. For instance, Short *et al*.'s (2009) analysis of stratified randomly sampled Swedish firms showed that between two-thirds to 99% of the variance in performance (in terms of sales, sales growth and survival) can be attributed to firm-specific factors, while only up to 24% can be attributed to industry-factors. Studies on new product development have also noted the mixed impact of industry environments on firm performance (Slater and Narver, 1994). In particular, including innovations in the analysis has tended to improve the significance of the link between industry conditions and firm performance (e.g., Han, Kim and Srivastava, 1998).

Studies on innovation spillovers have opened an important avenue to understanding how innovations, or specifically, innovation development from other industry peers, impact firm performance. Specifically, Knott, Posen and Wu (2009) show that the impact of industry- or market-level factors such as the degree of competition may only be unmasked when the potential spillover effect is included in the analysis. In other words, before the industry spillover effect is included, the significance of industry-specific effect such as inter-firm competition may not show up in econometric analyses. This gave us confidence to examine how the state of industry innovativeness, i.e., the level of how innovations are competitively commercialized, impacts performance of a focal firm in the same industry.

Meanwhile, the mixed evidence of link between industry conditions and firm performance has prompted scholars to adopt a contingency approach. Li and Atuahene-Gima (2001), and Li and Yang (2007), for instance, highlight how ‘dysfunctional’ institutional environments can play an important role in moderating performance that would be otherwise expected in an ‘efficient’ market. In the so-called ‘dysfunctional’ environment, firms can win contracts and business licenses via political networking even though their technologies and products are inferior to those of their rivals. As a result, social ties – not innovative performance in a particular technology or products – often help ‘seal the deal’ (Peng and Luo, 2000). In these environments, product innovativeness and functional experience among managers may mean less to a firm’s performance than the proper social ties.

However, even in an ‘efficient’ environment – with adequate institutional infrastructure (i.e., far from a ‘dysfunctional’ environment), the effect of an innovative industry can have opposing impacts on the performance of the focal firm. On one hand, studies on innovation spillovers note how the production of any focal firm can be augmented as a result of increased R&D spending by its industry peers (e.g., Knott, Posen and Wu, 2009). This could happen because the state-of-the-art R&D investment in rivals can increase the level of product information and awareness of the potential customers, even though some of these informed customers may still not opt to buy from the state-of-the-art producer. An increased reputation of a producer from a particular location may also improve the perception of its competitors from nearby locations, as in the production of fine wine in certain locations in France. The mobility of industry talents among co-located firms offers another possible mechanism for this observed impact. This leads to a conclusion that any firm in an industry (in an efficient, ‘functional’ environment) can benefit from an innovative stance taken by its peers in the same industry:

Hypothesis 3: The innovativeness of an industry has a positive effect on the performance of its constituent new ventures.

On the other hand, studies on innovation spillovers on publicly listed firms across multiple industries pointed to imitation by rivals as an important impetus for continuous innovation for established firms (Knott and Posen, 2009; Geroski and Pomroy, 1990). Even though these studies tend to focus on relatively mature industries, where R&D spending may be used to adopt or replicate rivals’ innovations instead of developing genuinely new ones, the effect that firms respond to their competitors’ ‘raising the bar’ cannot be denied. The overall impact may be akin to what is known as the ‘Red Queen Effect’ in competition (D’Aveni, 1994; Derfus *et al.*, 2008): as rivals up their ante in innovations, a focal firm intending to develop innovative products must now reach higher in its innovation attempt for its products to be effectively competitive in the marketplace. Effectively, higher degrees of innovativeness in a functional industry setting set up higher ‘entry barriers’ for subsequent firms to develop technological innovations (Harrigan, 1981; Robinson and McDougall, 2001). While studies on innovation spillovers and the ‘Red Queen Effect’ are based on established firms, the situation for new ventures can be more acute because of their relative lack of resources, legitimacy and complementary resources. In other words, new ventures provide a setting where the negative impact of industry innovations can be magnified on individual firms:

Hypothesis 4. The innovativeness of an industry negatively impacts the performance of its constituent new ventures that develop innovative capability.

In particular, we base Hypotheses 3 and 4 on the assumption that the underlying institutional environment is ‘functional’ (i.e., its institutional support is adequate), and firms are relatively efficient.

Method

Research Setting and Sample

This research utilized a panel of independent manufacturing ventures that were less than six years old from 1994 to 1998. To ensure that we select an industry setting that was generally competitive internationally (i.e., far from being ‘dysfunctional’), we focus on Australia – a developed country with adequate institutional development, and specifically on its manufacturing industry in the 1990s. Firms in this industry in this period were generally efficient compared to their competitors elsewhere in the world, as witnessed by the fact that many manufacturers – including some very young ones – managed to derive a significant portion of their sales from international customers. In fact, data from this industry setting spawned a new stream of research specialization within the international business domain, under the title of international new ventures, or 'born-global' firms (e.g., Oviatt and McDougall, 1994; McDougall and Oviatt, 2000).

To construct our sample, we relied on the Business Longitudinal Survey (BLS) of Australian businesses conducted by the Australian Bureau of Statistics (ABS) over four yearly periods from 1994 to 1998. ABS conducted the survey under the authority of the Australian Census and Statistics Act 1905, using a self-administered structured and close-ended set of questionnaires (ABS, 2000a). Accordingly, the survey had a response rate of over 90 percent, which is significantly higher than what is typically achieved in academic research, and thus provides strong data reliability (McMahon, 2001). The BLS data set contains a sample of 9,731 small- and medium-sized enterprises (SMEs). The Australian Manufacturing Council (1996, p. 78) indicates that "responses were sufficient in each of the 48 cells (industry by size) to be taken as reflecting the full population." This study is concerned only with firms operating in the manufacturing sector, which represents approximately 25 percent of the sample. In addition, since we are interested in the growth performance of new ventures, businesses which were not incorporated and/or incorporated six years or more prior to 1994, and thus conventionally do not represent new ventures with growth potential were excluded (cf. Bloodgood *et al*., 1996; McDougall *et al*., 2003; Robinson and McDougall 2001). We also eliminated firms which were subsidiaries or spin-offs of existing organizations.

There are a number of important reasons why we chose to utilize a sample of independent new manufacturing ventures for our analysis. First, we are investigating whether the technological innovation environment is favorable or unfavorable to new entrants relative to incumbent firms in the industry, and past research has shown that incumbent firms enjoy a greater advantage over independent new entrants, *vis-à-vis* corporate spin-offs or subsidiaries (Gorecki, 1975). Second, prior research has highlighted that entry barriers in other sectors of the economy relative to manufacturing have historically been negligible, or at least significantly low, even after accounting for structural economic changes and industrial consolidations (Bain 1959; Robinson and McDougall, 2001). Indeed, empirical studies have consistently focused on barriers to entry in the manufacturing sector (e.g., Geroski et al., 1990; Harrigan, 1981; 1983; Lieberman, 1989; Robinson and McDougall, 2001; Zoltan and Audretsch, 1989). Third, modern manufacturing has strong vertical and horizontal links with innovation, including in applied research, engineering, industrial design, and process improvement. In Australia, manufacturing has made disproportionally large impact to research and development and innovation (Smarter Manufacturing, 2012).

The final sample consisted of a panel of 163 ventures competing in 45 different four-digit ANZIC (1993) codes in all yearly periods from 1994 to1998. ANZIC codes were used primarily to gather industry information. The ANZIC codes in Australia and New Zealand are similar to the SIC codes in the United States, which are a widely used and accepted industry classification system (Clarke, 1989). Information used to operationalize industry technology barriers to entry: cost of innovation, time to commercialize innovation, expected time to recover cost of innovation, and proportion of business with innovations new to industry worldwide was primarily drawn from *Innovation in Australian Manufacturing* (1994) published by ABS.

Data Analysis

We model and test our hypotheses in a two-stage process. In the first stage, our hypotheses test whether new manufacturer innovativeness is a function of its own innovation development as well as the contribution of rival innovation knowledge. As discussed earlier, this follows prior conceptualizations of organizational innovativeness or relatedly, absorptive capacity, which specifies a firm's ability to generate domain knowledge and assimilate external knowledge, and transform acquired knowledge into innovative ideas that can be exploited (Coven and Levinthal, 1990; Zahra and George, 2002). Accordingly, we model a new manufacturer's innovativeness based on the expression Levin and Reiss (1988) and Knott *et al.* (2009) used for innovative output of focal firm, Y_i in a selected year, *t*:

$$Y_{it} = INN_{it\text{-}1} + RVL_{it\text{-}1} \tag{1}$$

where $INN_{i,t\text{-}1}$ is the logged firm expenditure on innovation and $RVL_{i,t\text{-}1}$ is the logged pool of rival firms expenditure on innovation in the industry. We estimate new manufacturer innovativeness using discrete-time logit regression. We note that this measure can be interpreted as a modified version of what Adler and Shenbar (1990) called innovative capability (Subramaniam and Youndt, 2005) after incorporating suggestions from Henderson and Clark (1990), and Guan and Ma (2003). Accordingly, Y – a probit measure – is based on a scale of zero to one, with zero being no capacity to change existing products and services, and one being a definitive capacity to produce new or substantially changed products and service, innovative capability represents the varying ability to reconfigure existing products and services by applying appropriate technologies and responding to spillovers from competitors.

In the second stage, our hypotheses test how new manufacturer innovativeness and the industrial innovation environment in which it is embedded predict performance. We focus on absolute level rather than improvement or change because using the level of performance assumes that new ventures are competing successfully, whereas improvement creates the ambiguity of either strong or only satisficing performance. For example, in the scenario where a new manufacturer has improved but still records negative return on assets, its performance is likely to be weaker than its competitors. Or, in the case where a new manufacturer has improved its annual sales by 50%, but which only reflects a \$100 increase in sales, its performance is likely to be relatively lackluster. Therefore, if π_i denotes the performance level of a new manufacturing venture in a selected year, *t*, we model the determinants of performance using the following equation:

$$\pi_{it} = \alpha + \beta Y(Z)_{it\text{-}1} + \chi CST_{i,m} + \delta COM_{i,m} + \eta RCV_{i,m} + \lambda \mathrm{GBL}_{i,m} + \varpi I_{it\text{-}1,m} + \gamma C_{it\text{-}1} + \mu_{it}. \tag{2}$$

$Y(Z)_{it\text{-}1}$ is the instrumental variable for new manufacturer innovativeness derived in the first stage of the model. For a given industry, *m*, in which a new manufacturer is embedded, $CST_{i,m}$ is the average cost of a major innovation project, $COM_{i,m}$ is the average time to commercialize an innovation, $RCV_{i,m}$ is the average expected time to recover cost of innovation, and $GBL_{i,m}$ is the proportion of firms with innovations that are new to industry worldwide. $I_{it\text{-}1,m}$ refers to the set of two-way interaction terms of innovativeness and industrial innovation environment, C_{it} refers to the vector of time-varying control variables, and μ_{it} denotes a stochastic error term.

We estimate the parameters of equation (2) using feasible generalized least squares (FGLS). Because differences in industrial innovation environment are more likely to manifest in inter-firm variations, rather than intra-firm variation over the short-term, fixed effects model is less suitable. Another advantage of using FGLS over the well-known GLS method, such as fixed effects and random effects is that this procedure estimates, rather than assumes the error process when analyzing longitudinal data (cf. Parks, 1967). We use the XTGLS procedure in STATA 12 by choosing the "i.i.d." error structure. We also experimented with alternative specifications of heteroskedastic and correlated error structures, which largely produced similar effect estimates for the independent variables. We select the 'i.i.d.' version as it produced the best model fit. Further, since autocorrelation turned out to be negligible in a new manufacturer's observations ($p < 0.91$), we specified an independent working correlation matrix.

Measures

New venture innovative capability We operationalized innovative capability as the likelihood to produce technological innovation output that creates new products and services or at least, significantly transforms existing products and services, and which is a function of focal firm's own expenditure and industry rivals' pooled expenditure toward innovation output. The output of technological innovation is measured as a binary outcome of a logit model, on whether the new manufacturer has developed or introduced any new or substantially changed products or services or processes in a selected year, *t*. We measured a new manufacturer's own contribution to the development of innovative capability using the natural log transformed expenditure on development of new or substantially changed products, services or processes, which includes research and development, patents, trademarks and licenses, tooling up, industrial engineering and manufacturing start up, training of staff and marketing of new products and services in year, *t* - 1. Similarly, we measured rival contribution to innovative capability using the natural log transformation of total expenditure on development of innovative output in a given industry in which a new manufacturer is embedded in year, *t* -1, minus focal firm's own expenditure.

New venture performance We operationalized new manufacturer performance in terms of sales growth (using absolute amount of sales in each yearly period) and return on assets (ROA). Successful entrepreneurs routinely prescribe that sales are the most important aspect of a new or small business, without which, there is no company (Fell, 2012). Annual sales of a new firm would indicate whether a new firm is competing successfully and growing year after year. On the other hand, ROA would indicate operational efficiency. Our panel data has a large cross-section relative to time-series, and so mathematically, ROA is a more conservative measure than other common efficiency measurements of performance that use the same income numerator, such as return on equity (ROE). Because equity must be equal to or less than the total assets of the firm, it follows that ROE will be higher than ROA to the extent of the firm's leverage. Further, the capital structure of independent new ventures are unlikely to change significantly over the short term, such that the increase in equity is larger than the increase in assets. Combined, annual sales and ROA provides a multidimensional view of new venture performance. They would allow us to better make specific conclusions about performance outcomes due to innovating and the industrial environment.

Industry innovativeness We operationalized industry innovativeness using four important measures of a manufacturing industry's innovation environmental characteristics: average cost of innovation, average time taken to commercialize innovation, average expected pay-off period from innovation and the degree of novelty of innovation. As mentioned earlier, these measures were based on the data drawn from the ABS' *Innovation in Australian Manufacturing* (1994) publication. First, based on our setting of relatively efficient firms in an institutionally functional industry, a higher average cost of major innovation project by industry participants signals a potentially high commitment to innovation, but also potentially sets a potentially high entry bar for aspiring innovation-based new ventures. We measured average cost of innovation by taking the weighted average of the percentage of firms within a particular manufacturing industry which incurred costs for innovation ranging from less than \$5,000 to more than \$100,000. Second, previous studies have indicated that the time taken, on average, for an innovation to be commercialized from idea inception is an important measure of the competitive intensity on innovation development (Schoonhoven, Eisenhardt, and Lyman, 1990). We measured time to commercialize innovation by taking the weighted average of the percentage of firms in a given manufacturing industry which took periods ranging from less than six months to more than five years for their innovations to reach commercialization. Third, the attitude of an average firm in an industry on the expected pay-off from commercializing an innovation is an important determinant on the investment horizon in that industry (Ali *et al*., 1993). We use an average expected pay-off period for each of the respective manufacturing sub-sectors to measure this. A longer pay-off period, on average, means that firms in the particular manufacturing industry generally have long investment horizons (e.g., resistant to change), potentially setting a high entry bar for innovations developed by new entrants. We measured expected pay-off period from innovation by taking the weighted average of the percentage of firms in a manufacturing industry which expected pay-offs within periods of less than six months to more than five years. Last but not least, the novelty of innovations developed by firms in a particular manufacturing sub-sector is important (Kotabe and Swan, 1995), as it also potentially sets a high entry bar for innovations developed by new entrants. We measure this by the percentage of all reported innovations by firms in a manufacturing industry that were deemed to be 'new to the industry worldwide' (not just 'new to the industry'). We did not include time lag in performance for the industry technology entry barriers variables. As discussed earlier, we expect that differences in industrial innovation environments are more likely to manifest in inter-firm variations, rather than intra-firm variation over the short-term. Data collected in our sample spanned less than a five-year period, and as such, we do not consider any changes in technology regimes in such a short period of time to be significant. Studies on technological regimes in multiple industries typically span up to a century (e.g., Sarker *et al*., 2006).

Control variables Our sample does not consist of a homogeneous set of firms with respect to their characteristics. Therefore, we included controls for these variables in order to isolate the effects of firm innovativeness. We measured firm size using the number of employees. We used the raw data for firm age, which was operationalized as two-year periods (e.g., 1 == 0 to <2 years; 2 == 2 to <4 years; 3 = 4 to <6 years). Liquidity is an important factor in determining whether new and small firms have sufficient cash reserves in the working capital cycle needed for production, selling and distribution. However, since new ventures typically have little cash endowments, a larger working capital usually requires extending a shorter debt collection period to customers, which could hurt performance, especially sales growth. Thus, we include working capital as control variable and measure it by calculating the ratio of its current assets to current liabilities in each year. The amount of equity held by outside investors could also hinder performance, in that there could potentially be conflict in the strategic direction of the firm. We measure *outside equity* by the percentage of equity held by investors not related to the venture *a priori* in each year. However, if a new manufacturer were to have a major decision maker (e.g., founder) who possesses the necessary experience to guide the firm, it is expected the new firm would perform well, all things equal. As such, we control also for this possibility by multiplying whether a new manufacturing venture has a major decision-maker (1) or not (0) by the number of years of working experience. *Industrial relations* are another important factor that could influence new manufacturer performance. New firms which are more unionized are more likely to have better industrial relations and consequently greater market legitimacy. We measure this by the percentage of employees in a firm that are union members in each year. *Family businesses* have been shown to be associated with stronger sales performance in the U.S. manufacturing context (Zahra, 2003). Therefore, we control for whether a new manufacturer is family-owned (1) or not (0). Finally, we controlled for *industry growth* by taking the weighted average percentage sales growth of each manufacturing industry. In general, an industry with a higher growth rate signals better opportunities for new ventures.

Insert Tables 1 and 2 about here

Results

Table 1 presents descriptive statistics, variance inflations factors and condition indices for variables used in the analysis. Among new manufacturers, the likelihood of producing a technological innovation is between 0.11 and 0.97. The mean annual sales and ROA were more than $1.5 million and 30.6 percent respectively. To address potential multicollinearity between main effects and the interaction terms, we employed a technique used by Sine and his colleagues (Sine, Shane, and DiGregorio, 2003; Sine, Haveman, and Tolbert, 2005), and orthogonalized the variables associated with industrial innovation environment (cost of innovation, time to commercialize innovation, pay-off period from innovation, and novelty of innovation). Specifically, we used the Gram-Schmidt procedure (cf. Saville and Wood, 1991) so that all the variance inflation factors and condition indices become less than 2.5 and 13. Overall, we did not find any significant problems related to multicollinearity.

In Table 2, we present our test of Hypotheses 1a and Hypotheses 1b, whether investment in innovation by the focal firm, as well as pooled investment on innovation by rivals in the industry, increases the likelihood of new ventures developing a technological innovation that is commercially viable, as expressed in Equation (1). In support of Hypothesis 1a, the coefficient focal firm investment on innovation is positive and significant. However, rival pool investment on innovation does not have any significant effect on new venture's innovative output. These results suggest that new ventures do not benefit from efficiency effect of innovation spillover from rivals, as compared to established firms (cf. Knott *et al*., 2009).

Table 3 presents the results from the FGLS estimates of new venture performance shown in Equation (2). Model 1-1 and Model 2-1 are the base models for new venture performance, containing only the control variables. In Model 1, firm size is positive and significant, while firm age is positive but only mildly significant. Expectedly, a larger working capital adversely impacts sales growth. Stronger industrial relations produce a positive and significant effect on sales. This could suggest that new manufacturers with a higher degree of unionization potentially enjoy greater market legitimacy. At least for new ventures, family-run businesses do not experience higher sales growth than other firms in Australia (cf. Zahra, 2003). Although the presence of a more experienced founder or employer, who makes the major decisions in the new firm, has a positive and significant effect on sales and growth, the decision-making process could potentially be hindered if there was a higher percentage of equity held by outside investors. Quite differently, in Model 2-1, we do not see any significant effects in the baseline measures on ROA.

Insert Table 3 about here

Models 1-2 and 2-2 add the main effects of all the key variables in our study. In Hypothesis 2, we had predicted that new ventures with greater innovative capability have stronger performance. In support of Hypothesis 2, our results show that more innovative new manufacturers perform better than their less innovative counterparts, not only in terms of their ability to achieve higher sales year-on-year, but also in their ability to leverage limited resources to be more profitable. To illustrate the magnitude of the innovative effect in Models 1-2 and 2-2, one standard deviation (= 0.143) increase in innovative capability results in an increase in annual sales by $1,237 (=exp[1.486 x 0.143] = 1.237) and 32.2% improvement in ROA (=2.255 x 0.143 = 0.322). Hypothesis 3 postulated that industry innovativeness can have a positive impact on new venture performance. While the industrial innovation environment within which a focal firm is embedded has no effect on its performance here, when the interaction terms are included, the main effects of time to commercialize innovation and novelty of innovation become positive and significant for sales growth. The main effects on ROA, however, remain not significant. The change in results of the main effects of industry innovativeness on sales is consistent with Aiken's and West's (1991) caution against interpreting the lack of significance from main effects without first considering whether interaction effects exist. Thus, our findings provide some support for Hypothesis 3, which indicates the possibility that not withstanding innovative capability, new ventures grow faster in environments where industry innovativeness is greater in some measure, commensurate with the phrase, 'a rising tide lifts all boats'.

In Models 1-3 and 2-3, we present our test of Hypothesis 4, whether the innovativeness of the particular industry in which a new manufacturer is embedded actually decreases (rather than increases) the positive effect of its innovative capability on performance. In support of Hypothesis 4, Model 1-3 shows negative and significant two-way interaction effects for innovative capability x time taken to commercialize and innovative capability x novelty, while in Model 2-3, the coefficients for innovative capability x cost and innovative capability x time to commercialize are negative and significant. This can be interpreted as evidence that innovative new manufacturers operating in industrial environments with lower innovativeness perform better than those operating within industries with a higher level of innovativeness. To illustrate this effect on new venture sales growth, in an industry where the time to commercialize innovation is shorter than average across the manufacturing sector (mean - 1 s.d.), one standard deviation increase in innovative capability increases annual sales by $930 (=exp[2.116 x 0.143 - 1.724 x 0.143 x 1.52] = 0.890), whereas in an industry where the time to commercialize innovation is longer than average (mean + 1 s.d.), one standard deviation increase in innovative capability increases annual sales by $890 (=exp[2.116 x 0.143 - 1.724 x 0.143 x 1.698] = 0.890). The interaction effect on new venture performance is even more dramatic when graphically illustrated by Figures 1 and 2, which plots innovative capability against annual sales and ROA respectively. The interaction effects for innovative capability x cost and innovative capability x novelty are qualitatively similar. Chi-square difference test show that both two-way interaction term models (Models 1-3 and 2-3) significantly increase model fit ($p < 0.01$) relative to the models with main effects alone (Models 1-2 and 2-2). We find no significant moderating effects from expected pay-off period in the industry.

Insert Figures 1 and 2 about here

Discussion and Conclusion

Inconsistent findings between innovations undertaken at the firm level and the subsequent performance at the firm have been around for several decades. Scholars have resolved some of these inconsistencies via pointing out the discrepancy between simply linking performance to R&D investments, or to propose contingency approaches. In this study, we took an additional step to unpack how innovations developed at the firm level may not improve performance, by examining the influence of the innovativeness of the industry the firm is in, and more importantly, the contradictory joint effect of industry versus firm innovativeness. Our focus on the relatively efficient Australian manufacturing industry of the 1990's allowed us to eliminate notions of inefficient competitors or dysfunctional environment that would otherwise help explain the inconsistent findings between innovations and firm performance.

Our main finding provides support to the idea that a firm developing innovations on average positively impacts its performance – and this is expected in a relatively efficient industry and functional institutional environment. However, our findings highlighted how this firm performance is significantly influenced by the industry innovativeness in two ways. First, a firm situated in an industry with a high level of innovativeness as denoted by a large percent of innovations being new to industry worldwide enjoys higher sales growth than a firm in another industry. A similar trend is observed in industry where the time to commercialize a major innovation is longer – although in the latter case, a new entrant also enjoys a longer period of technological stasis. The observation that a higher level of industry innovativeness helps an average new venture before better is akin to the phenomenon that 'a rising tide lifts all boats'. In a very broad manner, this also illustrates how industry innovativeness confers benefits to its constituent firms, even though the latter may not be innovating much. This harks back to an innovation equivalent of physical agglomeration (e.g., Chung and Kalnins, 2001), where physically co-located firms on average benefit more through the co-location than being isolated. This same effect, however, is not found when returns to assets are used as the dependent variable, because of complications from the cost involved in commercialization. Recent studies (e.g., Davidsson, Steffens and Fitzsimmons, 2009) have noted the weak correlation between firm growth and profits.

Second, an innovative industry effectively places a high barrier for an innovative firm (one that has successfully developed an innovation). The estimated effect for our interaction variables is significantly negative for a number of measures of industry innovativeness, and for both sets of analyses using sales growth and returns on assets as the dependent variable. More importantly, the negative impact can negate any positive impact from the main effect of the innovativeness of the firm. Figure 1 illustrates the impact of sales growth from the industry environments with different time to commercialization: at an efficient, functional industry environment with a high time to commercialization (1 standard deviation above the mean) results in almost no sales growth for a range of innovativeness. Likewise, Figure 2 illustrates a similar impact on returns on assets from industry environments with different time to commercialization: in an industry with a high time to commercialization (1 standard deviation above the mean), a new venture developing and commercializing an innovation would in fact result have a negative impact on its returns on assets compared with another new venture not developing an innovation. This clearly illustrates how a high level of innovations in an industry can act as a high barrier for new ventures to cross over to be competitive to the marketplace. Our data in this study does not provide for information on the competitors of the new ventures, which have in other studies proved to be vital for the survival of new ventures (e.g., Fan, 2010), and could be included in other industry contexts.

In particular, the estimated coefficient for the interaction term between innovativeness and novelty of innovations in an industry is significant only when sales growth is used as the dependent variable, and not when returns on assets is used. This may be because the prevalence of novel innovations in an industry serves as a barrier for new ventures developing innovative products, but those new ventures that persist on developing innovations can still command a healthy profit margin (not so adversely affecting returns on assets) even though sales growth suffers. Likewise, the estimated coefficient for the interaction term between innovativeness and the average cost of a major innovation project in an industry is significant only when returns on assets is used as the dependent variable, and not when sales growth is used. This maybe because the average cost of a major innovation project in an industry drives up the cost required to develop and commercialize an innovation project – impacting more on the firm's profit measures than its growth in sales.

Taking into account of the impact of rival's investment, we did not find that the R&D spending from industry rivals significantly impact a focal firm's probability of successfully developing a significant innovation, even though the sign of the estimated coefficient is positive. This non-significance likely reflects the generally higher variability of strategic orientations among new ventures compared with established firms often studied in the innovation spillovers literature (e.g., Knott, Posen and Wu, 2009), but consistent with studies comparing new ventures with established firms (Short *et al*., 2009).

In conclusion, our study shows that even in a relatively efficient and functional industry setting, the relation between innovative capability and new venture performance can be significantly moderated by the industry level of innovativeness. The effect is in general can be complicated: on average, developing innovations positively impact firm performance, and situating a firm within an innovative industry also positively impacts firm performance. However, a firm developing innovations in an already innovative industry negatively impacts firm performance.

References

Adler PS and Shenbar A. 1990. Adapting your technological base: The organizational challenge. *Sloan Management Review*, 25: 25-37.

Aghion P, Harris C, Howitt P, and Vickers J. 2001. Competition, imitation and growth with step-by-step innovation. *Review of Economic Studies* 68: 467-492.

Aiken LS and West SG. 1991. *Multiple Regression: Testing and Interpreting Interactions*. Sage: Newbury Park, CA.

Ali A, Kalwani MU, and Kovenock D. 1993. Selecting product development projects: pioneering versus incremental innovation strategies. *Management Science* 39: 255-274.

Australian Bureau of Statistics. 1994. *Innovation in Australian Manufacturing* (ABS Publication No. 8816.0). Retrieved from http://www.abs.gov.au/

Australian Bureau of Statistics. 2000. *Business Longitudinal Survey: Confidentialised Unit Record File1994-1995, 1995-1996, 1996-1997, 1997-1998.* Canberra: Australian Bureau of Statistics.

Australian Government: Department of Industry, Innovation, Science, Research and Tertiary Education (2012). *Smarter manufacturing for a smarter Australia*. Retrieved from http://www.innovation.gov.au/Industry/Manufacturing/Taskforce/Documents/SmarterManufacturing.pdf

Bain JS. 1959. *Industrial Organization*. Wiley: New York.

Bloodgood JM, Sapienza HJ, Almeida JG. 1996. The internationalization of new high-potential U.S. ventures: Antecedents and outcomes. *Entrepreneurship Theory and Practice* 20(4): 61-76.

Capon N, Farley JU, Hoenig S. 1990. Determinants of financial performance: A meta-analysis. *Management Science* 36: 1143-1159.

Christensen, JF. 1995. Asset profiles for technological innovation. *Research Policy*, 24: 727-745.

Chung W, Kalnins A. 2001. Agglomeration effects and performance: A test of the Texas lodging industry. *Strategic Management Journal* 22(10): 969-988.

Clarke RN. 1989. SICs as delineators of economic markets. *Journal of Business* 62: 17–31.

Cooper G. 2000. Strategic marketing planning for radically new products. *Journal of Marketing* 64: 1-16.

Covin JG, Slevin DP, Heeley MB. 2000. Pioneers and followers: Competitive tactics, environment, firm growth. Journal of Business Venturing 15(2), 175-210.

D'Aveni RA. 1994. *Hypercompetition: Managing the Dynamics of Strategic Maneuvering*. Free Press: New York.

Davisson P, Steffen P, Fitzsimmons J. 2009. Growing profitable or growing from profits: Putting the horse in front of the cart? *Journal of Business Venturing* 24(4): 388-406.

Derfus PJ, Maggitti PG, Grimm CM, Smith KG. 2008. The red queen effect: competitive actions and firm performance. *Academy of Management Journal* 51(1): 61-80.

Desphande R, Farley JU, Webster FE. 1993. Corporate culture, customer orientation and innovativeness in Japanese firms: A quadrad analysis. *Journal of Marketing* 57: 23-27.

Fan TPC. 2010. De novo venture strategy: Inaugural entry and arch-incumbency. *Strategic Management Journal*, 31 (1), 19-38.

Fell J. (2012, Dec. 26). Mark Cuban: What entrepreneurs need to know before starting a business. *Entrepreneur*. Retrieved from http://www.enterpreneur.com

Ferrier WJ, Smith KG, and Grimm CM. 1999. The role of competitive action in market share erosion and industry dethronement: A study of industry leaders and challengers. *Academy of Management Journal* 42: 372-388.

Gimeno J, Folta TB, Cooper AC, Woo CY. 1997. Survival of the fittest? Entrepreneurial human capital and the persistence of underperforming firms. *Administrative Science Quarterly*, 42 (4), 750-783.

Geroski P, and Pomroy R. 1990. Innovation and the evolution of market structure. *Journal of Industrial Economics* 38: 299-314.

Geroski PA, Gilbert RJ, and Jacquemin A. 1990. *Barriers to Entry and Strategic Competition*. Harwood: Chur, Switzerland.

Geroski PA, Mata J, and Portugal P. 2010. Founding conditions and the survival of new firms. *Strategic Management Journal*, 31(5): 510-529.

Gilbert BA, McDougall PP, and Audretsch DB. 2006. New venture growth: A review and extension, *Journal of Management*, 32 (6), 926-950.

Gorecki PK. 1975. The determinants of entry by new and diversifying enterprises in the U.K. manufacturing sector 1958–1963: some tentative results. *Applied Economics* 7: 139–147.

Guan J and Ma N. 2003. Innovative capability and export performance of Chinese firms. *Technovation*, 23: 737-747.

Han JK, Kim N, Srivastava RK. 1998. Market orientation and organizational performance: Is innovation a missing link? *Journal of Marketing* 62(4): 30-45.

Harrigan KR. 1981. Barriers to entry and competitive strategies. *Strategic Management Journal* 2(4): 395–412.

Harrigan KR. 1983. Entry barriers in mature manufacturing industries. In *Advances in Strategic Management*, Vol. 2, Lamb RB (ed). JAI Press: Greenwich, CT; 67–97.

Hausman JA. 1978. Specification Tests in Econometrics. *Econometrica* 46(6): 1251–1271.

Hawawini G, Subramanian V, and Verdin P. 2003. Is performance driven by industry-or-firm-specific factors? A new look at the evidence. *Strategic Management Journal* 24(1): 1-16.

Henderson RM and Clark KB. 1990. Architectural innovation: The recofiguration of existing product technologies and failure of established firms. *Administrative Science Quarterly*, 35: 9-30.

Huber, PJ. 1967. The behavior of maximum likelihood estimates under nonstandard conditions. *Proceedings of the Fifth Berkeley Symposium on Mathematical Statistics and Probability*, 1:221–33.

Knott AM and Posen HE. 2009. Firm R&D behavior and evolving technology in established industries. *Organization Science* 20(2): 352-367.

Knott AM, Posen HE, and Wu B. 2009. Spillover asymmetry and why it matters. *Management Science* 55(3): 373-388.

Kotabe M, and Swan KS. 1995. The role of strategic alliances in high-technology new product development. *Strategic Management Journal* 16(8): 621-636.

Kotha S, and Nair A. 1995. Strategy and environment as determinants of performance: Evidence from the Japanese machine tool industry. *Strategic Management Journal* 16(7): 497-518.

Levin R, Reiss P. 1988. Cost-reducing and demand-creating R&D with spillovers. *Rand Journal of Economics* 19(4): 538-556.

Li H, Atuahene-Gima K. 2001. Product innovation strategy and the performance of new technology ventures in China. Academy of Management Journal 44(6): 1123-1134.

Li H, Zhang Y. 2007. The role of managers' political networking and functional experience in new venture performance: Evidence from China's transition economy. Strategic Management Journal 28(8): 791-804.

Lieberman MB. 1989. The learning curve, technology barriers to entry, and competitive survival in the chemical processing industries. *Strategic Management Journal* 10(5): 431–447.

Lin CYY, Chen MYC. 2007. Does innovation lead to performance? An empirical study of SMEs in Taiwan. *Management Research News*, 30 (2): 115 – 132.

Lumpkin GT and Dess GG. 1996. Clarifying the entrepreneurial construct and linking it to performance. *Academy of Management Review*, 21(1): 135-172.

McDougall PP, Oviatt BM, Shrader RC. 2003. A comparison of international and domestic new ventures. *Journal of International Entrepreneurship* 1: 59-82.

Montoya-Weiss MM, Calantone R. 1994. Determinants of new product performance: A review and meta-analysis. *Journal of Product Innovation Management*, 11(5): 397-417.

Peng MW, Luo Y. 2000. Managerial ties and firm performance in a transition economy: The nature of a micro-macro link. *Academy of Management Journal*, 43 (3): 486-501.

Pérez-Luño A, Wiklund J, and Valle Cabrera R. 2011. The dual nature of innovative activity: How entrepreneurial orientation influences innovation generation and adoption. *Journal of Business Venturing* 26: 555-571.

McDougall PP, and Oviatt BM. (2000). "International entrepreneurship: the intersection of two research paths". *Academy of Management Journal* 43: 902–908.

McMahon R. 2001. Business Growth and Performance and the Financial Reporting Practices of Australian Manufacturing SMEs. *Journal of Small Business Management* 39(2): 152-164.

Oviatt BM, and McDougall PP. (1994). "Toward a theory of international new ventures." *Journal of International Business Studies*, 25: 45-64.

Parks R. 1967. Efficient estimation of a system of regression equations when disturbances are both serially and contemporaneously correlated. *Journal of the American Statistical Association*, 62:500-509.

Reynolds PD, Bygrave WD, and Autio E. 2003. *Global Entrepreneurship Monitor*. Babson College: Babson Park, MA.

Rhee M. 2009. Does reputation contribute to reducing organizational errors? A learning approach. *Journal of Management Studies*, 46: 676-703.

Robinson KC and McDougall PP. 2001. Entry barriers and new venture performance: A comparison of universal and contingency approaches. *Strategic Management Journal* 22(6-7): 659-685.

Sarkar MB, Echambadi R, Agarwal R, Sen B. 2006. The effect of the innovative environment on exit of entrepreneurial firms. *Strategic Management Journal* 27(6): 519-539.

Saville, D., G. R. Wood. 1991. *Statistical Methods: The Geometric Approach*. Springer-Verlag, New York.

Schoonhoven CB, Eisenhardt KM, and Lyman K. 1990. Speeding products to market: waiting time to first product introduction in new firms. *Administrative Science Quarterly* 35: 117-207.

Short JC, McKelvie A, Ketchen DJ Jr, Chandler GN. 2009. Firm and industry effects on firm performance: A generalization and extension for new ventures. *Strategic Entrepreneurship Journal* 3(1), 47-65.

Sine WD, Shane S, and DiGregorio D. 2003. The halo effect and technology licensing: The influence of institutional prestige on the licensing of university inventions. *Management Science*, 49: 478–496.

Sine WD, Haveman HA, and Tolbert, PS. 2005. Risky business? Entrepreneurship in the new independent power sector. *Administrative Science Quarterly*, 50: 200–232.

Slater SF, and Narver JC. 1994. Does competitive environment moderate the market orientation-performance relationship? *Journal of Marketing* 58(1): 46-55

Song M, Podoynitsyna K, Van Der Bij H, Halman, JIM. 2008. Success factors in new ventures: A meta-analysis. *Journal of Product Innovation Management* 25 (1): 7-27.

Subramaniam M and Youndt MA. 2005. The influence of intellectual capital on the types of innovative capabilities. *Academy of Management Journal*, 48(3): 450-463.

White H. 1982. Maximum likelihood estimation of misspecified models. *Econometrica*, 50, 1-25.

Wiklund J, Davidsson P, and Delmar F. 2003. What do they think and feel about growth? An expectancy-value approach to small business managers' attitude towards growth. *Entrepreneurship Theory and Practice*, 26 (3), 247-270.

Zahra SA. 1996. Technology strategy and company performance: Examining the moderating effect of the competitive environment. *Journal of Business Venturing* 11(3): 189-219.

Zahra, S.A. (2003). International expansion of U.S. manufacturing family businesses: ownership and involvement. *Journal of Business Venturing*, 18, 495-512.

Zahra, SA, Bogner WC. 2000. Technology strategy and software new ventures' performance: exploring the moderating effect of the competitive environment. *Journal of Business Venturing*, 15: 135-173.

Zahra SA, and George G. 2002. Absorptive Capacity: A review, reconceptualization, and extension. *Academy of Management Review*, 27(2):185-203.

Zahra SA, Ireland D, and Hitt MA. 2000. International expansion by new venture firms : international diversity, mode of market entry, technological learning, and performance. *Academy of Management* 43(5): 925-950.

Zahra SA and Nielsen AP. 2002. Sources of capabilities, integration and technology commercialization. *Strategic Management Journal* 23(5): 377-398.

Zoltan J and Audretsch, DB. 1989. Small-firm entry in US Manufacturing. *Economica*, 56(222): 266-265.

Appendix

Table 1 Descriptive Statistics, Variance Inflation Factors, and Condition Indices (*N* = 489)

Variables	Mean	S.D.	Min.	Max.	VIF	Cond. Index
Industry growth (%)	17.25	2.325	13.203	20.09	2.42	1.00
Lagged firm size (employee)	13.84	16.56	0	136	1.33	2.16
Firm age[a] (yrs.)	2.802	0.858	1	4	1.08	2.27
Working capital ($'000)	99.68	1059	5172	15003	1.15	2.35
Industrial relations (% union members)[b]	1.603	1.299	1	6	1.14	2.38
Family business	0.485	0.500	0	1	1.07	2.42
Major decision-maker's experience (yrs)	6.546	9.513	0	1	1.11	2.59
Outside investor equity (%)	2.146	13.15	0	100	1.07	3.11
Lagged innovativeness (instr. var.)	0.202	0.143	0.114	0.973	1.15	3.36
Cost of innovation ($'000)	60.04	14.93	34.98	81.11	1.07	3.97
Time to commercialize innovation (yrs)	1.609	0.089	1.421	1.69	1.47	4.48
Expected time to pay-off from innovation (yrs)	2.595	0.154	2.306	2.767	1.40	5.15
Novelty of innovation (%)	2.444	1.863	0.08	5.898	1.70	12.22
Sales ($'000)	1537	3102	0	22625	-	-
Return on assets	0.306	3.536	-8	86	-	-

[a]*1 = 0 to <2 years; 2 = 2 to <4 yrs; 3 = 4 to <6 yrs; 4 = 6 to <8 yrs.* [b]*1 = none; 2 = 10% or less; 3 = 11-25%; 4 = 26-50%; 5 = 51-75%; 76-100%.*

Table 2 Logit Estimates of Innovative Capability (*N* = 489)

Variable	
Log (lagged firm investment on innovation)	0.256***
	(0.042)
Log (lagged rival firms' pooled investment on innovation)	0.096
	(0.088)
Constant	-2.325
	-1.159
Chi-square	49.88***
R^2	0.105

*Robust standard errors in parentheses; * p < 0.10; ** p < 0.05; *** p > 0.01; 2-tailed tests.*

Table 3 FGLS Estimates of New Venture Performance, 1994-1998 (N = 489)

	Sales growth			Return on assets		
Variables	Model 1-1	Model 1-2	Model 1-3	Model 2-1	Model 2-2	Model 2-3
Industry growth	0.045	-0.045	-0.019	-0.149	0.049	0.049
	(0.050)	(0.074)	(0.074)	(0.080)	(0.120)	(0.119)
Lagged firm size	0.045***	0.039***	0.040***	-0.008	-0.010	-0.006
	(0.007)	(0.007)	(0.007)	(0.012)	(0.012)	(0.012)
Firm age	0.315*	0.331*	0.335*	0.228	0.274	0.284
	(0.173)	(0.178)	(0.175)	(0.281)	(0.288)	(0.282)
Working capital x 10^{-2}	-0.022**	-0.021**	-0.024**	0.001	0.003	-0.001
	(0.010)	(0.010)	(0.010)	(0.017)	(0.017)	(0.016)
Industrial relations	0.172*	0.169*	0.163*	-0.009	-0.025	0.008
	(0.096)	(0.096)	(0.095)	(0.156)	(0.155)	(0.153)
Family business	0.219	0.277	0.353	-0.466	-0.459	-0.462
	(0.229)	(0.230)	(0.228)	(0.371)	(0.372)	(0.367)
Major decision-maker's experience	0.026**	0.023*	0.026**	0.005	0.003	-0.001
	(0.012)	(0.012)	(0.012)	(0.020)	(0.020)	(0.020)
Outside investor equity	-0.027**	-0.025**	-0.024**	-0.007	-0.004	-0.007
	(0.011)	(0.011)	(0.011)	0.008	(0.018)	(0.018)
Years since 1994	-0.656***	-0.633***	-0.587***	(0.018)	0.245	0.320
	(0.163)	(0.164)	(0.162)	0.230	(0.266)	(0.262)
Lagged innovativeness (instr. var.)		1.486*	2.116**	(0.265)	2.255*	3.572**
		(0.837)	(0.959)		(1.355)	(1.547)
Cost of innovation		-0.096	-0.076		-0.367	0.383
		(0.115)	(0.214)		(0.186)	(0.346)
Time to commercialize innovation		0.202	0.431**		-0.301	0.551
		(0.135)	(0.214)		(0.218)	(0.345)
Expected pay-off period from innovation		-0.122	0.219		-0.102	0.250
		(0.131)	(0.228)		(0.213)	(0.368)
Novelty of innovation		0.139	0.636***		-0.171	-0.244
		(0.145)	(0.238)		(0.235)	(0.384)
Innovativeness x cost			-0.106			-4.758***
			(1.068)			(1.723)
Innovativeness x commercialize			-1.724*			-4.930***
			(0.974)			(1.571)
Innovativeness x pay-off			-1.540			-2.252
			(1.089)			(1.756)
Innovativeness x novelty			-2.783**			0.384
			(1.119)			(1.805)
Constant	3.880***	5.116***	4.428***	-0.209	-1.873	-2.268
	(1.049)	(1.450)	(1.444)	(1.702)	(2.347)	(2.329)
Wald Chi-Square	83.70***	91.85***	112.10***	5.09	14.04*	35.43***
D.f.	9	14	18	9	14	18

*Standard errors in parentheses; * p < 0.10; ** p < 0.05; *** p < 0.01; 2-tailed tests.*

Figure 1: Innovativeness and Sales Growth by Time to Commercialize Innovation in an Industry

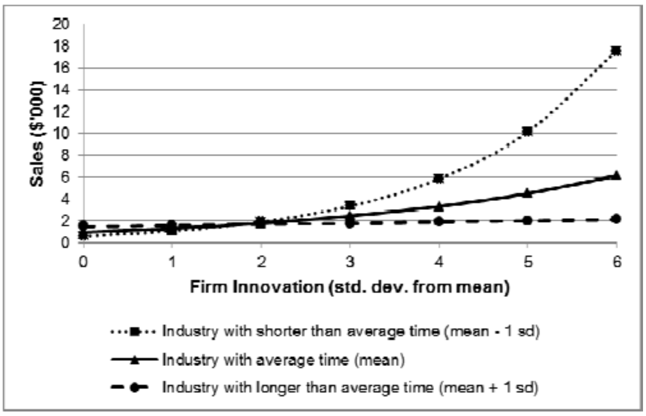

Figure 2: Innovativeness and ROA by Time to Commercial Innovation in an Industry