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The confounding impact of industry innovations on new venture performance

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Abstract

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Key words: new venture performance, innovations, industry environment, red queen

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 (Capon, Farley and Hoenig, 1990). 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). 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. 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).

In 'functional' institutional environments where better technical performance and lower prices by the end-products or services are critical to the purchase decisions by customers (Li and Zhang, 2007), 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). In any case, an innovation that turned out to be undesirable by customers can be withdrawn by the focal firm, which can then revert to its prior product offering. In other words, innovations generally expand the operational and marketing options for the focal firm, who can choose not to realize these options. 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).

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, innovations undertaken by industry rivals have been shown to 'expand the pie' for the entire industry, in turn improving – and not worsening – the performance of a focal firm in that industry. This provides a fresh contingency perspective to unpack the inconclusive link between innovations and performance for the focal firm.

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 and cannot simply play 'catch-up' to rivals as in established firms – can be 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). 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 with underperformance (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 innovations 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 had functional institutions and was 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 a new and important stream of research on international new ventures, or the notion of 'born-global' firms. 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 moderated 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 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.

Innovations and new venture performance

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 at a focal firm in a competitive manner (see e.g., Mu and Bernadetto, 2011). As a result, we follow in our subsequent modeling 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 the likelihood of innovations that in turn improve performance in a functional environment, given everything else the same. Our baseline expectation on innovations developed by a focal new venture on its own performance is as follows:

Hypothesis 1: Innovations developed by a focal new venture improve its subsequent performance.

Industry innovations and the performance of new ventures

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 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.

In a ‘functional’ environment – with adequate institutional infrastructure (i.e., far from a ‘dysfunctional’ environment), an innovative industry – as evidenced by innovative activities undertaken by firms other than a focal firm – can improve the performance of a focal firm. We discuss four ways in which this level of innovation activities can be observed, and how the these in turn influences the performance of constituent new ventures of the focal industry: novelty of innovations, time to commercialization, total R&D expenditure, and expected pay-off period.

The novelty of innovations dictates the kind of competitive advantage sought by the undertaking firms, and has important implications on resource requirement and capability development (Kotabe and Swan, 1995). An industry with many innovations being new to the industry worldwide signals an international reputation for the firms that undertake these innovations and for the industry in general. These innovations help increase the level of product information and awareness by potential customers, such that potential buyers of the products from innovative firms in this industry may likely consider what other firms in this industry have to offer. In this way, an increased reputation of a producer from a particular location can also improve the perception of its competitors from nearby locations, as in the production of fine wine in certain locations in France. In general, the many novel innovations pursued by firms in an industry also likely attests to an internationally competitive industry.

Meanwhile, firms in the same industry which are also located in the same country or geographic region can benefit from the mobility of well-trained professionals at firms that undertake these novel innovations. Professionals experienced in an R&D project in one firm may recognize similar analogies in another unrelated project upon moving to a different firm (e.g., Gavetti, Levinthal and Rivkin, 2005). Further, even firms that are not undertaking innovation activities can benefit from such activities undertaken by others in the same industry through the often unexpected turns of technological investigations (Merton and Barber, 2004; Dew, 2009; Austin, Devin and Sullivan, 2012). For instance, an uninteresting technological finding in one project may be the solution to a critical aspect of another project. More novel innovations in an industry translate into more opportunities for such unexpected discoveries and applications. As a result, this leads to the following in a functional institutional environment:

Hypothesis 2a: New ventures in an industry with more novel innovations perform better than their counterparts in an industry with less novel innovations.

Apart from novelty, prior studies indicate 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). In a functional institutional environment, efficient firms thrive while inefficient ones either rejuvenate in time or die out – leaving only efficient firms in the industry in the long run. Efficient firms do not take unnecessarily long time to commercialize an innovation. If the time to commercialization for an average innovation is high even with these efficient firms around (i.e., in a functional institutional environment), the average innovation must be reasonably complicated to implement. In other words, the standard of innovation must be relatively high in this industry, and this industry should likely be quite competitive internationally.

At the same time, a longer average time to innovation commercialization means that firms in the same industry can expect the *status quo* to persist for longer, delaying technological disruptions to the existing business. This lead to the following in a functional institutional environment:

Hypothesis 2b: *New ventures in an industry with longer times to commercialize an innovation perform better than their counterparts in an industry with shorter times to commercialize an innovation*.

In a similar logic, efficient firms should not engage more resources than necessary to develop and innovation. In a functional institutional environment with relatively efficient firms, an industry with a larger R&D expenditure per innovation project is likely more advanced, more committed to innovations and likely more internationally competitive than another one with a lower cost per project. Meanwhile, high costs spent on innovations by each firm increase the demand for related complements or raw materials – thereby increasing related activities in this industry. With increased activities, more economies of scale or information can be reaped – bringing down costs to further innovations or to simply acquiring raw materials or manufacturing related products. In this way, even though a focal firm is not directly involved in undertaking certain innovation activities, its competitors undertaking them inadvertently helps improve the performance of the focal firm. Recent studies on innovation spillovers confirm how 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).

The overall impact of a higher investment on innovations in an industry would similarly, as longer time to commercialization, be expected to improve the performance of new ventures in the same industry, except perhaps with the difference that a larger innovation spend may also incur larger cost over-runs over time – potentially also mitigating the positive impact on the performance of new ventures. As such, we have the following a functional institutional environment:

Hypothesis 2c: *New ventures in an industry with higher R&D expenditure for the average innovation project perform better than their counterparts in an industry with lower R&D expenditure*.

Larger absolute costs per innovation project and a longer average time to commercialization are two important aspects on the complexity of innovations pursued in an industry. A third measure that is more related to the financial nature of these projects concerns the expected pay-off period for the average project (Ali *et al*., 1993). In spite of an average innovation requiring much resource and taking a long time to commercialize, it may still make a lot of investment sense if its expected pay-off is short.

In an industry with functional institutions and hence generally efficient firms, long average expected pay-off periods are indicative of the intensive nature of innovations in that industry – likely because innovations projects with shorter pay-off periods have already been explored, implemented, and possibly even imitated by rivals. As such, constituent firms – including new ventures – may enjoy the international reputation garnered as a result of the competitiveness in innovations.   Long expected pay-off periods for innovation projects are also indicative of the confidence firms generally have in their own future, likely a reflection of the international competitiveness of the industry as a whole. Suppliers to firms undertaking innovation projects may therefore more likely to make longer-term investments as in human capital and high-technology machinery – which in turn boost longer-term productivity. Based on this logic, we have the following for an environment with functional institutions:

Hypothesis 2d: *New ventures in an industry with longer expected pay-off periods in innovation projects perform better than their counterparts in an industry with shorter expected pay-off periods*.

Industry innovations and the performance of innovative new ventures

The preceding discussion leading to Hypotheses 2a through 2d primarily concern how new ventures in general can benefit from the innovation activities undertaken by their competitors in their industry under functional institutions (and the prevalence of efficient firms). These new ventures need not themselves be involved in developing innovations in their respective industries.

For a new venture that actually develops its own innovation to carve out its own business niche, however, internationally competitive innovations by their industry peers may in fact translate into higher barriers for successful product entry. As we describe in this section, the harmful effects from competitive innovations undertaken by industry peers can erode the performance-enhancing effect from the high reputation or spillovers from innovations by industry peers.

If innovation activities developed by industry peers are highly novel and competitive, that is an indication that less novel or less competitive innovations developed by a new venture might not be sufficient to win a lot of customers. In other words, the highly novel innovations pursued by industry peers set up a high entry barrier in terms of innovativeness in that industry. In view of these novel innovations (compared with other industries where firms develop much less novel ones), new ventures have to redouble their efforts if they intend to rely on innovative products to break into the marketplace (Harrigan, 1981; Robinson and McDougall, 2001).

Meanwhile, studies on innovation spillovers on publicly listed firms across multiple industries point to the imitation of successful innovations 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. Likewise, even as new ventures successfully commercialize their own innovations. In industries where competitors routinely develop novel innovations, competitors can easily imitate successfully commercialized innovations of new ventures. The overall impact of this competition for innovations 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. Given the generally constrained resources and legitimacy of new ventures compared to established incumbents, such Red Queen Effects can be detrimental to the performance of new ventures developing their own innovations. This leads to the following in a functional institutional environment:

Hypothesis 3a: *For new ventures that develop their own innovations, an industry with more novel innovations impacts more negatively on their performance than an industry with less novel innovations*.

Similarly, in a functional environment, an industry with a long time to commercialization for an average innovation signals that the average innovation must be reasonably complicated to implement. For new ventures relying on their own innovations to carve out a business niche, the entry bar is set relatively high. The long time for innovation commercialization also reflects the high innovative capacity of firms in this industry. Less thoughtful or complicated innovations developed by new ventures may be imitated easily by competitors. As a result, we have the following:

Hypothesis 3b: *For new ventures that develop their own innovations, an industry with longer times to commercialize an innovation impacts more negatively on their performance more than an industry with shorter times of commercialization*.

Likewise, in a functional institutional environment with efficient firms, an industry with a larger expenditure on the average innovation project is likely more advanced, more committed to innovations and likely more internationally competitive than another one with a lower cost per innovation project. Meanwhile, the larger R&D spending also means that competitors in this industry are likely to be more willing to invest in innovations than firms in another industry with lower average investments. These mean that new ventures developing their own innovations have to contend with their more capable and possibly more resourceful rivals to successfully eke out a place for their innovations in the marketplace.

Note that the willingness for firms in an industry to spend large amounts of resources on their innovation projects is not necessarily reflective of their underlying profits. Davidsson, Steffens and Fitzsimmons (2009), for instance, have demonstrated that firms may be willing to sacrifice short-term profits for larger growth in volumes or market share. Similarly, firms may be willing to sacrifice short-term profits for a chance in getting ahead of others by investing in and thus spending more on innovations today. In any case, a larger average spend on innovations means that firms in that industry in general are willing to spend on imitating a successful innovation developed by a new venture, or to spend on developing an improved innovation that would in turn erode the competitive advantage of an innovation developed by a new venture. As such, we have the following a functional institutional environment:

Hypothesis 3c: *For new ventures that develop their own innovations, an industry with higher R&D expenditure for the average innovation project impacts more negatively on their performance than an industry with lower R&D expenditure*.

In a similar vein, with functional institutions (and prevalence of efficient firms), an industry that has on average longer expected pay-off periods (Ali *et al*., 1993) is likely indicative of the competitive nature of innovations in that industry, as well as the confidence firms generally have in their own future. In other words, these firms are likely able and willing to imitate successful innovations developed by new ventures should these projects entail shorter pay-off periods. New ventures developing their own innovations therefore have a high entry barrier in terms of how likely their competitive advantage due to their own innovations can be eroded by competitive retaliation or imitations brought on by their industry rivals. Note also that a having a longer average pay-off period again does not necessarily mean that firms in that industry are more profitable (Davidsson, Steffens and Fitzsimmons, 2009). Based on this logic, we have the following for a functional environment:

Hypothesis 3d: *For new ventures that develop their own innovations, an industry with longer expected pay-off periods in innovation projects impacts more negatively on their performance than an industry with shorter expected pay-off periods*.

In view of Hypotheses 2a through 2d, and Hypothesis 3a through 3d, we expect that under functional institutions and hence a prevalence of efficient firms, new ventures in general would perform better in an industry with novel and competitive innovations, but new ventures themselves developing innovations would fare worse in the same industry. These two effects are clearly opposite in nature and negate each other.

Method

Research setting and sample

To ensure that we select an industry setting that was generally competitive internationally (i.e., not ‘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 yearly periods from 1994 to 1998. In particular, the 1994 survey also asked firms about their activity, expenditure and intentions up to two previous years. 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 includes only with firms operating in the manufacturing sector, which represents approximately 25 percent of the sample. Within manufacturing, nine subsectors were used to test our hypotheses based on their respective industry environments. These are: 1) food, beverage and tobacco manufacturing, 2) textile, clothing, footwear and leather manufacturing, 3) wood and paper product manufacturing, 4) printing, publishing and recorded media, 5) petroleum, coal, chemical and associated product manufacturing, 6) non-metallic mineral product manufacturing, 7) metal product manufacturing, 8) machinery and equipment manufacturing, and 9) other manufacturing.

In addition, since we are interested in the performance of new ventures, we include inour analysis only those firms that were less than six years old prior to 1994 or founded during our sampling period (cf. Bloodgood *et al*., 1996; McDougall *et al*., 2003; Robinson and McDougall

2001). We eliminated firms which were subsidiaries or spin-offs of existing organizations. The final data set consisted of 163 new ventures from 1994 to1998.

A number of reasons explained why we chose a sample of independent new manufacturing ventures for our analysis. First, we planned to investigate whether an industry's innovation environment is favorable or unfavorable to new entrants, which behave differently from 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 entry barriers 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, R&D had made important inroads in the manufacturing industry (Smarter Manufacturing, 2012).

Data analysis

We modeled and tested our hypotheses in two stages. Noting that firm performance is more directly impacted by commercialized innovations instead of R&D spending (Zahra, 1996; Zahra and Bogner, 2000), and that R&D spending in turn increases the probability of successfully commercializing innovations (Mu and Bernadetto, 2011), we used the first stage in our empirical model to estimate the probability (Y) for which a firm (*i*) developed or introduced any new or substantially changed products or services in a given year (*t*). This estimation, based on both the R&D spending of the focal firm as well as the R&D spending of all other firms in the same industry (as per Levin and Reiss, 1988, and Knott, Posen and Wu, 2009), is based on a logit model (probit model yields similar results):

$$Y_{it} = Y(INN_{it\text{-}1}, RVL_{it\text{-}1}) \qquad \ldots(1)$$

where $\mathrm{INN}_{i,t\text{-}1}$ is the (logged) expenditure on innovation (on the development of new or changed products or processes) by the new venture itself (firm *i*) and $\mathrm{RVL}_{i,t\text{-}1}$ is the (logged) total of expenditure on innovation by all rival firms in the same industry of firm *i*. Based on the Australian BLS survey, we considered costs associated with developing new or substantially changed products, services or processes as part of R&D spending.

In the second stage, we tested our hypotheses using two measures of performance (denoted by π below), and include the probability of commercializing an innovation from the first stage as our variable together with other independent and control variables in this equation:

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

$Y_{i,t\text{-}1}$ is the probability of a new venture (*i*) developing an innovation to the point of commercialization in year *t*-1, projected from our first-stage estimation (equation 1), and was used to test Hypothesis 1. For a given industry subsector *m*, in which new venture *i* 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 $\mathrm{GBL}_{i,m}$ is the proportion of firms with innovations that are new to the industry worldwide (i.e., not just new-to-the-firm). These measures were drawn from the ABS' *Innovation in Australian Manufacturing* (1994) publication and were used to test Hypotheses 2a through 2d, where *CST* and *GBL* were reported by different subsectors of the Australian Manufacturing industry, and *COM* and *RCV* were weighted averages for a subsector estimated based on the distribution from all respondent firms across subsectors. To respect commercial sensitivity, ABS masked the identity of individual firms by selectively offering to the public those data elements that could not be used to reverse-engineer the identity of individual firms. $I_{it\text{-}1,m}$

refers to the set of multiplicative interaction terms between our estimated probability of new venture *i* commercializing an innovation and our four characteristics of innovations in an industry subsector – these are used to test Hypotheses 3a through 3d. C_{it} refers to the vector of time-varying control variables, and μ_{it} denotes a stochastic error term. α, β, χ, δ, η, λ, ϖ and γ are coefficients to be estimated.

Equation 2 was estimated using feasible generalized least squares (FGLS). Because differences in innovation environments are more likely to manifest in inter-firm variations, rather than intra-firm variation over the short-term, generalized least squares (GLS) models such as the fixed effects model are less suitable. Another advantage of using FGLS over GLS is that this procedure estimates rather than assumes the error processes when analyzing longitudinal data (cf. Parks, 1967). We used the XTGLS procedure in STATA 12. We also experimented with alternative specifications of heteroskedastic and correlated error structures, which largely produced similar effect estimates for the independent variables.

Performance Measures and Controls

Consistent with the latest studies entrepreneurship (e.g., see Davidsson, Steffens and Fitzsimmons, 2009), we used two measures that potentially capture two polar views of new venture performance. The first was sales growth – meant to capture to the degree of success of commercialized innovations. 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). Sales growth recorded in the one-year period starting from the year after the R&D spending by the focal firm and its industry peers was used to estimate the probability the focal firm successfully develops an innovation for commercialization. This lag was instituted to ensure we indeed capture the effect of the innovations developed by a focal new venture.

Because of the multiple years of the ABS-BLS responses, we were able to include more than one observation for many new ventures in our sample.

To account for potential temporal trade-offs between growth and profit, we instituted a second performance measure – returns on assets (RoA) as a profitability measure. Understandably, however, new ventures typically do not already have a steady stream of revenue when they start their business. At the same time, much cost is required to be spent on initiating production and marketing activities. As such, profitability measures such as RoA are typically negative for the first few years for these ventures, and changes in these measures might not be as sensitive as sales growth to strategic choices made early in the life of new ventures.

As our sampling frame was only over several years within a decade, we did 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).

Several controls were included in our analysis. Some of these were basic information on each venture, including the number of employees in each firm as a proxy for size, firm age (reported in two-year periods to disguise the identity of individual firms), and the number of years of work experience of the major decision-maker. Some of these concern about the finances of new ventures: the size of the working capital as a crude proxy of resources and prior sales, the ratio of its current assets to current liabilities as a measure of liquidity, and the percentage of equity held by investors not related to (i.e., 'outside' of) the venture (since outside interest could potentially conflict with strategic decisions made by a new venture). A new venture that is family-owned has have been shown to be associated with stronger sales performance in the U.S. manufacturing context (Zahra, 2003), and hence we included a dummy variable for this (1 if the new venture is family-owned, 0 otherwise). We also controlled for the percentage of employees in a new venture who are union members, as a proxy measure of wage protection or job security. Finally, we controlled for the growth in each industry subsector by taking the weighted average percentage sales growth. In general, an industry subsector with a higher growth rate signals better opportunities for new ventures.

Table 1 presents descriptive statistics, variance inflations factors and condition indices for variables used in the regression analysis. The mean annual sales and ROA were more than $1.5 million and 30.6 percent respectively. To address potential multicollinearity concerns among main effects and between them and the interaction terms, we followed Sine and his colleagues (Sine, Shane, and DiGregorio, 2003; Sine, Haveman, and Tolbert, 2005) in orthogonalizing the four industry innovation variables (cost of innovation, time to commercialize innovation, pay-off period from innovation, and novelty of innovation) via the Gram-Schmidt procedure (cf. Saville and Wood, 1991). The resultant variance inflation factors and condition indices were less than 2.5 and 13 respectively (i.e., there were no concerns for multicollinearity).

Results

Table 2 shows the estimation results for the first stage of the analysis. In particular, spending on innovations by the focal new venture was positively and statistically significantly associated with developing innovations to the point of commercialization by that firm. Spending on innovations by other firms in the same industry subsector did not significantly influence the probability of the focal firm commercializing its innovations, although the estimated sign of the coefficient was positive. The non-significance of the coefficient for innovation spending by other firms in the same industry subsector is in contrast to the findings of Knott *et al*. (2009), although their study focused on established incumbents imitating one another in adopting similar innovations, while our context focused on new ventures developing innovations. From results shown in Table 2, we estimated for each of our observations the probability of commercializing an innovation, and this ranged between 11% and 97%.

Table 3 presents the results from the second-stage, FGLS estimates of new venture performance shown in Equation (2). Models 1-1 and 2-1 are the base models for new venture performance, containing only the control variables with sales growth and returns on assets respectively as dependent variables. In Model 1-1, the coefficient for the number of employees was positive and significant, while firm age was positive but only marginally significant. A larger working capital implied larger prior sales, and hence was negatively associated with sales growth. Larger proportions of employees being union members turned out to have a positive and significant effect on sales growth, likely because this corresponded with how new ventures were able to make use of traditional functional roles in their organization, enabling an earlier establishment of routines and specialization. At least for new ventures in our sample, family-owned businesses did not experience higher sales growth than other firms (cf. Zahra, 2003). The presence of a more experienced founder or employer as a major decision-maker was found to have a positive and significant effect on sales growth, while a higher percentage of equity held by outside investors had a negative impact. In contrast, we did not observe any significant coefficient for the control variables in Model 2-1 (when RoA was used as the dependent variable).

Models 1-2 and 2-2 added the main effects of the independent variables in our study. In Hypothesis 1, we had predicted that those new ventures that developed innovations to the point of commercialization (i.e., developed or introduced any new or substantially changed products or services) would perform better. In support of Hypothesis 1, our results showed that the greater the probability a new venture would develop innovations to the point of commercialization, the better their performance – in both sales growth and returns on assets.

Hypotheses 2a through 2d postulated that an industry subsector with advanced innovations would generally be beneficial to the performance of new ventures than an industry subsector with less advanced innovations. When only the main effects of the four industry innovation attributes were included in the regression analysis (Models 1-2 and 2-2), the estimated coefficients were not significant – but this non-significance could be a result of the opposing effect for new ventures that did develop innovations themselves versus those that did not. Aiken and West (1991) cautioned against interpreting the lack of significance from main effects without first considering whether interaction effects exist. When the interaction terms were included (Models 1-3 and 2-3), two of the estimated coefficients became significant when sales growth was the dependent variable. In particular, the coefficients for innovation novelty (percent of innovations that were new-to-industry worldwide, $p < 0.01$) and time to commercialize an innovation ($p < 0.05$) were positive and statistically significant – supporting Hypotheses 2a and 2b respectively.

Several of the estimated coefficients for the interaction terms were also statistically significant. In particular, when sales growth was the dependent variable, the estimated coefficient for the interaction term between a new venture developing its own innovations and the industry of this new venture being novel in innovations in general was negative and statistically significant ($p < 0.05$) – supporting Hypothesis 3a. The negative estimated coefficient for the interaction term between a new venture developing its own innovations and the industry of this new venture having long time to develop commercializable innovations was marginally significant ($p < 0.10$) when sales growth was the dependent variable and statistically significant ($p < 0.01$) when returns on assets was the dependent variable – supporting Hypothesis 3b. When returns on assets was the dependent variable, the estimated coefficient for the interaction term between a new venture developing its own innovations and the industry of this new venture having high costs per innovation project was negative and statistically significant ($p < 0.01$) – supporting Hypothesis 3c.

The interaction effect on new venture performance is more dramatic when graphically illustrated by Figures 1 and 2, which plot the probability of innovation against sales and ROA respectively. In particular, in an industry (subsector) where the time to commercialize innovations is high, the total projected sales growth would be stagnant whether a new venture develops its own innovations or not (Figure 1), while the returns on assets may actually be worse for a new venture which develops its own innovations (Figure 2). Chi-square difference tests showed that both interaction terms (Models 1-3 and 2-3) significantly increased model fit ($p < 0.01$) relative to the models with main effects alone (Models 1-2 and 2-2). We found no significant moderating effects from expected pay-off period in the industry.

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. 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 innovations undertaken by the rest of the industry a new venture is in. Our focus on the relatively efficient Australian manufacturing industry of the 1990's allowed us to eliminate notions of inefficient competitors or dysfunctional institutional environments that would otherwise help explain the inconsistent findings between innovations and new venture performance.

Our main finding provided support to the idea that a new venture developing innovations on average positively impacts its performance – and this has been expected in a relatively efficient industry and functional institutional environment. However, our findings highlighted how this performance is significantly influenced by innovations undertaken by other industry peers in two ways. First, a new venture situated in an industry subsector with advanced innovations (as denoted by a large percent of innovations being new to industry worldwide or a long time to commercialize innovations) enjoyed higher sales growth than in another subsector. This was akin to the phenomenon of ‘a rising tide lifts all boats’. In a very broad manner, this also illustrated how industry innovativeness conferred benefits to its constituent firms, even though the latter might not be innovating. Because our data was on manufacturers in Australia, our finding could also in part be explained by physical agglomeration (e.g., Chung and Kalnins, 2001). This same effect, however, was not observed when returns to assets are used as the dependent variable. Recent studies (e.g., Davidsson, Steffens and Fitzsimmons, 2009) have noted the tendency for firms to trade off between short-term growth and profits, and this could explain our non-significance of main effects when the profit measure of returns on assets is used.

Second, an innovation-intensive industry effectively placed a high barrier for an innovative firm (one that actually developed or introduced an innovation). The estimated effect for our interaction variables is significantly negative for a number of measures of industry innovations, 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 (one standard deviation above the mean) an innovating new venture achieved 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 (one standard deviation above the mean), an innovating new venture would in fact have a negative impact on its returns on assets compared with another new venture not developing an innovation. This clearly illustrated how intensive innovations in an industry acted as a high barrier for innovative new ventures.

Consistent with recent studies on the sometimes competing directions for new ventures to focus on short-term growth or profitability (e.g., Davidsson, Steffens and Fitzsimmons, 2009), our regression analyses clearly showed that depending on whether sales growth or returns on asset was used as the dependent variable. For instance, the estimated coefficient for the interaction term between a new venture developing its innovations and the novelty of innovations in its industry subsector 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 novel innovations can still command a healthy profit margin even though sales growth suffers. Conversely, the estimated coefficient for the interaction term between a new venture developing its innovations and the average cost of a major innovation project in its industry subsector 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 directly drives up the cost required to develop and commercialize an innovation project (directly hurting the returns on assets for the new venture) but sales growth could still be sustained if the price is still competitive relative to industry peers.

In our first-stage analysis, R&D spending from industry rivals was not found to significantly impact a focal venture's probability of developing or introducing an 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), and is consistent with studies comparing new ventures with established firms (Short *et al*., 2009).

Certainly, our study has many limitations. In deciding to rely on broad-based surveys on new venture performance, we decided to forego the fine-grained perspective on the competitive relations between specific new ventures and its rivals. We also were not able to ascertain the nature of the products of the new ventures included in our sample, whether they were intended to be novel or competitive to an existing product (e.g., Chen, Su and Tsai, 2007; Fan, 2010). Future studies could perhaps complement our approach in this paper with such finer-grained perspective to offer more insights.

New ventures are typically resource-constrained relative to established incumbents. As such, influences from the environment have a more pronounced impact on the performance of these firms relative to established incumbents. While our study showed how new ventures are impacted by the innovations of their industry peers – and in a confounding manner, the impact on established incumbents is not known, and may be less pronounced. Future studies could perhaps compare whether incumbents too are subjected to the confounding effect of innovations by their industry peers.

Our data was taken from the 1990's in the Australian manufacturing industry. That was also a period where the Australian dollar was much lower than in the 2000's or 2010's. Unfortunately, the ABS-BLS survey changed their survey methodology after 1999, and hence we could not follow the same firms surveyed in the 1990s. Perhaps more statistical tools can be employed such that different snapshots of the Australian manufacturing industry can be taken at different points in time and then aggregated to provide a longer sampling frame, such that longer-term changes in currency movements and macro-economic conditions can also be controlled for.

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 status of innovations in that industry. 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.

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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
No. of employees	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 ($'000)	99.68	1059	5172	15003	1.15	2.35
Portion of employees being union members[b]	1.603	1.299	1	6	1.14	2.38
Family business	0.485	0.500	0	1	1.07	2.42
Major decision-maker's experience (yrs)	6.546	9.513	0	1	1.11	2.59
Outside investor equity (%)	2.146	13.15	0	100	1.07	3.11
Developing innovations (lagged, from first stage)	0.202	0.143	0.114	0.973	1.15	3.36
Cost per innovation project ($'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
% of innovations new-to-industry worldwide	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%; 6 = 76-100%.

Table 2 Probability of Developing an Innovation for Commercialization (N = 489)

Variable	Estimated coefficient
Log (lagged new venture spending on innovation)	0.256***
	(0.042)
Log (lagged rival firms' total spending 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			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)
No. of employees	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)
Portion of employees being union members	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***	0.230	0.245	0.320
	(0.163)	(0.164)	(0.162)	(0.265)	(0.266)	(0.262)
Developing innovations (lagged, from first stage) [H1]		1.486*	2.116**		2.255*	3.572**
		(0.837)	(0.959)		(1.355)	(1.547)
Novelty (% of innovations new-to-industry worldwide) [H2a]		0.139	0.636***		-0.171	-0.244
		(0.145)	(0.238)		(0.235)	(0.384)
Time to commercialize innovation [H2b]		0.202	0.431**		-0.301	0.551
		(0.135)	(0.214)		(0.218)	(0.345)
Cost per innovation project [H2c]		-0.096	-0.076		-0.367	0.383
		(0.115)	(0.214)		(0.186)	(0.346)
Expected pay-off period from innovation [H2d]		-0.122	0.219		-0.102	0.250
		(0.131)	(0.228)		(0.213)	(0.368)
Developing innovations x novel innovations [H3a]			-2.783**			0.384
			(1.119)			(1.805)
Developing innovations x time to commercialize innovation [H3b]			-1.724*			-4.930***
			(0.974)			(1.571)
Developing innovations x cost per innovation project [H3c]			-0.106			-4.758***
			(1.068)			(1.723)
Developing innovations x pay-off period [H3d]			-1.540			-2.252
			(1.089)			(1.756)
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 New Venture Growth by Time to Commercialize Innovation in an Industry

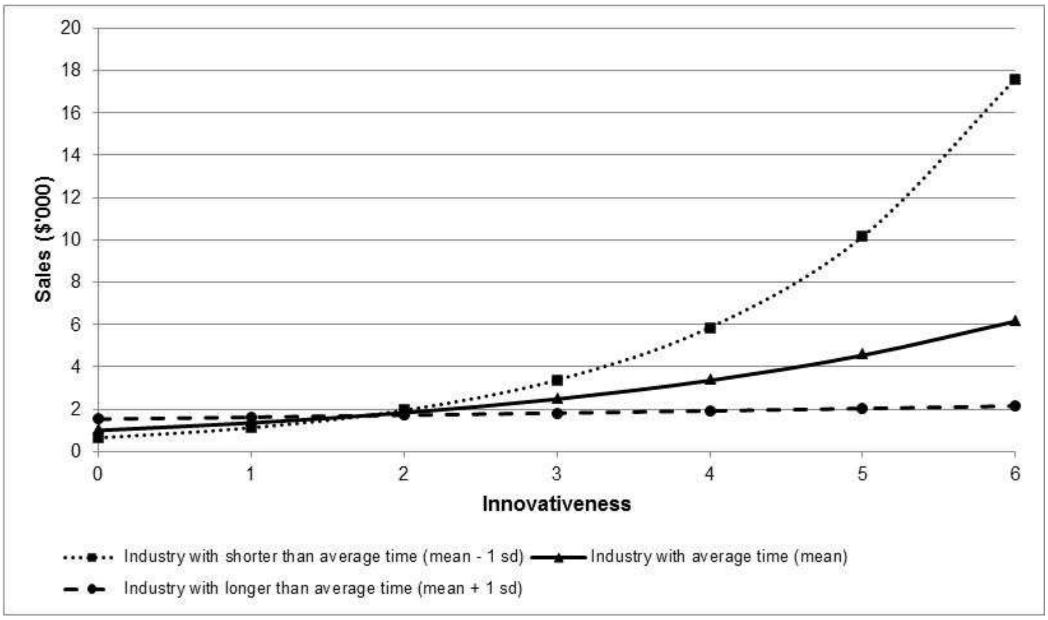

Figure 2: Innovativeness and New Venture Return on Assets by Time to Commercialize Innovation in an Industry