ABSTRACT

The role of open innovation in small firms is receiving more attention as its inherent benefits become clear. This paper investigates the relationships between open innovation, formal networks, innovation breadth and performance. It argues that the early formation of formal networks will enhance the benefits that a small firm will get from involvement in open innovation. These relationships are investigated in a longitudinal study of 1580 Australian small firms. Findings suggest that the adoption of inward open innovation has benefits for both improving the innovation breadth as well as the performance of small firms. Small firms mitigate their size handicap by establishing formal networks, and in the process enhance innovation and its effect on firm performance.

INTRODUCTION

Innovation is crucial to the advancement of living standards and wealth creation. While innovation occurs in many guises, firms play a leading role in creating innovation and translating it into useful applications for the market (OECD 2010a). Innovation in firms takes place when knowledge is commercialized, for example in the form of new products, services, processes or business models (Baldwin & Gellatly 2003). Since Schumpeter (1950) advanced his theory of creative destruction, touting that large firms are more likely to innovate than their smaller counterparts, researchers have investigated the relationship between innovation and performance in larger firms (Rosenbusch, Brinckmann & Bausch, 2010). The investigation of innovation in small firms is therefore more recent (Audretsch & Lehmann, 2005) and, although the evidence of a strong correlation between innovation and small firm performance is overwhelming (Baldwin & Gellatly 2003; Mansury & Love 2008; Roper et al. 2002), the exact nature of this relationship remains ambiguous.

Innovation research focuses variously on innovation as a strategy (Lichtenthaler & Lichtenthaler 2009), a process (Doloreux 2004; Love, Roper & Du 2009) or an outcome (Geroski, Machin & Van Reenen 1993). One process that has been touted as important to improved innovation outcomes is open innovation, viewed by Chesbrough (2003) as the propensity of firms to use internal and external ideas to innovate, as well as internal and external paths to market. Pressures such as global competition have led to greater cooperation between innovating firms (Gassmann 2006) causing firm boundaries to become more permeable and in turn facilitating knowledge exchange which is essential during innovation (Chesbrough 2006). Open innovation practices have also been observed in small firms (Van de Vrande et al. 2009), where it is argued that openness assists to overcome the liabilities of smallness. However, researchers are only starting to investigate how firms can best utilize and adapt to this approach (Elmquist, Fredberger & Ollila 2009).

This paper focuses on the inbound aspect of open innovation and explores how small firms use this phenomenon to overcome their resource restrictions (Van de Vrande et al. 2009). Laursen and Salter (2006) posit that the breadth and/or depth of use of external sources for innovation are typically the focus of open innovation research, and that results on the whole show that internal and external collaboration is complementary and beneficial to the innovation outcomes of firms. While there is much recognition that the role of open innovation may be more complex in improving innovation
outcomes, a lack of conceptualization focused on this issue, coupled with a lack of longitudinal data to test existing conceptualizations (Dahlander & Gann 2010), have hampered advancements in this area (Lee, Park, Yoon & Park 2010). Further, an understanding of the importance of established networks to shield small firms in relationships that are often unequal, remains elusive.

This paper aims to explore the differences in innovation and performance between networked and non-networked firms. It focuses on the adoption of inbound open innovation practices between these two groups of firms by exploring the Business Longitudinal Database (BLD) (ABS 2009a, 2009b). The paper is set out as follows. A literature survey is used to propose a number of hypotheses that address the research aim. These are tested in a sample of 1,580 Australian small and medium enterprises, defined as firms employing fewer than 200 full time equivalent employees (ABS 2009b). Several implications of the results are highlighted.

**LITERATURE**

**Innovation**
A large number of definitions for innovation can be found in the literature, ranging from broad to more narrow definitions (Damanpour & Evan 1984; Salavou & Lioukas 2003). The Oslo Manual has provided guidance and became the reference for various large scale surveys since 1992 when the first edition was published (OECD 2005). The Oslo Manual definition was also used by the large scale Australian Bureau of Statistics’ (ABS) Business Longitudinal Database (BLD) employed in this study (ABS 2009b). For this reason, the Oslo Manual’s definition (OECD 2005, p. 46) has been adopted to define innovation for the purpose of this study:

“**Innovation is the implementation of any new or significantly improved product (goods or services), operational processes (methods of production and service delivery), any new marketing methods (packaging, sales and distribution methods), or new organisational or managerial methods or processes in business practices, workplace organisation or external relations**”.

Substantial research evidence exists that innovation activities are important determinants of firm performance (Baldwin & Gellatly 2003; Hoffman at al. 1998; Goudis, Skuras & Tsegenidi 2003; Klomp & van Leeuwen 2001; Mansury & Love 2008; Prajogo 2006; Roper et al. 2002). More specifically, research on the link between innovation and subsequent profitability suggests that innovators are persistently more profitable than non-innovators (Love et al. 2009; Geroski et al. 1993).

When applying the Oslo Manual’s definition, it means that innovation in the present study is measured by a composite index of different types of innovations or introductions of new or significantly improved products, operational processes, organisational or managerial processes as well as marketing methods. This construct could therefore also be argued to be a measure of innovation breadth being indicative of the number of areas in which small firms apply innovations. With regard to the innovation – profitability relationship in large corporations Geroski et al. (1993) find the marginal effects on corporate profitability continue to increase as the number of innovation objectives rises, in that the marginal effects peak at eight objectives but are still nearly as high at 10 objectives providing support for the benefits of innovation breadth. They argue therefore that higher innovation breadth would benefit the firm’s profitability. Although the overwhelming majority of research, as indicated above, confirmed the positive link between innovation and small firm performance, it is not clear if greater innovation breadth will lead to increased small firm performance. Moreover, it is likely that other factors, such as the existence of networks, may play a role in this relationship.

**Networks**
A number of theoretical perspectives (e.g. process studies, systems theory, resource based view, absorptive capacity and open innovation) inform the understanding of the role that collaborations and networking play in enhancing innovation and firm performance used in this paper. Innovation is often regarded as a process which is the result of various interactions among different actors (Doloreux 2004). The innovation process in turn is a complex net of both intra-organisational and inter-organisational communication paths. These paths not only link internal functions, but also link the firm with its technological environment and marketplace (Rothwell & Zegveld 1985). System models emphasise these interactions, inter-connectedness and synergies. Much emphasis has been placed on the role of networks with external firm to benefit resource poor small firms, enabling them to survive competitive pressures from larger firms (Marinova & Phillimore 2003). Such a view finds support in the resource based perspective (Penrose 1959; Wernerfelt 1984), which sees the creation and maintenance of networks can be regarded as a mechanism in accessing scarce resources. Such scarce...
resources as well as the unique linkages or networks may manifest as organisational capabilities or competencies leading to the creation of competitive advantages for small and medium enterprises (hereafter small firms).

Network formation may also have an external impetus, being the consequence of strong technological and market uncertainties (DeBresson & Amesse 1991). For example, social capital theory argues that ‘the set of resources, tangible or virtual, that accrue to a corporate player through the player’s social relationships, facilitating the attainment of goals’ (Gabbay & Leinders 1999, p. 3), implying that firms should pursue strategies focusing on the development of valuable networks with external resource holders in order to succeed (Lee, Lee & Pennings 2001). While the rationale for the establishment of networks by small firms is clear, its importance to newer theoretical strands, such as open innovation, remains untested.

Open innovation in small firms
Open innovation is defined by Chesbrough (2003, p. XXIV) as “a paradigm that assumes that firms can and should use external ideas as well as internal ideas, and internal and external paths to market, as firms look to advance their technology”. Firms are fundamentally shifting their innovative effort from a closed innovation model to an open innovation model (Chesbrough, 2003; Chesbrough & Crowther 2006). The difference between closed and open innovation paradigms is to be found in the relative permeability of the firm’s boundaries to allow ideas and technology in-sourcing and spin-offs (Herzog 2008). Firms that embrace open innovation use purposive inflows and outflows of knowledge to accelerate internal innovation and expand markets. Open innovation therefore has two sides; inbound and outbound open innovation (Chesbrough & Crowther 2006). In inbound open innovation the firms monitor their environment with the object of sourcing technology and knowledge in addition to in-house R&D. Outbound open innovation relates to the manner in which technology are commercialised; the focal firm does not only rely on internal paths to market, but also look for external organisations (more suitably equipped or positioned) that may independently or jointly commercialise such technology.

Tidd and Bessant (2009, p. 295) summarises Chesbrough’s principles of open innovation stating that: to succeed firms need to make best use of internal and external ideas; internal innovation helps to unlock the value creation emanating from external but is also a useful vehicle for knowledge broking; intellectual property from internal and external sources are useful to advance a firm’s business model; and building a better business model is better than getting to the market first. Open innovation is receiving increased scholarly attention, yet until recently few studies explored it using large-scale databases covering a variety of different industries (Dahlander & Gann 2010). Instead, initial research was dominated by case studies, focussing on the prevalence and conceptualisation of open innovation adoption among firms (Jacobides & Billinger 2006).

As the field evolves, a number of themes are identified as important. For example, Poot, Faems and Vanhaverbeke (2009) provide longitudinal, large-scale empirical evidence that firms are shifting from a closed to an open innovation paradigm and that the shift occurs in shocks instead of manifesting as a continuous process over time. This highlights the temporal process dimension of open innovation. There also seem to be consensus that open innovation is mainly driven by larger firms (Lichtenthaler 2008). Another theme revolves around the degree of innovation openness (Laursen & Salter 2006; Lee et al. 2010; Lichtenthaler 2009; Poot et al. 2009). Open innovation practices are also increasingly being studied in more traditional industries and also at the level of the small firm (van de Vrande et al. 2009). Notwithstanding the increase in research output, the nature and prevalence of open innovation adoption among small firms remain controversial, as shown next (Lee et al. 2010).

This shifting emphasis to small firms raises a number of issues. Lichtenthaler (2008), for example, argues that although small firms contribute considerably to open innovation, they are affected by the open innovation process in a different way than large firms. Providing more clarity on the position of small firms in this trend, van de Vrande et al. (2009) suggests that innovation in small firms are becoming more open, reasoning that small firms often lack resources to develop and commercialise new products on their own and as a result they are more inclined or forced to collaborate with other organisations. It does, however, remains unclear what the prevalence of open innovation is among small firms and how it affects their innovation output and firm performance. Elucidation of the manner in which small firm performance is affected by the adoption of open innovation, specifically on determinants and contingencies, is required.

Open innovation and the innovation – performance relationship
Open innovation research focussed primarily on investigating the relationship between firms’ open innovation orientation and their innovation performance (e.g. Laursen & Salter 2006). The direct
relationship between open innovation and firm performance has been largely neglected, with the exception of Lichtenthaler (2009) who finds a positive effect of outbound open innovation on firm performance. One of the most important reasons offered by firms across a broad set of industries for adopting open innovation is the belief that utilising more technology from outside the firm is crucial for profitable growth (Chesbrough & Crowther, 2006). This paper attempts to test for the effect of inward innovation openness on both innovation output of the firm as well as small firm performance. The nature of this relationship in terms of causality will also be investigated.

The causality that adoption of an open innovation orientation has on firm performance can be viewed from two perspectives. Firstly, seen from a process or temporal perspective (van de Ven & Poole, 1998), it can be argued that direct causal effect exists in that greater openness will lead to more innovation output (in terms of innovation breadth) and subsequently higher performance. This relationship is depicted by links ‘a’ and ‘b’ in Figure 1. Greater innovation openness will direct a firm’s innovative activities to include both exploration and exploitation (Lichtenthaler, 2008; Van de Vrande et al., 2009) in line with what Chesbrough and Crowther (2006) respectively refer to as inbound and outbound open innovation, thereby enhancing innovation output. The impact of open innovation on performance is therefore argued to be completely mediated by innovation output.

Secondly, as seen from a dynamic capabilities perspective, not only does innovation output enhance firm performance because of increased competitiveness, but the innovation process also transforms the firm’s internal capabilities, making it more adaptive to change (Geroski & Machin 1993; Love et al. 2009; Teece et al. 1997). In an extensive meta-analysis of the relationship between innovation and performance in small firms, Rosenbusch et al. (2010, p. 5) find support for their hypothesis that “the positive relationship between an innovation orientation and performance is stronger that the positive relationship between innovation process output and performance”. They argue that the benefits of a small firm’s innovation orientation extend beyond the tangible outcomes of the innovation process itself. Similarly, Love et al. (2009) is of the opinion that profitable innovators have capabilities which are linked to the process of innovation and not solely related to innovating. Accordingly they find the efforts to promote innovation, associated with the process of innovation, have longer term benefits through their capacity effects. If the open innovation paradigm is regarded as an innovation orientation to the management of innovation which enhances the firm’s dynamic capabilities, then the adoption of open innovation will have a direct positive effect on firm performance (link ‘c’ in Figure 1) that extend beyond the mediatory effect identified by the process perspective.

Figure 1: Relational mediation model between open innovation, innovation and performance.

The nature of this relationship in terms of the causality and strength thereof requires further analysis. In doing so, the mediatory effect of innovation breadth on the inward open innovation – firm performance relationship will be examined. It is therefore proposed that:

Hypthesis 1: The positive inbound open innovation – performance relationship is partially mediated by innovation breadth.

The role of established formal networks in the small firm innovation – performance relationship

The importance of formal networks to innovation in small firms is well documented. For example, the ABS indicates that 26 per cent of innovating small firms are involved in collaboration, compared with 6.4 per cent of non-innovators (2005). This result is supported in several other studies (e.g. Ahuja 2000; Lee et al. 2010; Zeng et al. 2010). Ahuja (2000) elaborates that firms with a greater amount of direct ties are in a better position to unlock the information potential of indirect ties.

These studies do, however, not provide any evidence regarding the effect that these networks have on innovation and performance over time other than indicating that relationships between small
and large firms offers mutual benefits in enabling both to overcome their relative innovatory disadvantages. The question therefore remains; if a positive relationship between innovation and small firm performance is established, would inter-firm networking enhance this relationship and to what extent?

The establishment of formal inter-firm networks as a form of collaboration hold several benefits for small firms (Robinson 1982). Small firms normally lack economies of scale in research, have less access to information, and other critical innovation resources (Mohannak 2007). Small firms also tend to have insufficient capacity to individually manage the whole innovation process and are therefore encouraged to collaborate with other firms leading to potential pooling of resources and information (OECD 2010b). Through establishing network relations, small firms obtain advantages of large size without its associated disadvantages (Nooteboom 1994). Such an advantage is important, considering that once small firms establish formal networks, they are more efficient at utilising external networks due to their smallness (Rothwell & Dodgson 1994). Therefore, collaboration activities as well as direct and indirect ties would enhance a firm’s access to required inputs in the innovation process. Skill accumulation through the combination of complementary skills and collective learning occurs within networks (Pittaway et al. 2004). Networks spread risk, reduce innovation time and costs (Marinova & Phillimore 2003) thus positively impact on long-term firm performance and outweigh the immediate cooperation costs (DeBresson & Amesse 1991).

Although the network and social capital literatures highlight the importance of inter-firm collaboration and networking in innovation for small firms, Rosenbusch et al. (2010) challenge this assumption. They argue that internal innovation projects lead to greater firm performance than innovation projects with external partners. In fact they found that “the innovation projects that focus on external collaboration do not increase the performance of small firms” (Rosenbusch et al. 2010, p. 13). They attribute this to the “liability of smallness” and “liability of newness”. The liability of smallness is as a consequence of the dominance of bigger external innovation partners, dictating terms unfavourable to the small firm. Newness is associated with lack of experience concerning the identification of the appropriate collaboration partners. As Edwards, Delbridge & Munday (2005, p. 1121) points out “…the network relationships that bind small firms into innovative ties can be controversial.”

While conflicting arguments are identified above, this paper argues that networks permit small firms to draw on additional resources, allowing them to innovate across a broader range of activities. Such a broader resource base may also contribute directly to improved performance. Further, since it has been argued that innovation breadth is related to performance, it can now be argued that firms with formal networks are more likely to derive performance benefits innovation breadth. It is therefore proposed that:

- Hypothesis 2a: Involvement in formal networks contributes to increased innovation breadth.
- Hypothesis 2b: Involvement in formal networks contributes positively to small firm performance
- Hypothesis 2c: Innovation breadth is positively related to small firm performance and this relationship is moderated by involvement in formal networks in that networked small firms will derive greater performance benefits from innovation breadth.

Furthermore, the innovation – performance relationship has been found to be highly contextual and hence diverse in nature due to the complex array of factors that interplay and shape the innovation process (Rosenbusch et al. 2010). In addition to formal inter-firm networks, the innovation – performance relationship in Hypothesis 2c will also be controlled for endogenous and exogenous factors including age, size, number of competitors, market share and internationalisation.

**METHOD**

**Data**

The ABS’s BLD, released through a Confidentialised Unit Record File (CURF), comprises two independent samples (referred to as panels) drawn from the Australian business population (ABS 2009a). The statistical analysis included in this paper was done on Panel 1 due to its longer timeframe at time of analysis, being 2004-05, 2005-06 and 2006-07. This sample contains responses from 2,732 firms, which was selected from a frame containing 1,563,857 Australian businesses as at June 2005. This panel sample was stratified by industry division and business size. The BLD excludes firms classified as financial corporations, general government, not-for-profit institutions, and firms with income tax instalment payer role only as well as non-employing businesses which report less than $50,000 turnover. Small and medium enterprises (in this paper small firms) are classified as firms employing fewer than 200 employees. This classification is comparable to the majority of studies.
undertaken in the US and Europe, which ranges between 250 and 500 employees for small and medium enterprises (Verreyne, 2005). In addition, the BLD excludes firms from industries such as electricity, gas and water supply, finance and insurance, government, education, health and community services, libraries, museums as well as parks and gardens.

To ensure that the data were suitable for the study, the following restrictions were imposed on the sample. First, the non-employing firms were removed due to the overrepresentation of personal service providers and missing data on a number of variables for these subjects. Second, firms without sales data recorded on Business Activity Statements (BAS) were removed. BAS are submitted by businesses to the Australian Tax Authority on a regular basis in respect of their General Sales Tax obligations. Third, firms that did not participate in the complete panel were also removed. The sample used in the analysis of this study from Panel 1 contained 1,580 subjects after these restrictions were imposed.

Data analysis
Data were analysed using SPSS Version 13, the software available at the ABS premises. Data analyses consisted of two steps. First, the Cronbach’s Alpha test, also referred to as coefficient alpha, was used to test the internal consistency reliability of the construct measures as shown in Table 1. Validity, referring to accuracy in that a construct measures what it is suppose to measure (Hair et al. 2007), was tested by measuring correlation between the size measure employed and the derived size benchmark as well as between innovation and expenditure for innovation capacity. Both of these were positively correlated and statistically significant at 0.63 and 0.41 respectively. While the debate rages on about the significance of statistical significance (Chow 1998; Johnson 1999; Ziliak & McCloskey 2008) the arbitrary baseline error level for this research is set at below a p-value of 0.01 for highly statistical significance and below 0.05 for marginal statistical significance, corresponding to the Two-Sigma Rule.

Second, four types of statistic analyses were performed to test the hypotheses. Correlations, as shown in Table 1, were used to explore the data. Because the majority of the variables were non-continuous, mostly categorical (binary and multinomial) in nature, Spearman’s rank correlation coefficient for rank data was employed (Saunders, Lewis & Thornhill 2007). Correlations were used to test two-way relationships between all of the variables included in the hypotheses. Second, bivariate and multiple regression analysis was employed to test Hypotheses 1 and 2, in particular where controls were introduced to measure the relative contribution of these variables to the models. Third, subgroup analysis, in which the sample is split into subgroups on the basis of the third variable (formal networks), was used to test for moderation (Hypothesis 2c) due to the categorical nature of this moderating variable. In this method, to identify the moderator variable, regression analysis is employed to investigate the relationship between the predictor variable and the criterion of each subgroup variable. A t-test between regression coefficients are then conducted to test for significance. Fourth, the test for mediation (Hypothesis 1) was done in accordance with the test for mediation proposed by Baron and Kenny (1986) as discussed and shown in the findings.

**VARIABLES**

In order to test the hypotheses stated above, nine variables were needed. The variables were innovation, performance, open innovation, formal networks, age, size, market concentration, competition and internationalisation. These variables had to be constructed within the limitations of the secondary dataset employed (ABS 2009a). Five of the variables were presented as categorical data in the dataset, and used as such in the regression analyses. These include age (number of years the business have been in operation regardless of ownership), size (number of employees), market share and number of competitors. ‘Formal networks’ was a binary variable, and was used to divide the data into subsets of networked and non-networked firms for the purpose of moderation, as explained below. This variable was measured by determining if the small firm engaged in formal networking with other firms during 2005 implying a one year lag on innovation (2006) and a two year lag on performance (2007) in the longitudinal part of the study (Zeng, Xie & Tam 2010). The other four variables had to be constructed from the BLD as explained next.

**Innovation breadth**

To conform to the Oslo manual’s operational definition of innovation (OECD 2005), the statistic analysis of the innovation – performance relationship use a single measure for innovation. The BLD employs a direct subjective measure of innovation by asking respondents if they have introduced any new or significantly improved goods and/or services, operational processes, organisational and/or
managerial processes as well as marketing methods. Innovation breadth was therefore calculated by conflating the different types of innovation into a single composite measure of innovation (Bhattacharya & Bloch 2004; Laursen & Salter 2006). Cronbach’s Alpha for this variable was 0.736 indicating a high level of internal consistency or reliability.

Open innovation (sources of ideas)

The number of empirical studies that investigate the degree of openness is limited, especially those who seek to correlate the degree of openness with some performance measure either innovation performance or firm performance. Chesbrough (2003) argues that a firm’s open innovation orientation can be positioned on a continuum between high and low (or closed) degrees of openness. In general, the contingency perspective studies have focussed on one or both of the inbound or outbound processes associated with open innovation (Dahlander & Gann 2010). Lichtenthaler (2009) argues that there is not enough emphasis placed on outbound open innovation or technology exploitation (Van de Vrande et al. 2009) in the literature and address this by looking exclusively at outbound open innovation in his study. Technology exploitation is regarded as inside-out innovation activities aimed at leveraging firm technological capabilities outside the firm boundaries. Noting Lichtenthaler’s (2009) concern, due to the lack of appropriate exploitation measures in the dataset employed, the focus in this study would be on exploration or inbound open innovation.

The mechanisms by which inbound open innovation creates value have not been satisfactorily codified in research. Laursen and Salter (2006) examine how different strategies for using external sources of knowledge influence innovative performance. They, as well as authors such as Chiang and Hung (2010) explore the openness of firms’ external search processes by investigating search breadth as well as search depth. External search breadth in their study is measured by identifying the number of external sources of innovation and channels that firms utilise. They classify these sources as being; market (suppliers, clients, competitors, and commercial laboratories or R&D enterprises), institutional (universities, government research organisations, other public sector, and private research institutes), other (professional conferences and meetings, trade associations, technical or trade press, fairs and exhibitions), and specialised (technical standards, health and safety standards and regulations, environmental standards and regulations).

Sources of ideas in this study were measured as a composite index testing the extent to which the small firm made use of the following sources of ideas and information for the development or introduction of innovations: clients, customer or buyers; suppliers; competitors and other businesses from the same industry; consultants; websites, journals, research papers and publications; professional conferences, seminars, meetings and trade shows; industry associations; and lastly, any other sources. This measure does not test the frequency to which the small firms utilised these sources (depth) but rather test the number of source types (breadth) that small firms relied on in sourcing information and ideas for the development or introduction of new goods, services, processes or methods (Laursen & Salter 2006). The Cronbach’s Alpha for this variable was sufficient at 0.592 if the acceptable or arbitrary baseline error level for coefficient alpha is set at 0.6 for acceptance of the scale (Hair et al. 2007). A second, single measure variable for sources of ideas from inside the firm was also used as a categorical variable. The decision to use external and internal sources of ideas as separate variables was confirmed by a low coefficient alpha obtained for a measure conflating all (internal and external) sources of ideas into one construct. This is indicative of the fact that internal and external sources of ideas are indeed multidimensional measuring several attributes or dimensions rather than one and could not be measured in a single uni-dimensional latent construct.

Internationalisation

Internationalisation was calculated by a self reported composite index comprising of export and import activity, foreign ownership as well as an indication of overseas operations. The Cronbach’s alpha for both 2006 and 2007 were around 0.7 indicating sufficient internal consistency in the measurement.

Firm performance

Firm performance was measured employing subjective measures of effectiveness (sales and range of product growth) as well as efficiency (profitability and productivity growth) as performance indicators. Such a composite self reported measure of performance would assist in accounting for most aspects of small firm performance (Pangarkar 2008; Wiklund & Shepherd 2005). Similar composite measures of reported performance are used in research by Caloghirou et al. (2004) as well as Mansury and Love (2008). The Cronbach’s Alphas for this variable was 0.8 and 0.79 for 2006 and 2007 respectively.
RESULTS AND DISCUSSION

A cross sectional analysis was done for Hypothesis 1 due to the fact that the data on open innovation (sources of ideas) were only available for 2007 in the dataset, making a longitudinal design impossible. Hypothesis 2a-c were tested using a longitudinal design as indicated in the regressions used. No multicollinearity was detected, with VIF values ranging between 1 and 1.059 for all variables.

Hypothesis 1: Mediatory effect of innovation on the open innovation – performance relationship

Baron and Kenny’s (1986) method was applied to test for the possible mediating effect of innovation on the relationship between adoption of an open innovation orientation and firm performance. To enable the testing of this mediated relationship a single proxy for innovation openness, sources of ideas, was selected as discussed supra. In Baron and Kenny’s (1986) three variable model of mediation, the independent variable (open innovation) has to be related to the outcome or dependent variable (performance). The independent variable is also said to have a significant relationship with the mediator (innovation breadth). Therefore, as depicted in Figure 1, the mediator impacts on the outcome variable controlling for the independent variable. The impact of open innovation orientation on performance has two pathways, being, the direct relationship between open innovation orientation and performance (referred to as the direct effect) and the indirect relationships of open innovation orientation on SME performance through the innovation output or mediator (referred to as the mediating effect). Using the notations from Figure 1, the total effect (c + ab) of the independent variable on the dependent variable is the sum of the direct effect (c) and the indirect effects (ab). The mediation analysis was cross sectional using data from 2007. This was necessitated because ‘sources of ideas’ were only available in the BLD for the period 2006/2007.

In testing for mediation a three-step procedure for establishing mediation were followed. Firstly, Spearman’s correlation coefficients were calculated for all three pathways between external and internal sources of ideas (as indicators of open innovation), perceptual performance as well as innovation as shown in Table 1.

Table 1: Descriptive statistics, Cronbach’s Alphas, and Spearman’s correlations for all variables

<table>
<thead>
<tr>
<th>Variables</th>
<th>1</th>
<th>2</th>
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<th>9</th>
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<tr>
<td>Mean</td>
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<td>7.73</td>
<td>0.53</td>
<td>0.86</td>
<td>7.95</td>
<td>0.27</td>
<td>1.85</td>
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<td>1.54</td>
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<td>0.19</td>
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<td>S.D.</td>
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<td>0.68</td>
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<td>N</td>
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<td>1562</td>
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<td>1508</td>
<td>1449</td>
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<td>1532</td>
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<tr>
<td>Scale variables</td>
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<tr>
<td>Cronbach’s Alpha</td>
<td>0.73</td>
<td>0.79</td>
<td>0.69</td>
<td>0.73</td>
<td>0.73</td>
<td>0.8</td>
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</table>

Notes: The apostrophe 05, 06 and 07 after the constructs denotes the survey years 2004/2005, 2005/2006 and 2006/2007 respectively.

** Correlation is significant at the 0.01 level (2-tailed).
* Correlation is significant at the 0.05 level (2-tailed).
The correlations in Table 1 confirmed that all paths, except for internal sources of ideas and performance '07 were correlated at the significant level, establishing that there was an effect that may warrant testing for mediation using external sources of ideas as measure of innovation openness.

Second, open innovation on performance (path c) was regressed and found to be significant (Table 2). Third, as Baron and Kenny (1986) state, it is not sufficient just to correlate the mediator (open innovation) with the outcome (performance) as the mediator and the outcome may be correlated because they are both caused by the initial variable (innovation). Thus, innovation must be controlled for in establishing the effect of the mediator on the outcome. Performance was used as the independent variable in a regression equation and innovation and open innovation as dependable variables. Open innovation was therefore regressed on performance (path b) while controlling for the effect of innovation (path c). The results of this regression are provided in Table 2.

### Table 2: Mediation regressions – Performance '07 (Dependent variable)

<table>
<thead>
<tr>
<th>Direct effect:</th>
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<tbody>
<tr>
<td>Independent Variable</td>
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<tr>
<td>Open Innovation '07 (external sources of ideas)</td>
</tr>
<tr>
<td>Adjusted R square</td>
</tr>
<tr>
<td>F-value</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Open innovation '07 controlling for innovation '07:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Independent Variables</td>
</tr>
<tr>
<td>Open Innovation '07 (external sources of ideas)</td>
</tr>
<tr>
<td>Innovation '07</td>
</tr>
<tr>
<td>Adjusted R square</td>
</tr>
<tr>
<td>F-value</td>
</tr>
</tbody>
</table>

**Notes:** The apostrophe 07 after the constructs denotes the survey year 2006/2007.

**Correlation is significant at the 0.01 level (2-tailed).**

**Correlation is significant at the 0.05 level (2-tailed).**

The effect of open innovation on performance when controlling for innovation output is only significant at the lower level of <0.05 while the standardised regression coefficient was also less (0.134 – 0.106 = 0.028). This implies that the direct effect of open innovation on performance became less when the effect of innovation output on performance is taken into consideration. Hypothesis 1 was therefore confirmed as it was found that innovation partially mediates the open innovation – performance relationship. It follows that this relationship is better explained from the dynamic capabilities perspective as the complete mediation as was theorised from a temporal process perspective. Geroski and Machin (1993, p. 35) states that “… the process of innovation … transform firms in some way that give rise to what look like generic differences between innovators and non-innovators …” To conclude, the performance benefits derived from adopting inward open innovation as measured by external sources of ideas and information is not only a consequence of the resultant innovation but also because it transform the small firm and act as a dynamic capability. This finding indicates that open innovators seem to integrate external sources of ideas and information into their innovation processes and competitive strategy (Chesbrough 2003).

The establishment of inter-firm networks is a valuable source of obtaining information and ideas as well as establishing collaboration on the development innovations. Such inter-firm networks is another factor that differentiates innovators from non-innovators and is as expected positively correlated with the use of external sources of ideas (Table 1). The impact of inter-firm networks on the innovation – performance relationship is explored next.

### Hypothesis 2: The role of formal inter-firm networks on the innovation – performance relationship

Spearman’s correlations analysis indicated significant positive correlations between inter-firm networks established in 2005 and innovation 2006 as well as performance 2007 (Table 1). Once these relationships were established more detailed regression analysis was used to test our hypotheses. Accordingly Hypotheses 2a and 2b were accepted (see Table 3) in that both relationships were found to be significant. It has to be noted that the effect size or explanatory power for the models as depicted by their respective R squares were very small. Establishing formal inter-firm networks explained about four per cent of the variation in innovation breadth and only one per cent of the variation in performance, two years after establishment of such networks. These small effect sizes have to be seen in context. The full sample includes all sizes of small firms and is not industry specific nor does it...
differentiate between innovators and non-innovators. The independent variable accounts only for formal networks that were established and not informal networks that is said to potentially enhance firm performance (Lee et al. 2001). All types or forms of innovation encapsulated in the OSLO definition of innovation are incorporated in the dependent variable, innovation. Taking these considerations into account, the obtained effect sizes could be regarded as having sufficient explanatory power on the effect that established formal networks have on subsequent innovation and performance.

Table 3: Regression analysis, Hypothesis 2a and 2b

<table>
<thead>
<tr>
<th>Hypothesis 2a: Innovation’07 (dependent variable) (N = 1514)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Independent Variables</td>
</tr>
<tr>
<td>------------------------</td>
</tr>
<tr>
<td>Inter-firm networking ‘05</td>
</tr>
<tr>
<td>Adjusted R square</td>
</tr>
<tr>
<td>F-value</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Hypothesis 2b: Performance’07 (dependent variable) (N = 1513)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Independent Variables</td>
</tr>
<tr>
<td>------------------------</td>
</tr>
<tr>
<td>Inter-firm networking ‘05</td>
</tr>
<tr>
<td>Adjusted R square</td>
</tr>
<tr>
<td>F-value</td>
</tr>
</tbody>
</table>

Notes: The apostrophe 05 and 07 after the constructs denotes the survey years 2004/2005 and 2006/2007 respectively. ** Correlation is significant at the 0.01 level (2-tailed). * Correlation is significant at the 0.05 level (2-tailed).

Confirming Hypothesis 2c that networked firms were better able to unlock the performance advantages of innovation than their non-networked counterparts, the small but significant explanatory power (R²) of innovation had on performance is greater for the networked than the non-networked subsample (Table 4). This is also reflected in their respective standardised regression coefficients.

Table 4: Subgroup regression analysis, Hypothesis 2c: Dependent variable, Performance ‘07

<table>
<thead>
<tr>
<th>Independent Variables</th>
<th>Adj. R²</th>
<th>Standardised Reg. Coefficients</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Networked firms (N = 243)</td>
<td>0.054 (**)</td>
<td></td>
<td>0.00</td>
</tr>
<tr>
<td>Innovation’06</td>
<td></td>
<td>0.239 (**)</td>
<td>0.00</td>
</tr>
<tr>
<td>Non-networked firms (N = 1022)</td>
<td>0.043 (**)</td>
<td></td>
<td>0.00</td>
</tr>
<tr>
<td>Innovation’06</td>
<td></td>
<td>0.209 (**)</td>
<td>0.00</td>
</tr>
<tr>
<td>Networked firms with controls (N = 243)</td>
<td>0.065 (**)</td>
<td></td>
<td>0.01</td>
</tr>
<tr>
<td>Innovation’06</td>
<td></td>
<td>0.169 (*)</td>
<td>0.10</td>
</tr>
<tr>
<td>Age</td>
<td>-0.086</td>
<td>0.181</td>
<td></td>
</tr>
<tr>
<td>Number of competitors</td>
<td>-0.037</td>
<td>0.586</td>
<td></td>
</tr>
<tr>
<td>Market share</td>
<td>0.136</td>
<td>0.050</td>
<td></td>
</tr>
<tr>
<td>Internationalisation</td>
<td>0.009</td>
<td>0.886</td>
<td></td>
</tr>
<tr>
<td>Size</td>
<td>0.133 (*)</td>
<td>0.043</td>
<td></td>
</tr>
<tr>
<td>Non-networked firms with controls (N = 1022)</td>
<td>0.095 (**)</td>
<td></td>
<td>0.00</td>
</tr>
<tr>
<td>Innovation’06</td>
<td></td>
<td>0.112 (**)</td>
<td>0.00</td>
</tr>
<tr>
<td>Age</td>
<td>-0.068 (*)</td>
<td>0.025</td>
<td></td>
</tr>
<tr>
<td>Number of competitors</td>
<td>0.107 (**)</td>
<td>0.001</td>
<td></td>
</tr>
<tr>
<td>Market share</td>
<td>0.099 (**)</td>
<td>0.002</td>
<td></td>
</tr>
<tr>
<td>Internationalisation</td>
<td>0.068 (*)</td>
<td>0.027</td>
<td></td>
</tr>
<tr>
<td>Size</td>
<td>0.176 (**)</td>
<td>0.000</td>
<td></td>
</tr>
</tbody>
</table>

Notes: The apostrophe 05, 06 and 07 after the constructs denotes the survey years 2004/2005, 2005/2006 and 2006/2007 respectively. ** Correlation is significant at the 0.01 level (2-tailed). * Correlation is significant at the 0.05 level (2-tailed).

The addition of controls to Hypothesis 2c delivers interesting results. The marked differences in sample size between the split samples affect the power of the test hence the level of statistic significance is set at the <0.05 level for the comparison. The relative contribution of innovation to
performance was higher for networked than for non-networked firms further supporting Hypothesis 2c. In non-networked firms, size were more important for performance than innovation whereas for networked firms, innovation was more important than size. This potentially confirms Nooteboom’s (1994) conjecture that by establishing networks small firms obtain advantages of large size in that they gain access to resources essential for innovation. In this regard Pittaway et al. (2004, p. 137) find the principal benefits of networking to be, among other, “… obtaining access to new markets and technologies, speeding products to market, … pooling complementary skills … and acting as a key vehicle for obtaining access to external knowledge.” Small firms mitigate their size handicap in that they network to obtain knowledge, skills and technologies which are not internally available impacting positively on innovation as confirmed by Hypothesis 2a. It was also interesting to note that the contribution of the controls; number of competitors, internationalisation and age were found to be non-significant for the networked firms. Market share borders on significance at 0.05 and hence could be regarded as contributing more to the performance benefits derived from innovation in networked firms than non-networked firms. In summary, it is evident that networked firms derive more performance benefits from innovation and larger market share as well as mitigate the adverse effects of small size in an endeavour to level the playing field.

CONCLUSION

The findings indicate that small firms use networking and idea sourcing from external stakeholders to maximize the benefit gained from innovation. The adoption of an open innovation orientation by small firms in utilizing more external sources of ideas has a positive effect on performance which is partially mediated by innovation. Hence, not only does open innovation stimulate innovation breadth but it has a direct effect on the performance of small firms in that open innovation act as a dynamic capability. The establishment of networks has a longitudinal positive effect on innovation and subsequently performance. Generic differences have been identified between networked and non-networked small firms. Networked small firms mitigate their smallness by gaining access to tangible resources, knowledge and skills to enhance the performance benefits derived from innovation activities.

These results were obtained within the limits of this study. It has to be noted that the variables used in this paper were captured in the BLD as primarily categorical or binary data, and therefore they do not capture the depth of the phenomena investigated but rather represented a count of the use or presence of these variables. Industry effect which has been identified as having an impact on the innovation – performance relationship was also not accounted for. The test for mediation was done on a cross sectional analysis and hence limits causality interpretations.

This paper makes a theoretical contribution to the understanding of open innovation in small firms in establishing that the nature of open innovation in small firms are different from the processes identified in their larger counterparts as evident from the extant literature. From a practical perspective, the paper makes suggestions to small firm owners/managers how to best utilize their limited resources by establishing inter-firm networks and adopting an inward open innovation orientation.

REFERENCES

Baldwin, J & Gellatly, G 2003, Innovation strategies and performance in small firms, Edward Elgar, Cheltenham, UK.


