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Paper Title: Beyond the Ivory Towers â€“ Exploring Knowledge Transfer Pathways Between Universities and Innovative Small-to-Medium-Size Enterprises
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BEYOND THE IVORY TOWERS – EXPLORING KNOWLEDGE TRANSFER PATHWAYS BETWEEN UNIVERSITIES AND INNOVATIVE SMALL-TO-MEDIUM-SIZE ENTERPRISES

Abstract

This paper examines the extent and nature of knowledge transfer using university-industry relational pathways vis-à-vis generic university-to-industry knowledge transfer pathways. We compare the importance of university-industry knowledge transfer with other sources of knowledge for a sample of innovative SMEs. We also examine whether inter-organisational knowledge transfers are spatially driven, and specifically, the extent to which knowledge is acquired domestically (local and/or national) or internationally. The data employed in this research is based on a self-administered internet questionnaire from 1,226 SME owner-managers in Australia. While there are significant differences between the three size enterprises, the evidence suggests SMEs rely on generic university-industry knowledge transfer pathways rather than university-industry links with high relational involvement. Moreover, the results indicate SMEs are significantly more likely to rely on organisations other than universities and related R&D enterprises for knowledge acquisition. While collaboration is most likely to occur within the same state/territory, or Australia, 25% of SMEs also collaborate internationally, usually as part of normal supplier-customer relationships, underlining the importance of knowledge acquisition from organisationally proximate partners. The paper concludes by with policy recommendations that may help facilitate university-SME knowledge transfer.

Introduction

The ability to effectively transfer knowledge across organisational boundaries is important, with research suggesting firms increasingly use external sources of knowledge for innovation (Chesbrough 2003). Yet, with few exceptions, there is a paucity of empirical studies on knowledge transfer in the small to medium-sized enterprises (SME) context (Hughs, O'Regan and Sims 2009; Huggins and Johnston 2009), including in Australia. The use of universities (or higher education institutions (HEIs) as they are sometimes known), and related providers such as research institutes, and the pathways by which knowledge is acquired from these sources by SMEs for innovation purposes in particular, remains under-explored. Aside from cluster literature, there is also a dearth of empirical work on geographic patterns of knowledge acquisition in the small business literature.

The objective of this paper is twofold: firstly, to examine the extent and nature of inter-organisational links between SMEs and universities. Specifically, we investigate the importance of knowledge transfer using university-industry relational pathways vis-à-vis generic university-to-industry knowledge transfer pathways. We compare the importance of university-industry knowledge transfer with other sources of knowledge for a sample of innovative SMEs. Secondly, we examine whether inter-organisational knowledge transfers are spatially driven, and specifically, the extent to which knowledge is acquired domestically (locally and/or nationally) or internationally. The extent to which knowledge generation and innovative firms and activities tend to agglomerate geographically provides insight into the ongoing debate about whether and when spatially driven knowledge collaboration is important.

Literature review

Networks, innovation and university-industry knowledge transfer pathways

There is considerable literature on inter-firm cooperation amongst small enterprises, with the ensuing relationships typically referred to as networks (Hanna and Walsh 2008). The term 'network' is loosely defined, but generally describes a plethora of formal and informal relationships. The premise that underlies much of the work on inter-firm cooperation in the small business context is that through access to, and utilisation of, external resources, enterprises can overcome resource constraints (BarNir and Smith 2002; Madhok 2002), or some of the disadvantages of their 'smallness' (BarNir and Smith 2002). Thus individual firms can derive considerable benefits from collaborating, particularly in relation to innovation. For example, SMEs may gain access to the requisite knowledge and skills needed to develop new technology, products or services, and equally important, knowledge of new business and management processes, techniques and practices necessary for organisational innovation (Business Council of Australia 2006).

Recent research on innovation suggests that firms increasingly rely on external sources of knowledge for innovation, via inter-organisational network relationships rather than 'arms-length', transactional market links (Chesbrough 2003; Cooke, Heidenreich, and Braczyk 2004; Seely-Brown and Duguid 2001). These (inter-organisational) relationships may be formal (Hagedoorn, Link and Vonortas 2000), informal, or based on social relationships with acquaintances that individuals within organisations possess (Gulati 1998; Oliver and Liebeskind 1998). Furthermore, formal organisational-level relationships are often underpinned by informal, inter-personal relationships among members of different organisations (Perkmann and Walsh 2007). Under this interactive, network approach to innovation, inter-organisational networks, as opposed to single organisations, are the 'locus of innovation' (Powell et al. 1996; Chesbrough 2003).

While knowledge has been variously conceived in the literature – from an economic commodity, to a strategic resource, and more recently, as a social construct (Assudani, 2005) – for the purposes of this research, we adopt this latter, more nuanced perspective, since "the relevance of inter-organisational and social networks for innovation…is rooted in the nature of knowledge as a socially embedded process (Seely-Brown and Duguid 1991; Malmberg and Maskell 2002 cited in Perkmann and Walsh 2007, p.260)".

Building on Granovettor's (1973, 1985, 2000) ideas of social structures and embeddedness in the innovation process, Perkmann and Walsh (2007) argue that if the foregoing holds for innovation-related inter-organisational links in general, actual *relationships* between universities and industry, rather than generic university-industry *links,* are a more important source of innovation (emphasis in original). This is because firms that innovate using external knowledge and resources rely on collaboration and other relationship-intensive arrangements to underpin and enable knowledge transfer. 'University-industry' links comprise of ways in which publicly funded research may benefit industry, and include what is commonly referred to as knowledge/technology transfer of intellectual property (IP) (e.g., patenting, licensing, commercialisation and scientific publications) and human mobility aimed at transferring generic skills (e.g., graduate recruitment). In contrast, university-industry relationships include research partnerships (e.g., collaborative or sponsored research, university-industry research centres/institutes and alike) and academic consulting and contract research.

It is, however, important to acknowledge that relationships and links are not necessarily mutually exclusive, and indeed can occur in conjunction or succession (Agrawal 2006). For example, Agrawal (2001) suggests that tacit knowledge associated with inventions is not completely transferable in codified (patent or publication) form but instead

requires connectivity, in the form of interaction between the creator and recipient enterprise, in person, by phone or written correspondence.

It is unclear whether this proposition -– that actual relationships between universities and industry are a more important source of innovation than generic university-industry links – might also be expected to hold for SMEs. The few studies that have been conducted have been inconclusive. As noted above, SMEs engage in social and inter-organisational networks to access knowledge, including for innovation purposes (Nobuya 2006; Huggins and Johnston 2009). Indeed networks may be especially important for SMEs which do not engage in formal research and development (R&D) (Perkmann and Walsh 2007), and for firms whose competitive advantage is underpinned by R&D. In a qualitative study of innovative SMEs in New Zealand (NZ), Davenport (2005) found that SMEs in the early stages (only) of product development accessed expertise located in NZ public research institutions, with technology underpinning products developed in a local research institute, and researchers with complementary skills recruited from these institutes in order to internalise and augment SMEs' internal knowledge base.

On the other hand, Hughes et al. (2009) find that universities are more "remote" compared with other more proximate sources of advice within SME networks, and moreover, less effective. They suggest "…the "closeness" of the parties within the network …impact[s] on …effectiveness … universities need to consider how to achieve greater proximity to … potential "knowledge partners" (Hughes et al. 2009, p. 676). It is this issue of "proximity" to which we now turn.

The Role of Proximity in Knowledge Transfer

Proximity in general is considered to be an important antecedent for knowledge sharing and knowledge transfer at the inter-organisational level (Gertler 1995). However, the concept of proximity is used in various ways in the literature, with single labels incorporating different dimensions of proximity and different labels used for identical dimensions (Knoben and Oerlemans 2006).

When the proximity concept is used, what is often meant is geographical proximity, with the terms spatial, local or physical proximity used interchangeably (Knoben and Oerlemans 2006). Geographical proximity is considered important because short geographical distances facilitate face-to-face interactions and, therefore, foster tacit knowledge transfer (Torre and Gilly 2000; Agrawal 2001) and inter alias, innovation (Nonaka, Toyama and Konno 2000). Conversely, the greater the distance between organisations, the more difficult it is to transfer tacit knowledge. This is because tacit knowledge such as the embodied know-how of a skilled craftsperson, technician or scientist, is inherently difficult to articulate or codify in writing (Agrawal 2001; Ganesan, Malter and Rindfleisch 2005). Instead tacit knowledge is believed to be more effectively transferred through personal, face-to-face interactions that favour the exchange of high quality information and enable more nuanced understanding to be achieved (Boschma 2005).

While tacit knowledge flow is typically bounded within specific geographic locations, codified knowledge is usually considered to be less sensitive to spatial location (Bathelt, Malmberg, and Maskell 2004). However, the interpretation of codified knowledge may require tacit knowledge and thus geographic proximity (Howells 2002). Knoben and Oerlemans (2006) suggest that in the context of collaboration for innovation, geographical proximity may only be required in certain phases, for example, during the production of tacit knowledge (Gallaud and Torre 2004; 2005). Along similar lines,

research (Torre and Rallet 2005) suggests temporary geographical proximity in the form of temporary geographic co-location may be sufficient to develop other forms of proximity (e.g., organizational), which then enable collaboration over large geographical distances.

Close geographic proximity is also assumed to facilitate strong relational ties between knowledge providers and recipient firms (Granovetter 1973). Geographic closeness facilitates repeated interactions amongst firms and helps organisations to develop the mutual trust and reciprocity needed to maintain relationships between collaborators (Harrison 1992; Rosenfield 1997; Etzioni and Etzioni 1999). Yet empirical research suggests this relationship is not straightforward. For example, Ganesan et al. (2005) show that while geographic proximity is related to face-to-face communication, it is unrelated to relational ties, and that new product development outcomes which are often ascribed to close geographic proximity may actually be attributable to strong relational ties. In contrast Davenport (2005) attribute an overall lack of geographic proximity-based knowledge acquisition activity amongst NZ SMEs to a high-growth trajectory based on innovation-driven, internationalisation, and later, customisation strategies, together with characteristics of the local NZ environment (e.g., lack of depth and density of firms in most industries and a small domestic market). This growth path meant SMEs relied on geographically distant, but organisationally close, distributors, customers, consultants and peer organisations.

Huggins and Johnston (2009) found that knowledge was more frequently accessed from suppliers and customers outside, rather than within, the geographic region in which SMEs are located. However, innovative SMEs were more likely to source tacit knowledge from universities from within, rather than external to, the region.

Thus being close 'organisationally' – which is broadly define to incorporate related and overlapping proximity dimensions such as cognitive, cultural and social proximity (Knoben and Oerlemans 2006) – is important for inter-organisational collaboration, knowledge acquisition and innovation (Knoben and Oerlemans 2006; Kirat and Lung 1999). Similarities in the organisational context (e.g., vision, objectives, culture, values, frames of reference and space of relations) of collaborating partners is assumed to facilitate mutual trust, kinship, understanding, communication and generate a capacity to transfer and exchange new knowledge between organisations, including over geographical distances (Boschma 2005; Knoben and Oerlemans 2006). Hughes et al. (2009) ascribe the very limited role of universities as a source of knowledge for SMEs to the fact that they are *not* (organisationally, professionally or geographically) close.

In summary then, while the conceptual literature emphasizes the importance of geographic proximity to knowledge acquisition, results from recent empirical studies are equivocal. The objective of this paper is to begin to fill these gaps, by examining the extent and nature of inter-organisational links between SMEs and universities. We examine the importance of knowledge transfer using university-industry relationships vis-à-vis other university-to-industry knowledge transfer pathways. We also compare the importance of SME- university knowledge transfer to other sources of knowledge for a sample of innovative SMEs. Finally, we investigate geographic patterns of knowledge acquisition, and the extent to which knowledge is acquired locally or within Australia, or internationally.

Research Method

The study used data from a self-administered internet questionnaire to owner/managers of SMEs in the Adelaide Metropolitan area of South Australia. SMEs are defined as

firms with less than 200 employees (Australian Bureau of Statistics, 2001). SMEs are further categorised as micro enterprises employing less than five employees, small enterprises employing more than five but less than 20 employees, and medium enterprises employing more than 20 but less than 200 employees.

Sample

The population for the study consisted of all SMEs in the South Australian capital city's (Adelaide) metropolitan area. The South Australian State Government supplied the dataset from which the sample was selected. The dataset was based on the (2006) Australian Business Register (ABR) which is developed by the Australian Taxation Office (ATO). A subset of records were extracted from this database that met the following criteria: active businesses in the Adelaide metropolitan area; entities with contact addresses with postcodes that fell within the Adelaide metropolitan area; annual turnover of more than $50,000; Australian Business Number (ABN) registration for taxation purposes; and an email address (excluding businesses that used only email address provided by free providers such as Hotmail or Yahoo). The sample was further restricted to commercial enterprises by excluding entities in agriculture, forestry and fishing; public administration and defense; education and training; health care and social assistance; and other services. This population subset comprised 14,206 Adelaide businesses. However, of these, 33.7% (4,788) of the email addresses proved to be inoperable, meaning these businesses could not be reached. This resulted in a final Adelaide population dataset comprising 9,418 active firms.

Questionnaire

A web-based self-administered questionnaire was used. The content of the questionnaire was based upon the Australian Bureau of Statistics' Innovation Survey 2003 (ABS, 2003) which is based on the guidelines of the OECD's Oslo Manual, which is the standard reference for innovation surveys among OECD countries (OECD, 1997). A total of 1,226 questionnaires were received, however only 846 were used in the analysis because some questionnaires contained missing data. An analysis of the sample in comparison with the population revealed no apparent differences between the two groups. Thus, the active response rate was 13.03% (Neuman, 2000) and compares favourably with an expected rate for internet surveys of 11% (Saunders, 2007).

Analytical Method

Variables used in this research are either categorical in nature or, if metric, have irregular distributional properties (that is, they are non-normally distributed). Thus, non-parametric/distribution free techniques of statistical analysis are employed exclusively. Kruskal-Wallis one-way analysis of variance tests are used to examine differences in SME knowledge sources/transfer between the three size SME categories. The Kruskal-Wallis test examines possible differences between two or more groups. Differences identified by the Kruskal-Wallis test between the three sized SMEs are further investigated using a series of Mann-Whitney tests. The Mann-Whitney test tests the hypothesis that two independent samples come from populations having the same distribution**.** Furthermore, Cramer's V tests were used to examine associations between variables. Cramer's V measures the strength of the association between one nominal variable with either another nominal variable, or with an ordinal variable In order to enhance interpretation of results, percentages of the sample in each size category associated with the variable examined are included in the tables presented.

Discussion of results

Extent and nature of innovation: size differences

Before presenting the results to the research questions, it is useful to obtain an overview of the extent and nature of innovation in the sample and in the three categories of SMEs. As can be seen from Table 1, 71% of firms in the sample are innovative. There is a significant increase in the proportion of SMEs innovating with enterprise size: sixty-seven per cent, 80% and 88% of micro-, small and medium-sized enterprises respectively innovate. We investigated the extent to which SMEs implemented any or more of the following types of innovations: (1) product innovation, (2) process innovation, (3) organisational innovation, and/or (4) marketing innovation. We found that micro-sized firms are most likely to implement one type of innovation, and small and medium-sized businesses are most likely to implement two or more types of innovation (Table 1).

Insert Table 1 about here

Collaboration and geographic patterns: size differences

Table 2 shows the proportion of innovative SMEs in the sample and in the three size categories that collaborate with other organisations, and their geographic location. Innovative SMEs in all three categories are *least likely* to collaborate with universities and private non-profit and commercial R&D enterprises: 10% or less of SMEs in each size category collaborate with universities, 6% or less partner with commercial laboratories/R&D enterprises, and 5% or less collaborate with private not-for-profit research institutions. However, when SMEs do collaborate with universities/related institutions, it is more likely to occur within Australia than internationally.

Insert Table 2 about here

SMEs are most likely to collaborate with clients/customers or suppliers, with almost 50% or more of SMEs in the three size categories collaborating with clients/customers or suppliers in Australia (Table 2). Suppliers, followed by clients/customers, and other parts of the wider organisation, are also the most frequently used overseas partners.

Taken together, these results indicate SMEs collaborate with organisations *other than* universities and related R&D enterprises for knowledge acquisition. The results also show that collaboration occurs as part of existing business-to-business relationships; specifically, with customers and suppliers who are part of the SME's supply chain. Thus the findings are consistent with UK research that identifies universities as among the least important sources of knowledge for SMEs (Hughes et al. 2009) and suppliers and customers as the most important source (Huggins and Johnston 2009).

Table 2 also reveals while two-thirds or more of SMEs in the sample and in the three-sized categories collaborate within Australia, about 20 per cent or more of SMEs also collaborate internationally. This result, together with the results that show SMEs collaborate with supply chain members in Australia and internationally, but are unlikely to collaborate with universities/related institutes, may suggest that SMEs collaborate with 'organisationally close' enterprises (Davenport 2005; Knoben and Oerlemans 2006), irrespective of geographic location.

University-SME knowledge acquisition pathways and geographic patterns: size differences

Table 3 enumerates the pathways used by SMEs to acquire knowledge from universities and related-research institutions, and their geographic location. SMEs are most likely to use research results published by these institutions (12%) and employ new graduates (9%) in Australia. However, the actual proportion of SMEs in the three size categories acquiring knowledge using these channels is modest: 4%, 17% and 27% of (micro-), small- and medium-sized enterprises respectively employed new graduates; and 12%, 11% and 14% of micro-, small- and medium-sized businesses used universities' published research.

Insert Table 3 about here

Innovative SMEs in the sample are least likely to use patents, designs, or other intellectual property (IP) rights from institutions or employ academic or research staff (3% each). Specifically, only two and one per cent of micro- and small firms use IP rights. Medium-sized enterprises are also unlikely to utilise IP rights (8%), but significantly more likely than small and micro-sized firms ($p<.05$). Medium-sized enterprises are least likely to contract R&D to these institutions (6%).

Table 3 reveals significant differences between the three sized categories in the pathways used to acquire knowledge from universities: medium- and small-sized enterprises are significantly more likely than micro- firms to employ new graduates ($p<.05$). Medium-sized businesses are also significantly more likely than small firms to employ consultants from universities (13% and 3% respectively), and significantly more likely than small and micro-sized enterprises to employ academic or research staff: 13%, and 2% respectively ($p<.05$). Thus the evidence suggests that while, overall, SMEs in the three sized categories rely on generic university-industry links rather than pathways with high relational involvement, medium-sized organisations are more likely than their smaller colleagues to acquire knowledge via relationship pathways; and specifically, employ consultants and academic and research staff from universities.

However, we noted earlier that knowledge transfer using generic university-to-industry links and university-industry relationships are not necessarily mutually exclusive. In order to examine whether SMEs that use published results, patents and other IP, or employ graduates also use pathways with high relational involvement (i.e., employ university or related institutes' research or academic staff or consultants, use these institutes' research facilities or contract out R&D to these institutions), Cramer's V tests was used to examine associations, if any, between generic links and university-industry relationships. The results are presented in Table 4.

Insert Table 4 about here

As can be seen from Table 4, there are statistically significant associations between generic university-industry links and university-industry relationships. Specifically, the acquisition of knowledge using published research results is very strongly[1] associated with universities'/related institutes' research facilities, and has a moderately strong association with the employment of consultants. Moderate to strong associations also exist between the use of patents and other IP rights and using consultants, research facilities, employing academic/research staff and contracting out R&D. Similarly, the

[1] Following Cohen (1988), we interpret CRAMER'S V statistic as follows: 0 no relationship; 0 to 0.1 not generally useful; 0.1 to 0.2 weak; 0.2 to 0.25 moderate; 0.25 to 0.3 moderately strong; 0.3 to 0.35 strong; 0.35 to 0.4 very strong.

acquisition of knowledge via employment of graduates is moderately to very strongly associated with contracting out R&D and employing academic/research staff.

Taken together, the foregoing suggests that SMEs that acquire knowledge using generic university-industry links also acquire knowledge via relationships, supporting the proposition that relationships and links are not necessarily mutually exclusive, and can occur in conjunction or succession (Agrawal 2006). Consistent with the geographic trend identified above, when knowledge is acquired from universities and related providers, it is most likely to be acquired from Australian-based institutes, with SMEs at least twice as likely to acquire knowledge from within, rather than outside, Australia (Table 3). The results of a further series of Cramér V tests examining the association between knowledge acquisition pathways and geographic location are statistically significant, with six of the seven generic university-to-industry links and relationships associated (albeit weakly) with knowledge acquisition in Australia; only the use of patents and other IP rights is not significant in Australia (see table 5). Acquiring knowledge by employing new graduates and using research results published by institutions are significant internationally.

Insert Table 5 about here

Other knowledge acquisition methods and geographic patterns: size differences

Table 6 presents a range of other methods through which external knowledge can be transferred, including it is acquired locally, nationally or internationally.

Insert Table 6 about here

Innovative SMEs in the sample are most likely to acquire knowledge as part of a package with the acquisition of new capital (i.e., equipment/technology) (54%), and least likely to acquire or merge with another business (7%). Table 6 also shows, while micro enterprises are mostly likely to acquire knowledge with the purchase of new technology/equipment (54%), small and medium-sized businesses are most likely to employ new staff (66% and 84%). Statistically significant differences exist between enterprises, with small businesses more likely than micro firms, and medium enterprises more likely than small businesses, to employ new staff ($p<.05$). Small and medium-sized enterprises are also significantly more likely than micro firms to use consultants ($p<.05$), while small organisations are significantly more likely than micro firms to acquire knowledge as part of a package with new technology ($p<.05$). Although medium-sized firms are least likely to merge with, or acquire, a business to source knowledge, they are significantly more likely than micro enterprises ($p<.05$).

SMEs are most likely to acquire knowledge locally, with almost 50% or more of micro-, small and medium-sized enterprises acquiring knowledge from within the same state. Indeed, SMEs are at least twice as likely to acquire knowledge locally (from within the same state) relative to nationally, and with the exception of medium-sized enterprises, at least three times more likely to acquire knowledge locally compared with internationally. Medium-sized firms are more likely to source knowledge internationally, than nationally.

Conclusions

A key finding from this study is that a modest proportion only of all SMEs collaborate with universities and related research institutes. For SMEs that do (collaborate with universities/research institutes), knowledge is most likely to be acquired using generic, tangible transactional university-to-industry knowledge transfer pathways, in the form of published research results and employment of new graduates. However, differences are also evident between the SMEs of different sizes in their extent of use, with medium-sized enterprises significantly more likely than small and micro-sized firms to employ new graduates and use IP. However, we also found that SMEs that acquire knowledge using generic university-industry links also acquire knowledge via relationship mechanisms. Thus the findings are mixed with respect to the proposition that, in the SME context, actual relationships between universities and industry are a more important source of knowledge for innovation than generic university-industry links (Perkmann and Walsh 2007).

A second key finding is that SMEs rely on organisations *other than* universities and related R&D enterprises for knowledge acquisition, with the majority of SMEs collaborating with organisationally close supply chain members, and specifically, clients/customers or suppliers. Furthermore, the results indicate that, while innovative SMEs are most likely to collaborate and acquire knowledge within the same state/territory, or Australia, 25 per cent also collaborate internationally. International collaboration is most likely to occur with suppliers or customers; in other words, as part of normal supplier-customer relationships, underlining the importance of knowledge acquisition from organisationally proximate partners.

At the same time, the evidence in the study indicates that SMEs in Australia, overwhelmingly, collaborate and acquire knowledge from within their more local environment, whether defined as a region or nationally. From the university-firm knowledge transfer perspective, co-location in the same region or the same country appears particularly important, with three per cent or less of all SMEs collaborating with, and acquiring knowledge from, these institutions internationally.

Limitations

Firstly, there are sampling issues as the sample was taken from one Australian state, thereby raising issues of regional bias. Related to this was that although the sample was across a number of industry sectors, the cell sizes of the various industry sectors were too small to undertake separate analyses. Second, this research is cross-sectional. Future research would benefit from longitudinal studies using a repeated-measures model with at least three measurement points over time to examine the dynamic nature of the constructs of interest and their inter-relationships.

Research implications

While the ability to effectively transfer valuable knowledge across organisational boundaries is important for innovation, the research finds that SMEs rely on ‘generic’ university-to-industry knowledge transfer pathways, and, moreover, partners other than universities. Hence, our study finds that despite significant financial and other resources devoted to developing stronger links and networks between universities and SMEs with the aim of moving SMEs up the value chain and to a high-growth, knowledge-based pathway (e.g. through R&D spillovers leading to more rapid commercialisation of university-developed IP) and improving their long-term growth and sustainability , the policies do not seem to be working, especially in the Australian context (Roos, Fernström and Gupta, 2004; Roos, 2012). Policy and resources could be devoted to helping universities to get closer to SMEs (Hughes et al. 2009). But given

distance has long been identified as separating universities from SMEs (Shrivastava and Mitroff 1984) resources but may be better targeted at university-industry knowledge pathways that SMEs do value, including graduates and published research. Moreover, given the evidence in this and other research (Hughes et al. 2009; Huggins and Johnston 2009; Thorpe et al. 2005) shows SMEs utilise organisations other than universities to acquire knowledge, policy may be more effective at promoting these relationships.

References

Agrawal, Ajay, (2001) University-to-Industry Knowledge Transfer: Literature Review and Unanswered Questions. International Journal of Management Reviews, Vol. 3, pp. 285-302, December 2001.

Agrawal, A. (2006). Engaging the inventor: exploring licensing strategies for university inventions and the role of latent knowledge. Strategic Management Journal, 27(1), 63–79.

Andersen, E.S., Lundvall, B-A. and Sorrn-Friese, H. (2002) Editorial, Research Policy. Vol. 31, No. 2, pp.185–190.

Assudani, R.H. (2005), "Catching the chameleon: understanding the elusive term 'knowledge'", Journal of Knowledge Management, 9 (2): 31-44.

Australian Bureau of Statistics. (2001). Small Business in Australia. Canberra: Australian Bureau of Statistics.

Baptista, R. (2001) Geographical clusters and innovation diffusion Technological Forecasting and Social Change 66 (1), 31-46

BarNir, A.. and Smith, K. A. (2002). Inter-firm alliances in the small firm: The role of social networks. Journal of Small Business Management, 40(3): 219-232.

Bathelt, H., A. Malmberg, and P. Maskell. (2004). Clusters and knowledge: Local buzz, global pipelines and the process of knowledge creation. Progress in Human Geography 28(1): 31–56

Boschma, R.A. (2005). Proximity and innovation: A critical assessment. Regional Studies 39: 61–74.

Business Council of Australia (2006) New Pathways to Prosperity: A National Innovation Framework for Australia, BC, Melbourne.

Chesbrough, H.W. (2003). Open innovation: The new imperative for creating and profiting from technology. Cambridge, MA: Harvard Business School Press.

Cohen, J. (1988), Statistical Power Analysis for the Behavioral Sciences (2nd ed.), New Jersey: Lawrence Erlbaum Associates.

Cooke, P., M. Heidenreich, and H. Braczyk, eds. (2004). Regional innovation systems: The role of governance in a globalised world. London: Routledge.

Davenport, S. (2005). Exploring the role of proximity in SME knowledge-acquisition. Research Policy 34(5): 683–701.

Etzioni, A. and Etzioni, O. (1999) Face-to-Face and Computer-Mediated Communities, A Comparative Analysis. The Information Society: An International Journal Volume 15, Issue 4, 1999 pages 241-248.

Felzensztein, C. and Gimmon, E. and Carter, S.L. (2010) Geographical Co-Location, Social Networks and Inter-firm Marketing Co-operation: the Case of the Salmon Industry. Long Range Planning 43: 675-690.

Gallaud, D. and Torre, A. (2004). Geographical proximity and circulation of knowledge trough inter-firm cooperation. In Wink, R. (Ed.), Academia–Business Links: European Policy Strategies and Lessons Learnt. Basingstoke: Palgrave Macmillan, pp. 137–158.

Gallaud, D. and Torre, A. (2005). Geographical proximity and the diffusion of knowledge: the case of SME's in biotechnology. In Koch, A. (Ed.), Rethinking Regional Innovation. Dordrecht: Kluwer, pp. 127–146.

Ganesan, Shankar, Alan J. Malter, and Aric Rindfleisch (2005), “Does Distance Still Matter? Geographic Proximity and New Product Development,” Journal of Marketing, 69 (October), 44-60.
Gertler, M.S. (1995). Being there – proximity, organization, and culture in the development and adoption of advanced manufacturing technologies. Economic Geography, 71(1), 1–26.
Granovetter, M. S. (1973). "The Strength of Weak Ties". The American Journal of Sociology 78 (6): 1360–1380
Granovetter, M. S. (1973). “Economic Action and Social Structure: The Problem of Embeddedness.” American Journal of Sociology, 91(November): 481-510.
Granovetter, M. S. (2000). “Social Networks in Silicon Valley”. With Emilio Castilla, Hokyu Hwang and Ellen Granovetter. Pp. 218-247 in Chong-Moon Lee, William F. Miller, Marguerite Gong Hancock, and Henry S. Rowen, editors, The Silicon Valley Edge. Stanford: Stanford University Press.
Gulati, R. (1998). Alliances and networks., Strategic Management Journal, 19, 293.
Hagedoorn, J., Link, A.N. and Vonortas, N.S. (2000). Research partnerships. Research Policy, 29, 567–586
Hanna, V. and Walsh, K. 2008. Interfirm Cooperation among Small Manufacturing Firms. International Small Business Journal 26(3): 299-321.
Harrison, B. (1992) Industrial Districts: Old Wine in New Bottles? Regional Studies Volume 26, Issue 5, 469-83.
Howells, J.R.L. (2002). Tacit knowledge, innovation and economic geography. Urban Studies, 39(5–6), 871– 884.
Huggins, R. and Johnston, A. (2009) ‘Knowledge Networks in an Uncompetitive Region: SME Innovation and Growth’, Growth and Change, Vol. 40, No. 2, 227-259.
Hughes, T., O'Regan, N., and Sims, M. (2009),"The effectiveness of knowledge networks: An investigation of manufacturing SMEs", Education + Training, Vol. 51 Iss: 8 pp. 665 – 681
Kirat, T. and Lung, Y. (1999) Innovation and Proximity Territories as Loci of Collective Learning Processes European Urban and Regional Studies January 1999 vol. 6 no. 1 27-38
Knoben, J. and Oerlemans, L.A.G. (2006), Proximity and Inter-Organizational Collaboration: A Literature Review. International Journal of Management Reviews, Vol. 8, No. 2, pp. 71-89.
Madhok, A. (2002), Reassessing the fundamentals and beyond: Ronald Coase, the transaction cost and resource-based theories of the firm and the institutional structure of production. Strategic Management Journal 23: 535-550.
McKelvey M., H. Alm, M. Riccaboni (2003) Does Co-location Matter? Knowledge Collaboration in the Swedish Biotechnology-Pharmaceutical Sector, Research Policy, 32(3),
Neuman, W.L. (2000). Social Research Methods, Allyn and Bacon, London.
Nobuya, F. (2006), “Determining factors in innovation of small firm networks: a case of cross industry groups in Japan”, Small Business Economics, Vol. 27 Nos 2/3, pp. 181-93.
Nonaka, L., Toyama, R. and N. Konno (2000) ‘SECI, Ba and Leadership: a Unified Model of Dynamic Knowledge Creation Long Range Planning, 33(1): 5-34.
OECD (1997), “Oslo manual : proposed guidelines for collecting and interpreting technological innovation data”, OECD: Paris.

Oliver, A.L. and Liebeskind, J.P. (1998). Three levels of networking for sourcing intellectual capital in biotechnology: implications for studying inter-organisational networks. International Studies of Management and Organization, 27(4), 76–103.
Perkmann M, Walsh K, University-industry relationships and open innovation: Towards a research agenda (review article), International Journal of Management Reviews, 2007, Vol:9, Pages:259-280
Powell, W.W., Koput, K.W. and Smith-Doerr, L. (1996). Interorganizational collaboration and the locus of innovation: networks of learning in biotechnology. Administrative Science Quarterly, 41(1), 116-145
Roos, G. (2012). Manufacturing into the future. Adelaide: Government of South Australia.
Roos, G., Fernström, L., & Gupta, O. (2005). National Innovation Systems: Finland, Sweden & Australia Compared. Australian Business Foundation, Learning for Australia.
Roos, G and Pike, S 2011 'The relationship between university research and firm innovation', Chapter 3 in E Evans, R Burritt & J Guthrie (eds), Bridging the gap between academic accounting research and professional practice, The Institute of Chartered Accountants in Australia & Centre for Accounting, Governance and Sustain-ability, University of South Australia, Adelaide, pp. 31–50.
Rosenfeld' S.A. (1997) Bringing business clusters into the mainstream of economic development European Planning Studies Volume 5, Issue 1: 3-23
Saunders, M., Lewis, P. & Thornhill, A. (2007). Research Methods for Business Students, Pearson Prentice Hall Financial Times, Harlow, Essex, England.
Seely-Brown, J., and P. Duguid. 2001. Knowledge and organization: A social-practice perspective. Organisation Science 12(1): 198–213.
Shrivastava, P., Mitroff, I.I. (1984), "Enhancing organizational research utilization: the role of decision makers' assumptions", Academy of Management Review, Vol. 9 No.1, pp.18-26.
Thorpe, R., Holt, R., Macpherson, A. and Pittaway, L. (2005), Using knowledge within small and medium-sized firms: A systematic review of the evidence. International Journal of Management Reviews, 7: 257–281.
Torre, A. & Gilly, J.P. (2000) On the Analytical Dimension of Proximity Dynamics Regional Studies Volume 34, Issue 2: 169-180
Torre, A. and Rallet, A. (2005). Proximity and localisation. Regional Studies, 39, 47 – 59.

Table 1: Extent and Nature of Innovation: SME size differences

	Micro	Small	Medium	**Total**
# of SMEs/ % of sample	603 71%	171 20%	72 9%	846 100%
# of SMEs that innovate/ % of micro, small & medium firms that innovate	402 67%	137 80%	63 88%	602 [a]
% of innovative SMEs that implement …	Micro	Small	Medium	
1 type of Innovation	25	17	19	
2 types of innovation	19	27	28	
3 types of innovation	11	20	26	
4 types of Innovation	12	15	14	

Notes: Totals do not add to 100 as respondents could check more than one response.
[a] Indicates statistically significant differences between the three groups.;
*p <.05

Table 2: Collaboration and Geographic Patterns: size differences

	Innovative SMEs			Micro SMEs			Small SMEs			Medium SMEs		
	% Domestic	% Overseas	% Total	% Domestic	% Overseas	% Total	% Domestic	% Overseas	% Total	% Domestic	% Overseas	% Total
Other parts of the wider enterprise group to which your business belongs	27%	7%	30%[a]	25%	5%	26%[b]	33%	10%	36%	30%	14%	38%[d]
Suppliers of equipment, materials, components, or software	43%	14%	49%	40%	13%	46%	50%	10%	53%	51%	22%	59%
Clients or costumers	48%	11%	51%	49%	12%	52%	46%	7%	48%	44%	14%	49%
Competitiors and other businesses from the same industry	27%	6%	29%	27%	5%	29%	30%	4%	31%	22%	11%	27%
Consultants	26%	3%	27%	21%	4%	23%	36%	4%	36%	33%	0%	33%
Universities or other higher education institutions	9%	2%	9%	9%	1%	10%	7%	1%	8%	8%	3%	8%
Government agencies	14%	2%	14%	14%	2%	15%	12%	1%	12%	13%	3%	13%
Private non-profit research institutions	3%	1%	4%	4%	1%	5%	2%	0%	2%	5%	3%	5%
Commercial laboratories/ research and development enterprises	4%	2%	5%	4%	2%	6%	3%	1%	4%	5%	3%	6%
Total SMEs	75%	25%		65%	21%		74%	15%		76%	33%	

Notes
Totals do not add to 100 as respondents could check more than one response.
[a] Indicates statistically significant differences between the three groups.
[b] Indicates statistically significant differences between micro and small enterprises.
[c] Indicates statistically significant differences between small and medium enterprises.
[d] Indicates statistically significant differences between medium and micro enterprises.
*p <.05

Table 3: University-SME knowledge acquisition pathways and geographic patterns: size differences

	Innovative SMEs			Micro SMEs			Small SMEs			Medium SMEs		
	% Domestic	% Overseas	% Total	% Domestic	% Overseas	% Total	% Domestic	% Overseas	% Total	% Domestic	% Overseas	% Total
Employed new graduate(s)	7%	1%	9%a	4%	0%	4%[b]	17%	1%	17%	25%	6%	27%[d]
Employed academic or research staff	2%	1%	3%a	1%	0%	2%	2%	1%	2%[c]	11%	3%	13%[d]
Used research results published by these institutions	9%	6%	12%	11%	7%	12%	10%	5%	11%	11%	8%	14%
Used research facilities of	4%	1%	6%	5%	2%	6%	3%	1%	4%	8%	2%	8%

these institutions												
Used patents, designs, or other intellectual property rights initially from these institutions	2%	1%	3%a	1%	1%	2%	1%	0%	1% [c]	6%	3%	8% [d]
Used consultants from these institutions	4%	1%	6%a	5%	1%	6%	3%	0%	3% [c]	10%	5%	13%
Contracted out research and development to these institutions	2%	0%	6%	2%	1%	6%	1%	0%	3%	6%	2%	6%
Total SMEs	18%	7%		20%	9%		26%	5%		38%	14%	
	Innovative SMEs			Micro SMEs			Small SMEs			Medium SMEs		
	% Domestic	% Overseas	% Total	% Domestic	% Overseas	% Total	% Domestic	% Overseas	% Total	% Domestic	% Overseas	% Total

Notes
Totals do not add to 100 as respondents could check more than one response.
[a] Indicates statistically significant differences between the three groups.
[b] Indicates statistically significant differences between micro and small enterprises.
[c] Indicates statistically significant differences between small and medium enterprises.
[d] Indicates statistically significant differences between medium and micro enterprises.
*p <.05

Table 4. Correlations: Generic university-to-industry links and university-industry relationships.

	Employed academic or research staff (Aus)	Used research facilities of these institutions (Aus)	Used consultants from these institutions (Aus)	Contracted out research and development to these Institutions (Aus)
Employed new graduate(s) (Aus)	0.36	0.14	0.19	0.20
Used research results published by institutions (Aus)	0.16	0.37	0.29	0.14
Used patents, designs, or other intellectual property rights initially from these Inst (Aus)	0.25	0.24	0.23	0.30

Following Cohen (1988), we interpret CRAMER'S V statistic as follows: 0 no relationship; 0 to 0.1 not generally useful; 0.1 to 0.2 weak; 0.2 to 0.25 moderate; 0.25 to 0.3 moderately strong; 0.3 to 0.35 strong; 0.35 to 0.4 very strong.

Table 5. University-SME knowledge acquisition pathways and geographic patterns: Correlations

University-SME knowledge acquisition method	Australia	Internationally
Employed new graduate(s) from these institutions	0.15 *	0.10 *
Used research results published by institutions	0.14 *	0.10 *
Used patents, designs, or other intellectual property rights initially from these institutions	0.05	0.09
Employed academic or research staff from these institutions	0.16 *	0.03
Used research facilities of these institutions	0.13 *	0.07
Used consultants from these institutions	0.13 *	0.09
Contracted out research and development to these institutions	0.10 *	0.07

Following Cohen (1988), we interpret CRAMER'S V statistic as follows: 0 no relationship; 0 to 0.1 not generally useful; * 0.1 to 0.2 weak; 0.2 to 0.25 moderate; 0.25 to 0.3 moderately strong; 0.3 to 0.35 strong; 0.35 to 0.4 very strong.

Table 6. Other knowledge acquisition methods and geographic patterns: size differences.

	Innovative companies															
	Total				Micro companies involve in collaboration				Small companies involve in collaboration				Medium companies Involve in collaboration			
	% Same State	% Other States	% Ov.	Total	% Same State	% Other States	% Ov.	Total	% Same State	% Other States	% Ov.	Total	% Same State	% Other States	% Ov.	Total
Employed new skilled staff	29%	5%	5%	38% [a]	17%	1%	3%	22% [b]	51%	10%	5%	66% [c]	60%	16%	22%	84%
Interchanged staff with another business	6%	3%	2%	11%	6%	3%	1%	11%	7%	1%	1%	10%	5%	6%	8%	17%
Used consultants (or other paid advisors)	30%	8%	3%	43% [a]	25%	7%	3%	37% [b]	39%	12%	3%	50%	48%	13%	5%	67% [d]
Acquired new equipment or technology for producing the business' goods or services	29%	15%	12%	54%	28%	14%	12%	51% [b]	34%	19%	9%	61%	27%	13%	21%	57%
Merger/takeover with/of another business (in whole or part)	3%	1%	1%	7%	3%	1%	1%	6%	4%	2%	0%	7%	6%	2%	3%	14% [d]
% Total companies involve in collaboration	54%	25%	10%		46%	21%	15%		68%	33%	15%		73%	32%	38%	

Notes
Totals do not add to 100 as respondents could check more than one response.
[a] Indicates statistically significant differences between the three groups.
[b] Indicates statistically significant differences between micro and small enterprises.
[c] Indicates statistically significant differences between small and medium enterprises.
[d] Indicates statistically significant differences between medium and micro enterprises.
*p <.05