Chapter 3

Knowledge exchange behaviours of science park firms: The Innovation Hub case[4]

This study regards the knowledge flows between firms located on a science park as a type of network behaviour, and answers three research questions: What are the knowledge exchange behaviours of on-park firms? Can different types of behaviour be distinguished among these firms? And if so, what are the differences between these groups? A relational approach is taken in which actor and relationship features are studied in a sample of firms located at The Innovation Hub (South Africa). Results show that there are two groups of firms: on-park firms that network with other on-park firms (Group 1) and those that do not (Group 0). Compared with Group 0, Group 1 has more informal ties with off-park firms, is able to gain more useful knowledge from private knowledge sources, and has more access to unintended knowledge that flows in the park. However, the innovative performance of the groups does not differ.

3.1 Introduction

The majority of science park studies state that an important goal of science parks is to meet governments' requests for a greater exchange of knowledge and ideas between on-park firms in general, and between these firms and higher educational institutions such as universities in particular to transform ideas into innovations. It is this kind of innovation that governments believe to be the key to economic development and growth in the region and therefore science parks should be used as a catalyst or engine (Chan and Lau 2005). Firms located on science parks are assumed to profit from the transmission of (tacit) knowledge due to lower communication costs in a dense and knowledge-rich environment. Besides the knowledge exchange between on-park firms, there also can be knowledge

[4] This chapter has been published in a slightly different format as Chan, K.-Y. A., Oerlemans, L.A.G. and Pretorius, M.W., 2010. Knowledge exchange behaviours of science park firms: The Innovation Hub case. *Technology Analysis & Strategic Management*, 22(2), 207-228.

exchanges with off-park firms. This type of knowledge exchange causes spillover effects of science parks so that the government's goal of (regional) economic development is achieved. Many developing countries' governments were keen to invest in new science parks in an attempt to enhance economic competitiveness, and The Innovation Hub (TIH) in Pretoria, South Africa, was one such project by the Gauteng Provincial Government. This initiative has as its primary goals to stimulate and manage the flow of knowledge and technology between universities, R&D institutions, companies and markets so that it becomes the leading knowledge-intensive business cluster in South Africa.

From the above discussion, it is clear that knowledge flows between various actors play an important role at science parks. Therefore, in order to examine science parks, one should take knowledge flows into account and ask: To what extent do these knowledge flows actually occur on a science park? Exchanging knowledge is regarded as a type of network behaviour and therefore, to study different types of knowledge flows, one needs to look at the characteristics of interorganisational relations, as they serve as pipelines for these knowledge flows (Owen-Smith and Powell, 2004). The aim of this study is to obtain insight into the knowledge exchange behaviour of firms on a science park, and, in particular, firms located at TIH. Three research questions will be answered:

1. What are the knowledge exchange behaviours of on-park firms?
2. Do these behaviours distinguish groups among on-park firms?
3. If so, what are the differences between these groups?

By answering these questions, this study adds value to the field in a number of ways. Firstly, many studies take the science park as their level of analysis. This study takes a firm level perspective and investigates the knowledge exchange behaviour of firms located on a science park with other on- and off-park firms. Applying such an approach highlights knowledge diffusion processes in a bounded geographical space. Secondly, and related to the first contribution, this study takes a relational approach in which characteristics of interorganisational ties are thought to be of importance for the performance of organisations. It is a relatively new approach to include tie characteristics in studies of science parks. Thirdly,

while studying the performance of science parks or its firms, many scholars use patents as a performance indicator. This study applies a broader set of performance indicators in which not only inventions, but also innovations (invention + market introduction) are taken into account. Fourthly, recent science park studies tend to focus on parks in Asia (Taiwan, China, and South Korea). This research studies firms located on a science park in (South) Africa. To the researcher's knowledge, this is one of the first studies investigating the functioning and performance of science parks firms on this continent.

The remainder of this chapter is structured as follows. By taking a relational approach, Section 2 gives a brief review of the literature on networking and discusses how characteristics of interorganisational ego networks influence innovations. Section 3 describes the research methodology that is used and how the variables were measured. Section 4 describes the results of a survey of TIH resident companies (on-park firms) which the author carried out in 2008, focusing on the characteristics of knowledge exchange relationships and the actors involved. The discussion in this section includes the possible group distinctions and differences in knowledge exchange behaviours and innovative performances between them. Section 5 provides some concluding remarks.

3.2 Theoretical framework

3.2.1 Introduction

In the introduction of this chapter, it was stated that a relational perspective would be applied to study knowledge exchange behaviours of science park firms. But what is a relational approach? In this approach, organisations are viewed as being embedded in external networks and consisting of networks of relations within teams, with employees, suppliers, buyers, institutional actors such as governments, regulatory bodies, social movements, professional associations, employers organisations and trade organisations. The approach argues that relationships and their characteristics (for example, the level of exchanges, trust or

knowledge transfer) are relevant for understanding organisational behaviour and outcomes. The approach represents a move "away from individualist, essentialist and atomistic explanations toward more relational, contextual and systematic understanding" (Borgatti and Foster, 2003: 991). The forging of productive relations with a highly differentiated set of partners is one of the core activities of organisational decision makers. The sets of relations legitimise organisational actions and strengthen organisations' embeddedness in an organisational field and in society. Relations also co-determine the survival chances of organisations because relations enable access to complementary resources, create potential for avoiding risks, show reputation and status, and hence enable the assets and resources needed to develop adaptive repertoires and innovative strategies to cope with competitive and institutional pressures.

In terms of studying interorganisational relations and networks, a basic building block of any network is an interorganisational relationship, which is also known as a dyad. Per definition, each dyad consists of two actors and a tie. Consequently, when one studies knowledge exchange behaviours of science park firms, one has to focus on the so-called tie and actor characteristics.

In the next two sections, the focus is on a number of tie characteristics related to intended and unintended knowledge exchanges, which are, according to the literature, of importance to innovation. In a subsequent section, a number of actor characteristics are discussed, such as firm age, firm size, years located on a science park and its absorptive capacity, as they also contribute to a firm's innovative performance and network behaviours.

3.2.2 Tie characteristics

Relational characteristics include three categories: tie type (interorganisational knowledge flows), the number of direct ties (degree centrality) and tie strength (trust, proximities, frequency and usefulness of the knowledge flowing in the tie).

3.2.2.1 Intended and unintended knowledge flows

The literature distinguishes between two types of interorganisational knowledge flows: intended and unintended knowledge flows (Fallah and Ibrahim, 2004; Oerlemans and Meeus, 2005). *Intended* knowledge flow refers to flows between two actors who intentionally interact with the aim to exchange their knowledge resources. Researchers relate *unintended* knowledge flows to the knowledge spillover literature (Howells, 2002; Oerlemans and Meeus, 2005). They define unintended knowledge flows as the transmission of knowledge to other actors on an involuntary and unintended basis, or, in other words, the unintentional transmission of knowledge to others beyond the intended boundary. This type of knowledge can be acquired without the acknowledgement of the sending firms[5]. This is a relevant issue in the South African context is shown in several studies. Sawers, Pretorius and Oerlemans (2008) state that there are unintentional knowledge flows from SMEs to their larger partners in South Africa. In the study "*Industrial Innovation in South Africa, 1998-2000"* by Oerlemans and colleagues (2004), it is shown that many South African innovative firms benefit from this type of knowledge flows, which result in an imitation type of innovative behaviour. In other knowledge spillover studies, researchers also attribute innovative performance to knowledge spillovers (Fallah and Ibrahim, 2004; Oerlemans and Meeus, 2005). In this study, two dimensions of unintended knowledge flow are distinguished: the flow between on-park firms and between on-park firms and off-park actors.

3.2.2.2 Number of ties

Through networks, firms are able to access knowledge externally and apply this acquired external knowledge to develop their own innovations. When firms interact formally (by explicit agreement) or informally (on a social basis), knowledge

[5] The measurement of unintended knowledge spillover is based on Howells' study in which he stated that 'unintended knowledge spillovers are much harder to measure and therefore have been largely neglected in knowledge spillovers studies' (Howells, 2002: 877). He has listed some possible sources of unintended knowledge which can be used as measurement for unintended knowledge flows (which this thesis used).

sharing often occurs. Evidence from the literature illustrates that "those firms which do not co-operate and which do not formally or informally exchange knowledge, limit their knowledge base over the long term and ultimately reduce their ability to enter into exchange relationships" (Pittaway et al., 2004: 145). Network position, such as centrality, is an important aspect of a network structure because it conditions the degree to which an actor can have access to resources throughout the network; the more a firm is central in its network, the more it can compare knowledge across multiple knowledge sources and discover new knowledge. Furthermore, firms with a more central position are less likely to miss any vital knowledge and are able to combine knowledge in novel ways to generate innovations (Bell, 2005). In this study, centrality is examined using degree or local centrality that is measured by determining the number of direct relationships a so-called ego firm has with other actors. Various studies have shown that centrality is positively associated with innovation and enhances firm performance (Ahuja, 2000; Zaheer and Bell, 2005).

3.2.2.3 Trust

Studies have identified trust in relationships as an important relational asset that promotes the willingness to exchange knowledge (Abrams et al., 2003). Trust is often desired by knowledge-intensive and information-based firms who require the sharing of sensitive information (Lane and Bachmann, 1998). Zaheer, McEvily and Perrone (1998, 143) conceptualise trust as an "expectation rather than a conviction that reflects an uncertain anticipation of the referent's future behaviour". They define trust as the *expectation* that an actor: (1) can be relied on to fulfil obligations; (2) will behave in a predictable manner; and (3) will act and negotiate fairly when the possibility for opportunism is present (*ibid.*). They distinguished two types of trust: interorganisational and interpersonal. Both dimensions of trust form the foundation for effective interactions between actors and this can be observed by investigating trust deeper in its two forms.

Based on past interactions, when two actors are emotionally involved with each other and trust is eventually built between them, they are willing to put forth more

time and effort on behalf of each other to transfer knowledge. This form of trust is called "intentional trust" (Lazaric and Lorenz, 1998) because it refers to the belief that partners intend to uphold the commitments they make. Another form of trust is "competence-based trust", which refers to the belief that partners have the capability to meet their commitments. In this study, trust refers to the belief that a partner is capable (competence-based trust) of providing the knowledge a firm needs for innovations as well as the belief that a partner is willing to share such knowledge for the benefit of the other partner (intention-based trust). Therefore, higher trust levels are assumed to be conducive to the exchange of knowledge and thus reduce knowledge protection (Norman, 2002).

3.2.2.4 Types of proximity

Gertler (1995: 1) found that “recent work on innovation and technology implementation suggests the importance of closeness between collaborating parties for the successful development and adoption of new technologies”. Two actors are considered to be close because they are alike (Torre and Rallet, 2005) and this closeness between actors can be labelled as "proximity", which refers to "being close to something measured on a certain dimension" (Knoben and Oerlemans 2006, 71). There are various dimensions of proximity and they often overlap in their meanings and dimensions. For this study, the classification of proximity dimensions developed by Knoben and Oerlemans (2006) is used. They discern geographical, technological and organisational proximity.

In the study of innovation and knowledge transfer, there is an emphasis on the literature of geographical proximity. It is often defined as geographical distance expressed as a specified radius to a partner (Orlando, 2000) or travel times/perception of these distances (Boschma, 2005). A short distance between two actors facilitates knowledge sharing and the transfer of tacit knowledge in particular. Tacit knowledge transfer is enhanced through face-to-face contacts and these contacts are the richest and most multidimensional contacts available to humans (Desrochers, 2001). Therefore, the spatial dimension becomes essential to enhance the exchange of tacit knowledge for innovative activities and one could

argue that the high level of proximity science parks offer is conducive to the exchange of knowledge.

Furthermore, Desrochers (2001: 29) mentions that “geographical concentration of *related firms* balances cooperative and competitive forms of economic activity, leading to greater innovation and flexibility”. The term “related” points at similarity of technological backgrounds and knowledge between these firms. Technological proximity refers to the similarities between actors’ technological knowledge, in other words, how similar the knowledge bases are between them. The transfer of unrelated knowledge can cause difficulties because the firm that receives the knowledge is not capable of identifying, assimilating and exploiting the knowledge coming from external sources for its own innovative activities (Sapienza, Parhankangasand and Autio, 2004). On the other hand, similar knowledge contributes to efficient communication because knowledge can only be easily exchanged if the two actors share a similar language, codes, and symbols (Grant, 1996). Moreover, similar external knowledge is also likely to be more compatible than dissimilar knowledge, so that the receiving firm is able to *absorb* such knowledge from the sender for its own use (relative absorptive capacity, see Lane and Lubatkin 1988).

The third dimension is "organisational proximity". It is defined as “*the set of routines – explicit or implicit – which allows coordination without having to define beforehand how to do so. The set of routines incorporates organisational structure, organisational culture, performance measurements systems, language and so on*” (Knoben and Oerlemans, 2006: 80). Lane and Lubatkin (1988) state that similarity between the two firms’ organisational structures and policies contributes to firms’ ability to learn interactively from each other. This interactive learning does not only occur at the individual level, but also at the organisational level where its structure and routines represent the codification of the organisation’s historic pattern of roles and the organisation’s communication processes. Collaborating firms that have low organisational proximities have different sets of routines and thus, instead of creating innovations together, they create problems due to these routines; for example, they cannot communicate well due to their different communication

processes. As the worst result of such difference, an unsuccessful collaboration leads to no innovative outputs.

3.2.2.5 Frequency and knowledge usefulness

Soo and Devinney (2004) identified a positive relationship between quality of knowledge transferred and innovative performance. The quality of knowledge transferred comprises two factors: usefulness of the knowledge that a firm receives and how frequently it receives the knowledge. The context of the knowledge that a firm receives directly influences the success of the innovative outcomes if the firm can actually use such knowledge. The knowledge can be new to the receiving firm, but if it cannot be used and contribute to the firm's development of new innovations, then such knowledge has low knowledge quality for the firm. This is in line with Brachos and others (2007), who point out that knowledge transfer actually occurs when received knowledge is used to lead to something new (ideas, products, deeper knowledge, etc.). Furthermore, they suggested that perceived usefulness of knowledge is an adequate proxy of knowledge transfer effectiveness.

The frequency of knowledge exchange is the quality of the knowledge exchange because more frequent communication can lead to more effective communication (Reagans and McEvily, 2003). With repeated interaction, the receiving firm can better understand the knowledge that it receives and this increases the chances that the knowledge would be useful for the firm's innovations. Audretsch and Feldman (2004) state that the marginal cost of transmitting knowledge, especially tacit knowledge, is lowest with frequent interactions, observations and communications. Frequent interactions also enhance the parties' mutual trust, because relationships mature with interaction frequency (Atuahene-Gima and Li, 2002). Studies have shown that mutual trust affects the grade of tacit knowledge utilisation (Koskinen, Pihlanto and Vanharanta, 2003).

3.2.3 Actor characteristics

Actor characteristics contribute to the analysis of network behaviours and innovative performances of firms. These characteristics include the diversity of external actors, firm age and size, duration of location in the science park and a firm's absorptive capacity.

3.2.3.1 Diversity of external actors

Many innovators derive their ideas from a diverse set of actors because these provide diverse ideas that are a source of novelty, triggering new ideas and creativity in the knowledge-acquiring firm. Actors who interact with partners from diverse communities of practice will be able to convey more complex ideas than those individuals who are limited to interactions within a single body of knowledge (Reagans, 2003).

The process of knowledge building often requires dissimilar, complementary bodies of knowledge from diverse actors (Staber, 2001) who interact with each other to share diverse knowledge and take advantage of their "built-in" knowledge diversity to bring about successful projects (Ratcheva 2009) and to achieve a complex synthesis of highly specialised state-of-the-art technologies and knowledge domains for product innovations (Dougherty, 1992). A recent study also showed that knowledge diversity is an important source of productivity at firm level, so that the firm is able to cope with the technological turbulence that is concomitant with the rise of the knowledge economy (Nesta 2008). Diversity is defined here as the use of "multiple sources of knowledge" such as competitors, customers, suppliers, HEIs, etc.

3.2.3.2 Firm age and size

Prior studies have identified a significant positive relationship between firm size and innovativeness and a significant negative relationship between firm age and

innovativeness (Bell, 2005). Firm size in this study is identified by the number of full-time employees, including CEOs and directors, employed by a firm, and firm age is the number of years that have passed since a firm's founding. Small and young firms often face significant risk and uncertainty due to a lack of information and knowledge (Bürgel et al., 2001). For a firm to be innovative and competitive, accumulation of knowledge plays an important role (Malmberg, Sölvell, and Zander 1996) and this needs time and people to acquire knowledge. In particular, firm size determines the level of networking because "people" are at the core of tacit knowledge exchange (Erkuş-Öztürk, 2009). Science parks are designed to encourage the formation and growth of knowledge-based businesses and therefore consist mainly of young and small-size NTBFs.

3.2.3.3 Years of location on SP

Science parks (SPs) are believed to have made many value-adding contributions to firms (Fukugawa, 2006), especially by providing the opportunities (close geographical proximity) and support (from the science park management) to their on-park firms to establish knowledge linkages, and allowing on-park firms to engage in joint research. Firms that have been on a science park for longer are considered to receive more such benefits than those who are latecomers on the park.

3.2.3.4 Absorptive capacity

Following Cohen and Levinthal's seminal study (1990), firms' fundamental learning processes (their ability to identify, assimilate and exploit knowledge from the environment) are labelled absorptive capacity. Zahra and George (2002) propose additional definitions that separate Cohen and Levinthal's definition of absorptive capacity into two main dimensions: potential absorptive capacity (the capability to acquire and assimilate knowledge) and realised absorptive capacity (the exploitation or use of the knowledge that has been absorbed). Many empirical studies have shown that there is a positive relationship between absorptive

capacity and innovation. Pennings and Harianto's study (1992) shows that prior accumulated experience in a certain technological area increases the likelihood of innovation adoption. Nelson and Wolff (1997) and Becker and Peters (2000) argue that firms need higher absorptive capacities for scientific knowledge than for other types of knowledge. More recent literature also explores the positive relationship between absorptive capacity and innovations (Fosfuri and Tribó, 2008), and its relevance for absorbing external knowledge.

3.2.4 Innovative performance

Science parks are closely associated with innovation. In Castells and Hall's (1994) list of motivations for the establishment of technology parks, the "creation of synergies" is described as the generation of new and valuable information through human intervention to the extent that an "innovative milieu", which generates constant innovation, is created and sustained. In addition to the study of on-park firms' knowledge exchange behaviours and also since a science park is the seedbed for innovation, this study investigates the innovative performances of the on-park firms. Innovative performance is based on the definition by Ernst (2001), namely achievement in the trajectory from the conception of an idea up to the introduction of an invention into the market.

3.3 Research methodology and measurements

3.3.1 Research methodology

In this study, the focus is on the knowledge exchange behaviours of firms located on a science park. Therefore, the unit of analysis is firms located on TIH in Pretoria, South Africa. The sectoral distribution of current on-site firms (total = 47) is as follows: Bioscience: 5; Electronics: 2; Engineering: 6; Information, communication and technology (ICT): 28; Smart manufacturing: 1; and Professional services: 5.

This research applies a quantitative research methodology. A questionnaire was distributed to firms located on TIH and the CEOs or directors (units of observation) of these firms were asked to answer questions based on the characteristics of their firms' knowledge exchange behaviours with other on-park firms as well as with off-park firms/organisations (firms not located on TIH). Questionnaires were distributed personally or via emails to all NTBFs and 33 were returned. Twenty-five questionnaires were valid (response rate = 52%), comprising 17 from ICT, four from Engineering, two from Professional services and one from Electronics. Eight responses were invalid due to the firms' characteristics not meeting our criteria for inclusion (selection criteria for NTBFs: firm age of less than 10 years, total employee less than 50 and technology-based firm). The collected data was analysed by applying independent T-tests.

3.3.2 Measurements

This research studies the knowledge exchange behaviours of on-park firms at the ego-network level (an ego-network is a focal firm (the ego) with its direct ties, the alters) rather than at the whole network level (which requires data on the entire set of present and absent linkages between a set of actors).

Table 1 illustrates the items that are used in the questionnaire to measure the variables proposed in the research framework. Table 2 shows the literature that was sourced to construct the measurements, as well as the reliability statistics (Cronbach's alpha) of the scales used. Table 2 shows that several variables are measured by more than one item. Examples are trust, organisational proximity, and relative innovative performance. In these cases, factor analysis was conducted to explore the underlying dimensions of these specific variables. It turns out that there is one factor each for both interorganisational trust and interpersonal trust.

A reliability test was then done on these variables to determine how well the items measure a single, unidimensional latent construct. This procedure was performed

for all relevant variables and the results are shown in the last column of Table 2. Most variables have Cronbach's α's ≥ 0.6, which indicates reliable scales. Note that the Cronbach's α for off-park organisational proximity is 0.442. This means that for off-park organisational proximity, separate items will be used independently to measure this variable.

Table 1: Item(s) of variables

Variables	Item(s)
Direct ties	Formal interorganisational network ties: with how many on-park and off-park organisations does the on-park firm have formal/contractual agreements? Informal interorganisational network ties: with how many on-park and off-park organisations does the on-park firm have interactions on a non-contractual basis (i.e. informal, social basis)? Social network ties: with how many persons of on-park and off-park does the manager of the on-park firm have social interactions?
Trust	<u>Interorganisational trust:</u> Indicate level of agreement with the following statements: In general, the organisations with which my firm exchanges knowledge: (1) keep promises they make to our firm; (2) are always honest with us; (3) provide information that can be believed; (4) are genuinely concerned that our business succeeds; (5) consider our welfare as well as their own when making important decisions; (6) keep our best interests in mind; (7) are trustworthy; (8) it is not necessary to be cautious in dealing with them. <u>Interpersonal trust:</u> Indicate level of agreement with the following statements. In general, the persons with which my firm exchanges knowledge: (1) have always been impartial in negotiations with us; (2) can always be counted on to act as expected; (3) are trustworthy; (4) consider our interests even when it is costly to do so; (5) if their performance was below expectation, a sense of betrayal would be felt. (7-point Likert scale for all above items: 1 = completely disagree, 3 = neither agree nor disagree, 7 = completely agree)
Geographical proximity	Geographical distances with respect to off-park firms: Where are the most important partners situated: (1) same town/city, (2) different city but same province, (3) other province or (4) abroad?
Technological proximity	Technologically similar: To what extent is the knowledge your firm receives from most partners/actors similar to your firm's own knowledge? (7-point Likert scale: 1 = dissimilar to 7 = completely similar)

Variables	Item(s)
Organisational proximity	Our firm has contacts with the same third parties as our partners have Our partners have the same organisational routines and values as our firm Our partners have the same organisational structure as our firm (5-point Likert scale: 1 = completely disagree, 3 = neither agree nor disagree, 5 = completely agree)
Quality of knowledge transferred	Usefulness of knowledge: How useful is the knowledge your firm receives from the most important partners with regard to your firm's innovations? (5-point Likert scale: 1 = not useful to 5= completely useful) Frequency: How often does your firm access knowledge from its most important partners? (5-point Likert scale: never, rarely, sometimes, regularly or always)
Diversity of actors	Respondents were asked indicate which knowledge sources were used: (1) competitors; (2) buyers;(3) suppliers; (4) innovation centres; (5) public research labs; (6) universities; (7) consultants; and (8) sector institutes
Knowledge spillover (Unintended knowledge flows)	How often does your firm use the following sources from other organisations/actors to acquire knowledge for your firm's innovations?: (1) employing key scientists and engineers (including poaching key staff); (2) acquiring key information at conferences and workshops; (3) reverse engineering of technological knowledge embedded in products developed/produced by other firms/organisations; (4) accessing patent information filed by other firms/organisations; (5) knowledge embedded in organisational processes or routines of other firms/organisations; (6) publications in technical and scientific papers by other firms/organisations. (5-point Likert scale: never, rarely, sometimes, regularly or always).
Firm age	Number of years a firm exits.
Firm size	Total number of employees, including the CEOs and directors in 2005 and 2007.
Years on SP	Total number of years that the firm is located on the science park (SP).

Variables	Item(s)
Absorptive capacity	Indicate level of agreement with the following statements: (1) most of our staff members are highly skilled and qualified; (2) we invest a great deal in training; (3) we innovate by improving competitors' products and processes; (4) most of the time we are ahead of our competitors in developing and launching new products; (5) we have the capacity to adapt others' technologies; (6) we innovate as the result of R&D carried out in our own firm; (7) we have considerable resources and own knowledge resources for technological development; (8) we are able introduce into the market innovations that are completely novel on a worldwide scale. (5-point Likert scale: 1 = strongly disagree, 3 = neither agree nor disagree, 5 = strongly agree)
Firm's innovative performance	Five indicators of innovative performance were used: (1) number of patents; (2) number of new products/services that were developed but not yet introduced to the market; (3) percentage of sales of products/services that were technologically improved and technologically new in percentage; (4) percentage of sales of product/services that were not only technologically improved or new but also technologically new or improved in the market (the competitors had not already introduced such product/services); (5) relative innovative performance. For this last item, the following question was asked. To what extent did your firm's product and/or service innovations result in: (a) reduction of development and maintenance costs; (b) quality improvement of products and/or services; (c) increase in production capacity; (d) improvement in delivery times; (e) increase in sales; (f) increase in profits. (5-point Likert scale: 1 = very little, 3 = not little / not much, 5 = very much).
Total sales growth	Relative growth of sales in the period 2005-2007.
Employee growth	Relative growth of employee volume in the period 2005-2007
Labour productivity	Sales volume per employee in 2007
Labour productivity growth	Relative growth of labour productivity in the period 2005-2007

Table 2: Measurements, their sources, and reliability statistics

Variables	Source and Cronbach's α of items in this source, if provided	Measurement and Cronbach's α of items in this research, if applicable
Direct ties	Otte and Rousseau (2002)	Formal interorganisational network ties: count of total number of ties Informal interorganisational network ties: count of total number of ties Social network ties: count of total number of ties
Trust	Interorganisational trust: Lippert (2007) (α = 0.94) Interpersonal trust: Zaheer, McEvily and Perrone (1998) (α = 0.88)	Interorganisational trust: average sum score of all eight items using 7-point Likert scale (α = 0.938) Interpersonal trust: average sum score of all five items using 7-point Likert scale (α = 0.834)
Geographical proximity	Schreurs (2007)	Coding: 1 = same town/city, 2 = different city but same province, 3 = other province, 4 = abroad
Technological proximity	Cassiman et al. (2005)	One item: 5-point Likert scale
Organisational proximity	Knoben and Oerlemans (2008)	Average sum score of all three items using 5-point Likert scale (On-park: α = 0.566; Off-park: α = 0.853)
Quality of knowledge transferred	Soo and Devinney (2004)	One item: Usefulness of knowledge, 5-point Likert scale One item: Frequency, 5-point Likert scale
Diversity of actors	Oerlemans et al. (2004)	Count of total number of different knowledge sources
Knowledge spillover (Unintended knowledge flows)	Howells (2002)	Average sum score of all six items using 5-point Likert scale (On-park: α = 0.566; Off-park: α = 0.853)

Variables	Source and Cronbach's α of items in this source, if provided	Measurement and Cronbach's α of items in this research, if applicable
Firm age	Source: not applicable	2008 (the year when this research was conducted) minus the founding year of the firm
Firm size	Source: not applicable	Count of the total number of employees in years 2005 and 2007
Years on SP	Source: not applicable	2008 (the year when this research was conducted) minus the year when the firm was located on the science park
Absorptive capacity	Nietoa and Quevedo (2005)	Average sum score of all eight items using 5-point Likert scale (α = 0.771)
Firm's innovative performance	Cassiman et al. (2005) Relative innovative performance: Oerlemans and Meeus (2005)	(1) Total number of patents in years 2005 and 2007 (2) Total number of new products/services that were developed but not yet introduced to the market in years 2005 and 2007 (3) Innovative sales: Percentages of sales of products/services that were technologically improved and technologically new (4) Percentage of sales of product/services that were not only technologically improved or new but also technologically new or improved in the market (5) Relative innovative performance: average sum score of all six items using 5-point Likert scale (α = 0.656)
Total sales growth	Source: not applicable	[(Total sales 2007 – Total sales 2005) / Total sales 2005] * 100
Employee growth	Source: not applicable	[(Number of employees 2007 – Number of employees 2005) / Number of employees 2005] * 100
Labour productivity	Source: not applicable	Total sales 2007 / Number of employees 2007
Labour productivity growth	Source: not applicable	[(Labour productivity 2007 – Labour productivity 2005) / Labour productivity 2005] * 100

3.4 Empirical results

In this section the first two research questions are answered by applying descriptive statistics to tie and actor characteristics. The questions are:
(1) What are the knowledge exchange behaviours of on-park firms?
(2) Do these behaviours distinguish groups among on-park firms?.

3.4.1 Descriptive statistics: tie characteristics

As mentioned in the theoretical section, studying knowledge exchange behaviours of science park firms implies that one has to focus on tie and actor characteristics. In Table 3, descriptive statistics are presented on ties of on-park firms with both other on- and off-park firms.

The mean of the number of direct ties of on-park firms with off-park firms is higher than the means of ties with on-park firms in all (formal, informal and social) direct ties categories. On-park firms not only have more ties with off-park firms, they also interact more frequently with these off-park firms. These observations indicate that there are quite a number of respondents that have few and infrequent on-park interactions.

In general, on-park firms have more trust on an organisational level than on a personal level. Since trust enhances commitment to a relationship and trust at the organisational level is a stronger predictor of commitment than at the personal level (Ganesan and Hess 1997), the on-park firms are also slightly more committed to relationships at the organisational level than at the personal level.

As far as geographical proximity is concerned, most off-park partners of on-park firms are located geographically close to them. The relationships with buyers and suppliers seem to be the exception, but even in these cases partners seem to be relatively spatially close.

The variable technological proximity indicates how similar the externally acquired technological knowledge is to the knowledge base of the focal firm. Given the low averages in Table 3, it can be concluded that on-park firms acquire external knowledge

that is largely dissimilar to their own knowledge. This finding shows that interorganisational knowledge exchange relations are often based on a combination of complementary knowledge bases. It is also found that respondents get more similar technological knowledge from off-park firms than from other on-park firms. This implies that, in general, the technological proximity within the Hub is low. In other words, the technological knowledge backgrounds of the on-park firms are fairly different, whereas the knowledge backgrounds between on- and off-park firms are more similar.

This is also the case with organisational proximity: most partners of on-park firms seem to be organisationally distant. Moreover, on-park firms feel more organisationally close to off-park firms on all dimensions of organisational proximity (relational, cultural and structural).

The relatively high levels of organisational and technological distance between the Hub firms may be the explanation for the relatively lower levels of perceived usefulness of knowledge acquired from other on-park firms in the Hub as compared to the usefulness of the knowledge acquired from off-park firms. In terms of diversity of actors, the on-park firms interact more with off-park actors from different categories and the diversity in the Hub is quite limited. This implies that communities in The Innovation Hub are less diverse. This may be attributed to two reasons: the size of the Hub is limited and/or the Hub is *designed* to have communities that are less diverse.

Table 3: Means and standard deviation of variables (N = 25)

Relational characteristics					
Variables		**With on-park firms/organisations**		**With off-park firms/organisations**	
		Mean	**S.D.**	**Mean**	**S.D.**
Direct ties	Number of formal ties	0.48	1.005	19.32	40.197
	Number of informal ties	1.52	1.896	12.08	11.228
	Number of social ties	4.40	6.212	79.84	263.693
	Total number of ties	2	2.29	31.4	40.57
Trust	Interorganisatioal	Mean = 4.9150 S.D.= 1.17245			
	Interpersonal	Mean = 4.4240 S.D. = 1.15372			
		(trust levels in general, no on-park or off-park differentiation)			
Geogra-phical proximity	With competitors	Mean = 1 ; S.D.= 0 On-park firms are all situated in close geographical proximity (1 = same city)		1.04	0.338
	With buyers			1.56	1.158
	With suppliers			1.72	1.487
	With innovation centre			0.44	0.917
	With public research labs			0.20	0.5
	With university			0.72	1.275
	With consultant			0.96	1.020
	With sector institutes			0.36	0.757
Technolo-gical proximity	With competitors	0.96	2.031	2.68	2.911
	With buyers	0.32	1.145	3.88	2.522
	With suppliers	1.56	2.181	3.44	2.694
	With innovation centre	0.72	1.792	1	1.979
	With public research labs	0.16	0.624	0.84	2.035
	With university	0.72	1.990	1.44	2.417
	With consultant	0.48	1.388	2.92	2.857
	With sector institutes	0	0	1.28	2.622
Organisa-tional proximity	same third parties	1.60	1.756	2.88	1.364
	same routines and values	1.64	1.753	3.32	1.069
	same structure	1.76	1.877	2.52	1.122
Frequency	With competitors	0.36	0.860	0.88	1.054
	With buyers	0.24	0.879	2.64	1.319
	With suppliers	1.04	1.338	2.12	1.453
	With innovation centre	0.44	0.961	0.60	1.155
	With public research labs	0.12	0.440	0.32	0.900
	With university	0.2	0.577	0.56	1.121
	With consultant	0.32	0.748	1.68	1.464
	With sector institutes	0	0	0.56	1.261
Usefulness of knowledge	With competitors	0.76	1.640	1.64	1.890
	With buyers	0.40	1.384	3.60	1.848
	With suppliers	1.76	2.107	2.84	1.993
	With innovation centre	0.72	1.542	0.88	1.666
	With public research labs	0.24	1.012	0.60	1.443
	With university	0.52	1.447	1.00	1.732
	With consultant	0.60	1.500	2.36	2.139
	With sector institutes	0	0	0.88	1.833
Diversity of actors		1.32	1.676	3.56	1.583
Unintended knowledge flows		0.6872	0.39179	1.5733	0.7774

3.4.2 Descriptive statistics: Characteristics of on-park firms

Table 4 shows the descriptive statistics of the actor (on-park firms) characteristics. The average firm age and size are 5.28 years and 15.64 employees respectively and show that the on-park firm are small firms. This corresponds with most observations by science park researchers in the past (Löfsten and Lindelöf 2002). The Innovation Hub was opened officially in April 2005, therefore, its age is four years and the on-park companies have been located on the Hub for almost three years on average. This implies that most of the current on-park firms have located in the Hub during the first year of its existence. On-park firms have an average score of 3.74 on a scale of 5 on absorptive capacity. This high absorptive capacity level accounts may be for the higher percentages of innovative sales (percentage of new and improved innovations to the market almost 46%; percentage of sales of improved innovations 44.6%; and percentage of sales of new innovations 35.4%). The average score for other results of innovations is also high on a scale of 5 (3.77).

Table 4: Means and standard deviation of variables (N = 25)

Firm characteristics		
Variables	**Mean**	**S.D.**
Firm age	5.28	3.803
Firm size	15.64	28.269
Total sale growth percentage: 2005 – 2007	382.89	620.4
Employee growth percentage: 2005 - 2007	99.04	102.87
Labour productivity 2007	392.486	285.803
Labour productivity growth: percentage 2005-2007	200.08	439.59
Duration on SP	2.72	1.948
Absorptive capacity	3.74	0.67596
<u>Innovative performance indicators:</u> • Patents • Developed not introduced • Percentage sales of improved innovations • Percentage sales of new innovations • Percentage sales of new/improved-to-market innovations • Other results of innovations	 0.36 1.52 44.6 35.4 45.94 3.7667	 1.254 2.502 36.053 33.320 34.265 0.75615

3.4.3 Comparing knowledge exchange behaviours of on-park firms

3.4.3.1 Introduction

By taking a closer look at the data, two knowledge exchange groups of on-park firms can be distinguished: on-park firms that exchange knowledge with other on-park firms and those that do not. This enables the third research question to be answered: what are the differences between these groups? To answer this question, group comparison on various dimensions is needed. In this research, independent T-tests are used to compare the relational characteristics of the knowledge exchange of these two groups. Group 0 denotes the on-park firms without on-park networks and therefore they only interact with off-park firms; while Group 1 represents those who have both on-park ties and off-park ties. Since there are no relations with on-park firms in Group 0, the relational characteristics of the knowledge exchange are with the off-park only. Although Group 0 does not interact formally or informally with other on-park firms, this group of firms is still able to receive unintended knowledge that is flowing to the Hub. Therefore, the flows for unintended knowledge have two forms: on-park and off-park.

3.4.3.2 Comparing tie characteristics

The results of the T-test are summarised in Table 5. Some interesting observations can be made. One would expect that on-park firms who do not interact with other on-park firms (Group 0) will put more effort in establishing interactions with off-park firms. However, the result shows that Group 0 firms have fewer direct formal, informal and social ties with off-park firms as compared to Group 1 firms. The difference between the two groups regarding informal direct ties is statistically significant at the *p*-level of 0.05.

Moreover, Group 0 firms have both higher interorganisational and interpersonal trust with the off-park firms, although the differences are not statistically significant. For Group 0 it was found that the technological knowledge from the off-park public knowledge sources (universities, research labs, innovation centres and sector institutions) is more similar and useful, and they interact more frequently with these sources. On the other hand, Group 1

interacts more often with private knowledge sources (competitors, buyers, suppliers and consultants) and finds the knowledge from these sources more useful at a significant level.

One also would expect Group 0 to interact with a more diverse set of knowledge sources. However, the level of diversity of actors that Group 0 interacts with is lower. In other words, Group 0 interacts with fewer categories of knowledge sources. Furthermore, Group 0 has close organisational proximity on the internal aspects (organisational structure, routines and values) but not on the external aspects (sharing similar third partners). Lastly, Group 1 gets more unintended knowledge flows from the on-park firms as compared to Group 0.

Table 5: Results of independent T-tests of relational characteristics of Group 0 and Group 1 firms

Variables (knowledge exchange with off-park firms)		Group 0 (N = 11) On-park firms with no on-park knowledge exchange relations, only with off-park firms		Group1 (N = 14) On-park firms with on-park and off-park knowledge exchange relations		T-test[a] *p*-value[b]
		Mean	S.D.	Mean	S.D.	
Direct ties	Number of formal ties	7.82	11.453	28.36	51.79	-20.539
	Number of informal ties	6.55	9.933	16.43	10.515	***-9.883****
	Number of social ties	24.55	48.757	123.29	349.174	-98.740
Trust	Interorganisational trust	5.068	0.916	4.7946	1.363	0.274
	Interpersonal trust	4.709	1.122	4.2	1.169	0.509
Geographical proximity	Location of actors who provide supplementary knowledge	0.091	1.185	-0.714	0.868	0.162
	Location of actors who provide core knowledge	-0.315	0.816	0.248	1.088	-0.563
Technological proximity	Technological proximity of public knowledge sources	0.566	1.185	-0.045	0.872	0.101
	Technological proximity of private knowledge sources	-0.162	1.115	0.127	0.922	-0.29
Organisational proximity	Internal organisational proximity	0.284	1.068	-0.223	0.92	0.507
	External organisational proximity	-0.008	1.206	0.006	0.853	-0.014
Frequency	Frequency score for public knowledge sources	2.564	1.422	-0.201	0.438	0.458
	Frequency score for private knowledge sources	-0.162	1.09	0.127	0.945	-0.29
Usefulness of knowledge	Usefulness score from public knowledge sources	0.948	1.327	-0.075	0.691	0.169
	Usefulness score from private knowledge sources	-0.453	0.877	0.356	0.972	***-0.81****
Diversity		3.36	1.69	3.71	1.541	-0.351
Unintended knowledge flow off park		1.591	0.8	1.56	0.789	0.031
Unintended knowledge flow on park		0.472	0.222	0.833	0.429	***-0.361****

a. Mean differences between two groups
b. Significance at the 5 percent level (p-value < 0.05)
* mean difference is statistically significant at p<0.05

3.4.3.3 Comparing actor characteristics

Besides the relational characteristics, the firms' characteristics between Group 0 and Group 1 are also analysed. The results of independent T-tests are shown in Table 6.

There are no significant differences between Group 0 and Group 1 in terms of their firm characteristics. This result may be due to the fact that the firm entry criteria provided by the science park management have resulted in the similarities among SP firms' characteristics (firm age and size are restricted to a certain level). What is really surpising in Table 6 is that there are no statistically significant differences between the two groups as far as innovative sales and patents filed are concerned. One would expect that firms more strongly embedded in knowledge exchange networks (Group 1 firms) would outperform firms without such strong embeddedness (Group 0 firms). Moreover, the fact that on-park firms have knowledge exchange relations with other on-park firms does not seem to have added value to them as far as innovative outcomes are concerned. These findings give reason to believe that there are some indications that The Innovation Hub does not provide the knowledge exchange environment (yet) that many have hoped for.

Table 6: Results of independent T-tests of firm characteristics

Variables	Group 0 (N = 11) On-park firms with no on-park knowledge exchange relations, only with off-park firms		Group1 (N = 14) On-park firms with on-park and off-park knowledge exchange relations		T-test[a] *p*-value[b]
	Mean	S.D.	Mean	S.D.	
Firm age	5.27	3.894	5.29	3.911	-0.013
Firm size	24	41.96	9.07	3.931	14.929
Total sale growth percentage	558.43	883.84	265.87	361.05	292.57
Employee growth percentage	85.07	110.37	109.78	99.89	-24.71
Labour productivity 2007	365.691	312.577	409.711	278.012	-44.019
Labour productivity growth percentage	433.39	732.51	83.42	129.46	349.96
Years in SP	2.45	1.036	2.93	2.464	-0.474
Absorptive capacity	3.739	0.526	3.741	0.794	-0.002
Firms' innovative performance					
• Patents	0.55	1.809	0.21	0.579	0.331
• Developed not introduced	1.09	1.30	1.86	3.159	-0.766
• Percentage sales of improved innovations	43.18	37.435	45.71	36.314	-2.532
• Percentage sales of new innovations	35.91	38.524	35	30.128	0.909
• Percentage sales of total innovations	79.09	35.342	80.71	25.484	-1.623
• Percentage sales of new/improved-to-market innovations	33.18	41.126	26.43	31.097	6.753
• Other results of innovations	3.561	0.814	3.929	0.694	-0.302

a. Mean differences between the two groups

b. Significance at the 5 percent level (p-value < 0.05)

* mean difference is significant at p<0.05

3.5 Conclusions and discussion

Policy makers often regard science parks as important drivers of regional economic development because they provide firms with a facilitating environment in which they can more easily set up and maintain knowledge-intensive interorganisational relationships. The knowledge flows between the various actors are supposed to play an important role in science parks and the purpose of the study is to examine the knowledge exchange behaviour of on-park firms in order to answer three main research questions:

1. What are the knowledge exchange behaviours of on-park firms?
2. Do these behaviours distinguish groups among on-park firms?
3. If so, what are the differences between these groups?

In this section, the most important findings of this study are summarised and discussed. After carefully describing the theoretical and methodological background of the study, the empirical analyses consisted of two parts. In the first part, the focus was on the knowledge exchange behaviour of on-park firms and the characteristics of their knowledge exchange relationships. It was found that, compared with on-park knowledge exchange relationships:

- The knowledge exchange relationships with off-park firms occur more frequently. This is especially true for social ties.
- The knowledge exchange relationships with off-park firms are more technologically similar.
- The knowledge exchange relationships with off-park firms are more organisationally close.
- The knowledge exchange interactions with off-park firms are more frequent.
- The knowledge exchange relationships with off-park firms are assessed as generating more useful knowledge.
- The off-park actors involved are of a more diverse nature.
- More unintended knowledge flows take place in exchange relationships with off-park firms.

An interesting finding is the importance of off-park social ties as relevant sources for on-park firms. This has often been observed in the literature, especially for young, new and high-tech organisations (Maurer and Ebers, 2006). Using their social capital is a way to deal with the "liability of newness" (Freeman, Carroll and Hannan, 1983), that is, new and young firms experience a higher probability of failure due to a lack of external resources, access to formal financial funding, and internal routines. By capitalising on their social network ties, which provide informal funding and advice, this liability is mitigated.

The finding that on-park firms interact more often with off-park than with on-park firms is not a surprise as such. After all, the number of off-park firms with which knowledge exchange relationships can be established is much higher than the number of on-park firms. However, the results indicate that the quality and effectiveness of knowledge exchange relationships with off-park firms seem to be far better than those with on-park firms. A negative interpretation of these findings is that The Innovation Hub does not perform its functions well. However, this might be a too harsh an interpretation. Research has shown that most knowledge exchange relationships are reciprocal (Chiu, Hsu and Wang, 2006; Watson and Hewett, 2006). If the assumption is made that the same is true for the off-park relationships, then the off-park firms profit from the knowledge developed by the on-park firms. In this sense, the Hub could be regarded as focal driver of technological development.

The second part of the analyses answered research questions two and three. It could be shown that two groups of on-park firms exist, namely a group of on-park firms that have knowledge exchange relationships only with off-park firms (Group 0) and a group of on-park firms with both on- and off-park relationships (Group 1). More specifically, it was found that:

- Group 1 firms have more (informal) direct ties.
- Group1 firms get more useful knowledge from private knowledge sources.
- Group 1 firms have a higher inflow of unintended knowledge from other on-park firms.
- There are no differences between the two groups as far as firm characteristics are concerned.

How can these results be interpreted? One interpretation could be that the technologies of Group 0 firms are at an earlier stage of the technology life cycle than the technologies of Group 1 firms. The data give some indications that Group 0 firms are in the early stages of this cycle, because they interact especially with organisations who form part of the public knowledge infrastructure (universities, research labs) to which they feel organisationally and technologically close. Moreover, they assess the knowledge acquired from these sources as being more useful and the firms in this group generate twice as many patents as firms in the other group. All of this could imply that Group 0 firms are primarily technology developers that use the more fundamental knowledge generated by actors in the public knowledge infrastructure that cannot be found on-park. Group 1 firms, however, interact more with organisations who form part of the private knowledge infrastructure (buyers, suppliers) to which they feel more organisationally and technologically close. In the South African situation, Oerlemans and Pretorius (2006) have shown that the knowledge acquired from buyers and suppliers is often used for the incremental innovation of already existing products and services. This would imply that Group 1 firms are closer to commercialising their innovations or are already doing so.

A different interpretation could be that a science park such as the Innovation Hub serves other purposes for on-park firms in Group 0. Location on a science park is not primarily for networking and knowledge exchange, but also for reputation-building and creating an image of an innovative firm, which might give these firms an advantage in the market. A striking finding is that there are no differences between the two groups concerning their innovative outcomes, despite the fact that Group 1 firms have a more extended knowledge transfer network. The literature contains ample evidence that higher levels of network embeddedness are beneficial to the innovation outcomes of organisations (Ahuja, 2000). However, the firms in Group 1 seem not to be able to reap the benefits of their more extended network, which might be due to fact that their absorptive capacity is insufficiently high. Having more knowledge transfer ties with external actors implies that more knowledge and information have to be processed by the focal firm, which asks for higher levels of absorptive capacity. In view of the finding that

there are no differences between the absorptive capacity levels of the two groups, it might indeed be the case that this ability is not high enough for the Group 1 firms.

Even though the findings provided valuable insights, the study has limitations. The sample covers a large part (52%) of the firms located on this science park. Nevertheless, given a number of specifics of the South African economy (high unemployment, high crime rates, high dependency on foreign technology) and the relatively small sample, it is difficult to make general claims. In other words, the external validity of the findings is not high and is thus only applicable to The Innovation Hub situation.

As far as future research directions are concerned, it is suggested that researching the knowledge in- and outflows of science park-based firms could provide additional insights. In this research, only the inflows were explored, but by adding the knowledge outflows, a more complete picture of the (regional) impact of a science park could emerge. Furthermore, this research model could be extended by using a matched sampling approach in which on-park firms and comparable off-park firms are included. This allows for a comparison of the performance of on-park firms while controlling the performance of off-park firms. Consequently, a truer picture of the performance of on-park firms will emerge. In future research, the approach can also be used for benchmarking the knowledge exchange behaviours of firms located on science parks in emerging and developed economies. Such a comparison will increase the insights in the differences between the functioning of science parks in these regions and help to identify innovation bottlenecks.

References

Abrams, L. C., Cross, R., Lesser, E. and Levin, D.Z., 2003. Nurturing interpersonal trust in knowledge-sharing networks. *Academy of Management Executive*, 17, 64-77.

Ahuja, G. 2000. Collaboration networks, structural holes, and innovation: a longitudinal study. *Administrative Science Quarterly,* 45, 425-455.

Atuahene-Gima, K. and Li. H., 2002. When does trust matter? Antecedents and contingent effects of supervisee trust on performance in selling new products in China and the United States. *Journal of Marketing,* 66, 61-81.

Audretsch, D.B. and Feldman M.P., 2004. Knowledge spillovers and the geography of innovation. In: J.V. Henderson and J.-F. Thisse, eds. *Handbook of urban and regional economics.* New York: North Holland Publishing, 2713-2739.

Becker, W. and Peters J., 2000. *Technological opportunities, absorptive capacities, and innovation.* Augsburg: Volkswirtschaftliche Diskussionsreihe.

Bell, G.G., 2005. Clusters, networks, and firm innovativeness. *Strategic Management Journal*, 26, 287-295.

Borgatti, S. and Foster P., 2003. The network paradigm in organisational research: a review and typology. *Journal of Management*, 29, 991-1013.

Boschma, R., 2005. Proximity and innovation: a critical assessment. *Regional Studies*, 39, 61-74.

Brachos, D., Kostopoulos, K., Soderquist, K.E. and Prastacos, G., 2007. Knowledge effectiveness, social context and innovation. *Journal of Knowledge Management*, 11, 31-44.

Bürgel, O., Murray, G., Fier, A. and Licht, G., 2001. The rapid internationalisation of high-tech young firms in Germany and the United Kingdom. Research Report, London Business School.

Cassiman, B., Colombo, M. G., Garrone, P. and de Veugelers, R., 2005. The impact of M&A on the R&D process: An empirical analysis of the role of technological- and market-relatedness, *Research Policy,* 34(2), 195-220.

Castells, P. and Hall, P., 1994. *Technopoles of the world: the making of the 21st century*. London: Routledge.

Chan, K.F. and Lau, T., 2005. Assessing technology incubator programs in the science park: The good, the bad and the ugly. *Technovation,* 25, 1215-1228.

Chiu, C.M., Hsu, M.H. and Wang, E.T.G., 2006. Understanding knowledge sharing in virtual communities: an integration of social capital and social cognitive theories. *Decision Support Systems*, 42, 1872-1888.

Cohen, W. and Levinthal, D., 1990. Absorptive capacity: a new perspective on learning and innovation. *Administrative Science Quarterly* 35, 128-152.

Desrochers, P. 2001. Geographical proximity and the transmission of tacit knowledge. *The Review of Austrian Economics* 14: 25-46.

Dougherty, D., 1992. Interpretive barriers to successful product innovation in large firms. *Organisation Science,* 3, 179-202.

Erkuş-Öztürk, H., 2009. The role of cluster types and firm size in designing the level of network relations: The experience of the Antalya tourism region. *Tourism Management*, 30, 589-597.

Ernst, H., 2001. Patent applications and subsequent changes of performance: evidence from time-series cross-section analyses on the firm level. *Research Policy,* 30, 143-157.

Fallah, M.H. and Ibrahim, S., 2004. Knowledge spillover and innovation in technological clusters. 13th International Conference on Management of Technology. April 2004, Washington.

Fosfuri, A. and Tribó, J.A., 2008. Exploring the antecedents of potential absorptive capacity and its impact on innovation performance. *Omega*, 36, 173-187.

Freeman, J., Carroll, G.R. and Hannan, M.T., 1983. The liability of newness: age dependence in organisational death rates. *American Sociological Review*, 48, 692-710.

Fukugawa, N., 2006. Science parks in Japan and their value-added contributions to new technology-based firms. *International Journal of Industrial Organisation*, 24, 381-400.

Ganesan, S. and Hess R., 1997. Dimensions and levels of trust: implications for commitment to a relationship. *Marketing Letters*, 8, 439-448.

Gertler, M.S., 1995. Being there: proximity, organisation, and culture in the development and adoption of advanced manufacturing technologies. *Economic Geography*, 71, 1-26.

Grant, R., 1996. Toward a knowledge-based theory of the firm. *Strategic Management Journal,* Winter special issue, 109-122.

Howells, J.R.L., 2002. Tacit knowledge, innovation and economic geography. *Urban Studies*, 39, 871- 884.

Knoben, J. and Oerlemans, L.A.G., 2006. Proximity and interorganisational collaboration: a literature review. *International Journal of Management Reviews*, 8, 71-89.

Koskinen, K.U., Pihlanto, P. and Vanharanta H., 2003. Tacit knowledge acquisition and sharing in a project work context. *International Journal of Project Management*, 21, 281-290.

Lane, C. and Bachmann, R., 1998. *Trust within and between organisations: conceptual issues and empirical applications*. Oxford: Oxford University Press.

Lane, P.J. and Lubatkin, M.H., 1988. Relative absorptive capacity and interorganisational learning. *Strategic Management* Journal, 19, 461-477.

Lazaric, N. and Lorenz, E., 1998. The learning dynamics of trust, reputation and confidence. In: N. Lazaric and E. Lorenz, eds. *Trust and economic learning*, London: Edward Elgar, 1-20.

Lippert, S. K., 2007. Investigating postadoption utilisation: an examination into the role of interorganisational and technology trust. *IEEE Transactions on Engineering Management*, 54, 468-483.

Malmberg, A., Sölvell, Ö. and Zander, I., 1996. Spatial clustering, local accumulation of knowledge and firm competitiveness. *Geografiska Annaler*, 78, 85-97.

Maurer, I. and Ebers, M., 2006. Dynamics of social capital and their performance implications: lessons from biotechnology start-ups. *Administrative Science Quarterly*, 51, 262-292.

Nelson, R. and Wolff, E.N., 1997. Factors behind cross-industry differences in technological progress. *Structural Change and Economic Dynamics*, 8, 205-220.

Nesta, L., 2008. Knowledge and productivity in the world's largest manufacturing corporations. *Journal of Economic Behavior and Organisation*, 67, 886-902.

Nietoa, M. and Quevedo, P., 2005. Absorptive capacity, technological opportunity, knowledge spillovers, and innovative effort. *Technovation*, 25, 1141-1157.

Norman, P.M., 2002. Protecting knowledge in strategic alliances: resource and relational characteristics. *Journal of High Technology Management Research*, 13, 177-202.

Oerlemans, L.A.G., Pretorius, M.W., Buys, A.J. and Rooks, G., 2004. *Industrial innovation in South Africa, 1998-2000.* Pretoria: University of Pretoria.

Oerlemans, L.A.G., and Meeus, M.T.H., 2005. Do organisational and spatial proximity impact on firm performance?. *Regional Studies*, 39, 89-104.

Oerlemans, L.A.G. and Pretorius, M.W., 2006. Some views on determinants of innovative outcomes of South African firms: an exploratory analysis using firm-level data. *South African Journal of Science*, 102, 589-593.

Orlando, M.J., 2000. On the importance of geographic and technological proximity for R&D spillovers: An empirical investigation. *Federal Reserve Bank of Kansas City Research*. Working paper.

Otte, E. and Rousseau, R. 2002. Social network analysis: a powerful strategy, also for the information sciences. *Journal of Information Science*, 28, 443-455.

Owen-Smith, J. and Powell, W., 2004. Knowledge networks as channels and conduits: the effects of spillovers in the Boston biotechnology community. *Organisation Science*, 15, 5-21.

Pennings, J.M. and Harianto, F., 1992. The diffusion of technological innovation in the commercial banking industry. *Strategic Management Journal*, 13, 29-46.

Pittaway, L., Robertson, M., Munir, K., Denyer, D. and Neely, A., 2004. Networking and innovation: a systematic review of the evidence. *International Journal of Management Reviews*, 5-6, 137-168.

Ratcheva, V., 2009. Integrating diverse knowledge through boundary spanning processes – the case of multidisciplinary project teams. *International Journal of Project Management*, 27, 206-215.

Reagans, R. and McEvily, B., 2003. Network structure and knowledge transfer: the effects of cohesion and range. *Administrative Science Quarterly*, 48, 240-267.

Sapienza, H.J., Parhankangasand, A. and Autio, E., 2004. Knowledge relatedness and post-spin-off growth. *Journal of Business Venturing*, 19, 809- 829.

Sawers, J.L., Pretorius, M.W. and Oerlemans, L.A.G., 2008. Safeguarding SMEs' dynamic capabilities in technology innovative SME-large company partnerships in South Africa. *Technovation*, 28, 171-182.

Schreurs, R., 2007. *Assessing the impact of science parks on the innovative performance on NTBFs – a knowledge-based view*. Dissertation (Master). Tilburg University.

Soo, C.W. and Devinney, T.M., 2004. The role of knowledge quality in firm performance. In: H. Tsoukas and N. Mylonopoulos, eds. *Organisations as knowledge systems: knowledge, learning and dynamic capabilities,* New York: Palgrave Macmillan, 252-275.

Staber, U., 2001. The structure of networks in industrial districts. *International Journal of Urban and Regional Research*, 25, 538-552.

Torre, A. and Rallet, A., 2005. Proximity and localisation. *Regional Studies*, 39, 47-59.

Ulrich, K., 2000. Measuring knowledge spillovers in manufacturing and services: an empirical assessment of alternative approaches. *Research Policy*, 31, 125-144.

Watson, S. and Hewett, K., 2006. A multi-theoretical model of knowledge transfer in organisations: determinants of knowledge contribution and knowledge reuse. *Journal of Management Studies*, 43, 141-173.

Zaheer, A., McEvily, B. and Perrone, V., 1998. Does trust matter? Exploring the effects of interorganisational and interpersonal trust on performance. *Organisation Science*, 9, 141-159.

Zaheer A. and Bell, G.G., 2005. Benefiting from network position: firm capabilities, structural holes, and performance. *Strategic Management Journal*, 26(9), 809-825.

Zahra, S.A. and George, G., 2002. Absorptive capacity: a review, reconceptualisation, and extension. *Academy of Management Review,* 27(2), 185-203.

Chapter 4

A relational view of knowledge transfer effectiveness in small new technology-based firms: an empirical view from South Africa[6]

The open innovation model often neglects the frictions that external knowledge flows may encounter when crossing organisational boundaries. This study recognizes such barriers and investigates the impact of these barriers on knowledge transfer effectiveness by using data on small new technology-based firms located in the emerging South African economy. Empirical results show that the characteristics of interorganisational knowledge exchange relationships (organisational, technological similarity and contact frequency) do have an impact on the effectiveness of knowledge transfer. The findings stress the relevance of a relational approach, as factors derived from it act as barriers to effective knowledge transfer for small firms.

4.1 Introduction

Proponents of the so-called open innovation model argue that for most of the 20th century, firms innovated in an 'old' model of 'closed innovation' where an innovating firm 'generates, develops and commercializes its own ideas' (Chesbrough, 2006: 129). Due to globalisation and increasing complexity of technological innovation, competition has increased and in order to remain competitive, firms have shifted to an 'open innovation' model (also labelled as a 'networked' or 'distributed' innovation model) where they also draw on external sources of knowledge (Teirlinck and Spithoven, 2008; Scarbrough and Amaeshi, 2009) to complement their in-house innovative activities (Teirlinck and Spithoven, 2008). These interactions with external partners in an open collaborative

[6] This chapter has been submitted in a slightly different format as Chan, K.Y., Oerlemans, L.A.G. and Pretorius, M.W. (submitted). A relational view of knowledge transfer effectiveness in small new technology-based firms: An empirical view from South Africa. *Journal of Small Business Management*

innovation model allow knowledge and innovations to be distributed among various partners for mutual benefits (Baldwin and von Hippel, 2009). Moreover, firms that are more open to their external search of knowledge tend to be more innovative (Laursen and Salter, 2006).

Transferring knowledge between partners implies that knowledge has to cross organisational boundaries. This boundary crossing of knowledge may be less unproblematic as proponents of the open innovation model often believe, as firms may encounter frictions such as differences in organisational cultures, structures and knowledge bases inhibiting interorganisational flows of knowledge. A recent special issue of the Journal of Management Studies on interorganisational knowledge transfer (see Easterby-Smith et al., 2008) proposes that future research in interorganisational knowledge transfer should focus on the role of organisational boundaries. There, it is stated that the arduous relationship between the source and recipient of knowledge was one of the most important barriers to knowledge transfer and this arduous relationship is more likely to be present between two organisations than between two organisational units. Consequently, conducting a study on these crossing boundaries issue is relevant and timely.

The study of interorganisational knowledge flows asks for a relational perspective because the characteristics of the sender and receiver and their dyadic relationship matter for the outcomes of knowledge transfer (Cumming and Teng, 2003). In such a perspective, organisations are viewed as embedded in and consisting of internal and external networks of relations. Moreover, in this relational perspective it is believed that relationships and their characteristics (the quality of exchanges, trust or knowledge transfer, etc.) are relevant for understanding organisational behaviour and outcomes. This perspective represents a move "away from individualist, essentialist and atomistic explanations towards more relational, contextual and systematic understanding" (Borgatti and Foster, 2003: 991) and will be applied in this study, which is conducted in South Africa.

Most empirical studies on interorganisational knowledge transfer are conducted in developed economies and there is a lack of such studies on small firms in emerging economies in general and in South Africa in particular. A literature search[7] resulted in very few studies about knowledge transfer for this emerging economy. The study by Van Zyl et al. (2007), for example, identified nine factors that drive knowledge transfer for R&D collaboration between university departments and industry, namely: (a) the need to extract appropriate knowledge at the right time to make critical decisions; (b) the perception that knowledge is a valuable resource; (c) the emphasis on getting a return on investment in research; (d) the need to protect knowledge for competitive advantage; (e) the need to close the knowledge gap; (f) international trade; (g) the need to protect intellectual property such as patents and trademarks; (h) geographic proximity between the knowledge source and recipient; and (i) war, terrorism and natural disasters. These drivers were identified from the literature and 74 respondents ranked the level of significance based on their experience. One of the future research directions proposed in this paper concerns the need for increasing the understanding of the effects of barriers on knowledge exchange. Three other papers found do not directly relate to knowledge transfer per se (because they are focused on technology transfer, South African MNEs and learning networks), but do, however, indicate that firms in South Africa seek and acquire knowledge across organisational boundaries (Marcelle, 2003; Morris et al., 2006; Klein and Wöcke, 2009). In Marcelle's (2003) study of technological capability accumulation in South Africa, it was found that during technology acquisition, firms use different mechanisms during technology acquisition to acquire codified and tacit knowledge. Klein and Wöcke (2009) demonstrate how four companies from South Africa progressed from their domestic base to become successful MNEs, and have found that MNEs from less competitive economies, like South Africa, are driven by the transfer of intangible knowledge across national boundaries from foreign companies in order to expand their firms internationally. Morris et al. (2006) report on the ways in which learning networks were set-up. They conclude that the interactive nature of joint cluster activities enable firms to lock into a network of

[7] Databases used were Google Scholar, SA ePublications, ScienceDirect, Swetswise, Proquest and Sabinet using the following keywords: South Africa, knowledge transfer, knowledge flows, inter-firm learning, interorganisational learning.

learning. These studies show that knowledge flows are important to South African firms, but, due to their specific foci, only give a partial picture of knowledge exchange practices. Moreover, from a methodological point of view, it can be observed that most of these studies used small N case study methodologies and only the study by Van Zyl used descriptive statistical analyses. Consequently, it is hard to draw generalisable conclusions about the knowledge exchange behaviour of firms in South Africa because large N studies on interorganisational knowledge transfer that use more advanced statistical methods are lacking.

Drawing from the arguments presented above, the research question addressed in this study reads: To what extent do characteristics of interorganisational relationships between sender and receiver of knowledge influence the effectiveness of knowledge transfer for NTBFs in South Africa? New technology-based firms (NTBFs) are chosen as the unit of analysis because they are often regarded as knowledge-intensive organisations for promoting developing countries' knowledge-based economies. This study defines NTBFs as "young small companies founded by an entrepreneur or a team of entrepreneurs with a strong educational or professional background which are involved in the development, application and commercial exploitation of an innovative idea based on technological know-how" (Livieratos, 2009: 247).

By answering the above research question, this study contributes to the field in five ways. Firstly, it adds value to the studies on interorganisational knowledge transfer. In Becker and Knudsen's (2003) review on knowledge transfer literature in high-impact and key journals, it is stated that the majority of papers (60%) focus on intra-firm knowledge transfer. This is clearly a sign of a lack of studies of knowledge transfer in an interorganisational context. Moreover, regarding the level of the dyad, it was suggested that a more fine grained description of the characteristics of the relationships be developed. This will be done in this study. Secondly, this empirical study uses a relational approach to understand the effectiveness of knowledge transfer. Many studies in interorganisational knowledge transfer have focused on characteristics of knowledge that hinder or ease the transfer of knowledge (Mclnerney, 2002; Argote et al., 2003; Simonin, 2004), structural characteristics of knowledge networks (for example, sizes of

networks, node members in the network structure, linkage patterns; see: Fukugawa, 2005; Tang et al., 2008) and mechanisms that facilitate transfer of knowledge, for example, communication media types and team structures (Persson, 2006; Schwartz, 2007). Focusing on the characteristics of knowledge exchange relationships extends the knowledge of this field. Thirdly, previous studies are primarily focused on knowledge transfers of firms in developed countries such as the USA and the UK. This study will contribute to the knowledge transfer studies in emerging economies. Fourthly, this study focuses on the knowledge effectiveness in small NTBFs. Effective knowledge inflows are of crucial importance to such firms, because, due to a liability of smallness, these firms often lack valuable (knowledge) resources and the resources to manage a large external network (Baum et al., 2000). Fifthly, as compared to previous studies done in South Africa, which used mostly case studies as research methodologies, this study applies more advanced statistical tools (multivariate regression analyses) to explore the relational aspects of interorganisational knowledge transfer between firms in South Africa. The last two contributions add to the further generalisability of findings on interorganisational knowledge transfer.

This empirical chapter is organised as follows. In the next section, the theoretical framework and the hypotheses are developed. Section 3 describes the research methodology used. Section 4 discusses the results of a survey on NTBFs which the authors carried out in the South African province of Gauteng in 2008, focusing on the relational characteristics and the usefulness of knowledge received. Section 5 provides some concluding remarks and recommendations for policy makers and further studies.

4.2 Theoretical framework

Knowledge is often regarded as a type of resource that differs from physical resources. It does not depreciate quickly and is accumulated overtime. It is intangible and dynamic because it is embedded in people and processes. This resource can be acquired and developed within an organisation (for example, between units) or through knowledge transfer between and learning from other

organisations (for example, inter-firm knowledge transfer via joint research). In the past, many researchers have recognised knowledge as a valuable resource for firms (Argote and Ingram, 2000, Ichijo and Nonaka, 2007) because knowledge development and application enhance firm performances and innovativeness (Van Wijk, 2008). Compared to intra-firm knowledge transfer, inter-firm knowledge transfer is more difficult and complex mainly due to the "arduous relationship" between two firms (Easterby-Smith, et al., 2008: 685). Interorganisational knowledge exchange takes place between legally independent organisations and can therefore be viewed as a hybrid arrangement in which goals, identities, and cultures of the exchanging organisations are combined and in which traditional hierarchy governance is absent. The hybrid nature of these transfer relationships has a number of implications for the effectiveness of knowledge transfer. On the positive side, complementarities between exchanging actors can promote learning and synergy as a result of the coming together of experts from different backgrounds. On the negative side, effective transfer can be inhibited due to a number of barriers. For example, when too many competitive elements are present in the exchange relationship, reconciling different organisational identities may turn out to be too complex, levels of receptivity may be too low, or a lack of experience or capacity to acquire and absorb externally acquired knowledge (Child 2001: 659), impedes harvesting the benefits of knowledge transfer. In this study, the focus is on a number of these barriers, as they are regarded as crucial for effective knowledge transfer (Child, 2001).

The theoretical discussion starts with a description of the dependent variable in the model: the effectiveness of knowledge transfer.

4.2.1 Effectiveness of knowledge transfer

When knowledge is transferred from the sender to the recipient, the quality of such transfer can be based on the "level of the knowledge utilisation by the recipients" (Minbaeva et al., 2003: 592) where "utilisation" refers to how a firm uses the received knowledge for its innovative activities. When one evaluates the benefits of the knowledge received by the recipient, one should not only take into account

the quantity of knowledge flow, but also the value of using such knowledge (Soo and Devinney, 2003; Ambos and Ambos, 2009). In the past, researchers used the "usefulness' of transferred knowledge as assessed by the recipients as a key element in knowledge transfer effectiveness. For example, Brachos et al. (2007) proposed the concept of "perceived usefulness of knowledge" to indicate knowledge transfer effectiveness. Pérez-Nordtvedt et al. (2008) construed "comprehension" and "usefulness" as reflecting knowledge transfer effectiveness. Ambos and Ambos (2009) quoted Minbaeva et al. (2003: 587) who stated that “the key element in knowledge transfer is not the underlying knowledge, but rather the extent to which the receiver acquires potentially useful knowledge and uses this knowledge in own operations”. Drawing on the above, in this study the usefulness of knowledge received is used as an indicator to represent the level of effectiveness of knowledge transfer.

4.2.2 Key elements of dyadic relationships and the effectiveness of knowledge transfer

In a relational approach of the transfer of knowledge one can focus on three dimensions: (i) properties of units, (ii) the relationships between units and (iii) the knowledge exchanged between units (Argote et al., 2003). To explain these dimensions and their relationship with the effectiveness of knowledge transfer in more detail, it is necessary to first focus on the distinction between so called attribute and relational variables. Attribute variables are variables that can take certain values in the absence of interorganisational relationships. Examples are the size and age of an organisation or the economic activities a firm conducts. Relational variables are variables that only exist if an interorganisational relationship exists. Examples of the latter are trust, partner confidence, partner similarities, dependencies, and knowledge transfer. Once the relationship seizes to exist, the same happens to a relational variable. In the next subsections, a number of relational and attribute dimensions, namely: partner (dis)similarities, frequency of knowledge transfer, learning culture, are discussed and related to the dependent variable.

4.2.2.1 Partner (dis)similarities as barriers to effective interorganisational knowledge transfer

In a literature study on partner (dis)similarities by Knoben and Oerlemans (2006), three types are distinguished: geographical, technological and organisational (dis)similarities. If one looks at the (dis)similarity between two parties, one assesses the impacts of the distance between certain characteristics of the two exchanging parties. In this study, two relational (dis)similarities are explored: technological and organisational (dis)similarity. Geographical dimensions cannot be included because all firms in the sample are located in Gauteng; consequently this dimension cannot vary.

Relationships between organisational phenomena are fuelled by the effects of aggregated micro-level processes. Therefore, before specific hypotheses are presented, first a general micro-level theoretical mechanism explaining the negative impact of partner dissimilarity on knowledge exchange effectiveness is presented. In other words, partner dissimilarity is regarded as a barrier to knowledge exchange. Basically, the concept of partner (dis)similarity is a specification of the more general concept of differentiation. According to Child (2001), many barriers to knowledge exchange emerge from the external differentiation between organisations. Differentiation forms the basis of distinct social identities and perceptions of competing interests. When two or more independent organisations form a knowledge exchange relationship, such barriers are strengthened by, for example, different organisational or national cultures and knowledge bases. Hamel (1991) argues that these barriers reduce "transparency", that is, the openness of one actor to the other, and its willingness to transfer knowledge. In turn, this is caused by the “divergent ways of sense-making associated with the social identities of the different parties” (Child, 2001: 670) that are involved in a knowledge exchange relationship. When members of different organisations meet to exchange knowledge, they carry their own social identities and backgrounds with them. These identities are sets of meanings that are shaped by an individual’s interaction with different reference groups (work group, organisation, community, nationality, etc.). When these identities are very dissimilar, the knowledge sent by one party will clash with the mental constructs

and norms of conduct of the receiving party. Therefore, the larger the dissimilarity between these identities, the larger the distance between the parties involved, the lower the "transparency", and the more likely it is that the quality of the transfer is impeded.

Organisational (dis)similarity is defined as the distance between "the sets of routines – explicit or implicit – which allows coordination without having to define beforehand how to do so. The set of routines incorporates organisational structure, organisational culture, performance measurements systems, language and so on" (Knoben and Oerlemans, 2006: 80). Lane and Lubatkin (1998) state that similarity of firms' organisational structures and policies contributes to firms' abilities to interactively learn from each other. Firms who are similar organisationally share common language or communication processes and are able to reduce the cost associated in transferring the knowledge (Cohen and Levinthal, 1990) and hence possess more resources for trying to understand and use the knowledge received. If organisational dissimilarity acts as a barrier to effective knowledge transfer, the following hypothesis can be formulated:

Hypothesis 1: Organisational similarity is positively related to the usefulness of the knowledge received.

Technological (dis)similarity refers to the extent to which there are differences between exchanging actors' technological knowledge bases; in other words, the level of similarity of their knowledge bases. Transferring knowledge that differs too much in its technology domain can cause difficulties for the recipient in understanding and using the knowledge received because the recipient firm does not have the mutual understanding needed to absorb the knowledge exchanged. In other words, the recipient's prior knowledge base is not relevant to further explore the knowledge received for its innovative use. Technological similarity enhances the likelihood of knowledge transfer between collaborating firms (Rosenkopf and Almeida, 2003) because they are more able to understand common problems and better use the complementary knowledge to solve those innovative challenges. Moreover, alliances with partners who are technologically similar can promote the development of incremental innovations (Quintana-Garcia

and Benavides-Velasco, 2010). Despite the advantages that are brought into the firm by exchanging similar knowledge, too much similarity between knowledge bases may lead to 'lock-in', which may obscure the view on new technologies (Boschma 2005). It is argued that when people with different knowledge bases interact, they help each other to stretch their knowledge (Nooteboom et al., 2007) and provide openness that triggers new ideas (Boschma, 2005). In other words, there is nothing new to learn between partners with too much similarity in their knowledge bases, thus the knowledge they receive may not be so useful for innovative outcomes. Thus, very low and very high levels of technological similarity can act as barriers to effective knowledge transfer, whereas medium levels allow for both newness and understandability. The following hypothesis can thus be formulated:

Hypothesis 2: There is an inverted U-shaped relationship between technological similarity and usefulness of knowledge received.

4.2.2.2 Frequency of knowledge transferred as a barrier

The third relational dimension of knowledge transfer is the frequency with which transfer occurs. Tacit knowledge as compared to explicit knowledge is more difficult to articulate (Polanyi, 1966) because it is difficult to encode by writing and is resided in the firm's system (people and processes). Therefore it is not easy to interpret and transfer from one to another. Yet, tacit knowledge plays an important role in innovation processes (Koskinen and Vanharanta, 2002; Cavusgil et al., 2003; Rebernik and Širec, 2007). Tacit knowledge is viewed as "best delivered through individual, face-to-face contact" (Ganesan et al., 2005: 47). Frequent communication enables the receiving firm better to understand the knowledge that it receives (Szulanski, 1996) and increases the chances that the knowledge is useful for the firm's innovations. Moreover, frequent interactions improve mutual trust between exchanging parties (Atuahene-Gima and Li, 2002; Adobor, 2006) and as a result, the level of tacit knowledge utilisation is enhanced (Koskinen, Pihlanto and Vanharanta, 2003). Conversely, infrequent transfers of knowledge inhibit the understanding of tacit knowledge and the development of trust. Thus,

Hypothesis 3: Frequent knowledge transfer is positively related to the usefulness of the knowledge received.

4.2.3 Attribute variable as a barrier: the knowledge receiver's learning culture

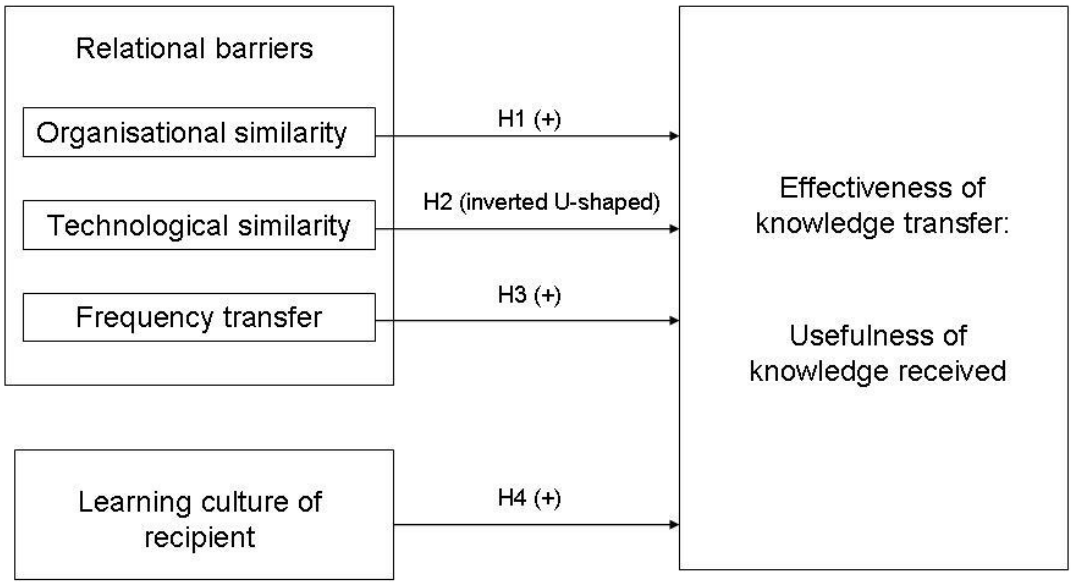
Becker and Knudsen (2003) point out that "absorptive capacity" is an important property of the recipient. This concept was firstly introduced by Cohen and Levinthal in 1990, when they recognised it as firms' fundamental learning processes, that is, their ability to identify, assimilate and exploit knowledge from the environment. In 2002, Zahra and George proposed additional definitions that separated Cohen and Levinthal's definition of absorptive capacity into (1) a broad set of skills needed to deal with the tacit component of transferred knowledge and the need to modify this transferred knowledge and (2) the capacity to learn and solve problems. Cummings and Teng (2003) pointed out that those firms with a supportive learning culture (which corresponds to Zahra and George's second definition: the capacity to learn and solve problems), have more slack to increase the richness of knowledge transferred; do not have the "not-invented-here syndrome" which prevents recipients from accepting outside knowledge; and have the people to retain, nurture and develop the knowledge received. Recipient firms who have a learning culture are therefore more able to explore the received knowledge further and put it into use for better innovative outcomes, whereas the opposite is proposed for recipient firms lacking such a culture. Thus,

Hypothesis 4: The learning culture of the recipient is positively related to the usefulness of the knowledge received.

As depicted in the research framework in Figure 4, the three relational features (frequency of knowledge transferred, organisational proximity and technological proximity) influence the usefulness of knowledge received as assessed by the recipient firm. The learning culture of the recipient firm, as an attribute variable, also impacts on the usefulness of the knowledge received. Some other attribute

variables are included as control variables and described in the methodological section of this chapter.

Figure 4: Research model



4.3 Research methodology

4.3.1 Sample and data collection

This study empirically explores a relational knowledge transfer model in an emerging economy. The unit of analysis is NTBFs located in the Gauteng region of South Africa. This region was chosen because it is one of the few regional systems of innovation that is well developed in the South African context (Lorentzen 2009). This implies that there are minimum levels of linkage among subsystems in this region, which is a necessity for studying knowledge transfer.

This research applies a quantitative research methodology. Questionnaires were used during face-to-face interviews (to assist in the completion of the questionnaires) with 52 NTBFs located in Gauteng. The CEOs or directors (units of observation) of these firms were asked to answer questions based on the relational characteristics of their knowledge transfer links with their external sources (suppliers, buyers, consultants, competitors, universities, public labs, innovation centres and sector institutes). The collected data were statistically analysed by applying multivariate regression analyses in SPSS, which fits the additive research model.

4.3.2 Measurements

Table 7 illustrates the items that were used in the questionnaire to measure the variables proposed in the conceptual model. All of the items were based on previous measures proposed in the literature using a five-point or seven-point Likert scale. Table 8 shows the literature that was sourced to construct the measurements, as well as the reliability statistics (Cronbach's alpha) of the scales used[8]. Most variables have Cronbach's α's ≥ 0.6, which suggests a high level of internal consistency.

The recipient's firm size, age, firm type and (science park) location were included as control variables. Firm size and firm age were controlled, since these two firm attributes have been recognised as important factors in the knowledge transfer literature (for example, Bresman et al., 1999; Agarwal and Gort 2002; Cavusgil et al., 2003). A firm needs time and people to acquire knowledge, therefore these two variables affect the accumulation of a firm's knowledge base, which determines its absorptive capacity to understand and use the knowledge received. Moreover, firm type (either a service provider or not) was included because, in certain industries, firms develop specific knowledge strategies and human resource practices (Laursen and Mahnke, 2004), which, in turn, influence the transfer of knowledge

[8] A reliability test was done on the variables which had multiple items to determine how well the items measured a single, uni-dimensional latent construct. This procedure was performed for all relevant variables and the results are shown in the last column of Table 8.

process. Finally, "science park location: y/n" was controlled because out of 52 NTBFs that were surveyed, 24 firms are situated in The Innovation Hub, which is the first South African science park accredited by the International Association of Science Parks (IASP) in South Africa. In the literature, it is maintained that science parks have many benefits for firms (Fukugawa, 2005). In particular, the knowledge exchange opportunities on science parks, which are due to co-location, are mentioned in the literature. Besides close geographical distance, these science park firms may also benefit from the support of the science park management to establish knowledge linkages. Thus, a science park plays a role in knowledge transfer between the firms located on the science park premises.

Table 7: Item(s) of variables

Independent variables	Item(s)
Frequency of knowledge transferred	How often does your firm access knowledge from its most important partners (suppliers, buyers, consultants, competitors, universities, public labs and sector institutes)? (5-point Likert scale: never, rarely, sometimes, regularly or always)
Organisational similarity	Our firm has contacts with the same third parties as our partners have. Our partners have the same organisational routines and values as our firm. Our partners have the same organisational structure as our firm. (5-point Likert scale: 1 = completely disagree, 3 = neither agree nor disagree, 5 = completely agree)
Technological similarity	To what extent is the knowledge your firm receives from the most partners/actors similar to your firm's own knowledge? (7-point Likert scale: 1 = not similar to 7 = completely similar)
Learning culture	Indicate level of agreement with the following statements: (1) most of our staff is highly skilled and qualified; (2) we invest a great deal in training; (3) we have the capacity to adapt others' technologies; (4) we have considerable resources and our own knowledge resources for technological development. (5-point Likert scale: 1 = strongly disagree, 3 = neither agree nor disagree, 5 = strongly agree)
Dependent variable	**Item(s)**
Usefulness of knowledge received	How useful is the knowledge your firm receives from the most important partners with regard to your firm's innovations? (5-point Likert scale: 1 = not useful to 5= completely useful)
Control variables	**Item(s)**
Firm size	Total number of employees in 2007, including the CEOs and directors.
Firm age	Number of years a firm exists.
Firm type	Is this firm a service provider or does it carry out other activities?
SP location	Is the firm located in The Innovation Hub (a science park in Gauteng)?

Table 8: Measurements, their sources, and reliability statistics

Variables	Source (where applicable)	Measurement and Cronbach's α in this research (where applicable)
Frequency of knowledge transferred	Source not applicable (n/a)	One item using 5-point Likert scale
Organisational similarity	Knoben and Oerlemans (2008)	Average sum score of all three items using 5-point Likert scale Cronbach's α = 0.817
Technological similarity	Cassiman et al. (2005)	One item using 7-point Likert scale
Learning culture	Nietoa and Quevedo (2005) Cummings & Teng (2003)	Average sum score of all four items using 5-point Likert scale Cronbach's α = 0.613
Usefulness of knowledge received	Soo and Devinney (2004)	One item using 5-point Likert scale
Firm size	Source n/a	Count of the total number of employees in 2007
Firm age	Source n/a	2008 (the year when this research was conducted) minus the founding year of the firm

4.4 Data analyses and findings

Means and standard deviations associated with the variables are provided in Table 9. On average, firms in the sample have received useful knowledge, especially from buyers and suppliers (mean value of 1.82). The usefulness of knowledge received from public research labs and sector institutes is regarded as relatively low (mean values of 0.26 and 0.39 respectively). By exploring this table further, it is evident that sample firms interact most frequently with suppliers and buyers (with mean values of 1.3 and 1.35 respectively) and the least with public research labs and sector institutes (with mean values of 0.13 and 0.23 respectively). Similarly, sample firms have higher levels of technological similarity with (are technologically closer to) their suppliers and buyers rather than with

public research labs and sector institutes. The average score for the three items on organisational similarity ranges from 1.71 to 2.21, which shows that the sample firms are close to halfway (on a scale of 1 to 5) similar to their partners organisationally. The averages of firm age and size are 5.13 years and 9.25 employees respectively. This shows that the sample firms are young and small. Of the sample firms, 76.9% come from the service provider industry and 46.2% of the firms are situated in The Innovation Hub.

The analysis aimed to determine if the eight items in the dependent variable "usefulness of knowledge received" could be combined into a single scale, because this would simplify the analyses. The Cronbach's alpha for these eight items is 0.729 and deletion of one of the items does not increase the alpha. This is, therefore, a highly reliable scale and it was decided to take the average sum scores of all eight items to measure "usefulness of knowledge received". Similarly, a reliability test was conducted on the independent variable "technological proximity" and the alpha of 0.573 suggests that the average sum scores of all eight items resulted in a reliable scale. The items in "frequency of knowledge transfer" were entered in a principal component factor analysis that produced a three-factor solution (*KMO* = 0.621; Bartlett = 44.291; *p* = 0.026); within which the third factor only contained one high-loading item. Table 10 shows the results where a new factor analysis was conducted by excluding this item ("frequency of transfer with innovation centres"), as this item has very low communality.

This new factor analysis produces two factors that were further interpreted as "frequency of knowledge transfer with business partners" and "frequency of knowledge transfer with research institutes". The corresponding *KMO* is 0.605 with *p* equalling 0.016, indicating that this solution fits the data well. Factor analysis was also done on the independent variables "organisational proximity" and "learning culture" and both yielded single-factor solutions (*KMO* = 0.573 with *p*= 0.002; *KMO* = 0.656 with *p*=0.000) respectively.

Table 9: Means and standard deviations

Independent variable		Mean	S.D.
Frequency of knowledge transfer	with competitors with buyers with suppliers with innovation centre with public research labs with university with consultant with sector institutes	0.50 1.35 1.30 0.34 0.13 0.55 0.88 0.23	0.69 0.83 0.95 0.73 0.37 0.82 0.89 0.55
Organisational similarity	same third parties same routines and values same structure	2.05 2.21 1.71	1.16 1.01 0.99
Technological similarity	with competitors with buyers with suppliers with innovation centre with public research labs with university with consultant with sector institutes	1.43 1.89 2.14 0.54 0.29 1.21 1.54 0.46	1.81 1.41 1.81 1.19 0.76 1.77 1.55 1.09
Learning culture	presence of slack no not-invented-here syndrome train for retention	3.60 3.94 3.77	1.11 0.80 0.83
Dependent variable		**Mean**	**S.D.**
Usefulness of knowledge received	from competitors from buyers from suppliers from innovation centre from public research labs from university from consultant from sector institutes	0.99 1.82 1.82 0.48 0.26 0.94 1.33 0.39	1.38 1.21 1.44 1.01 0.65 1.36 1.25 0.93
Control variable		**Mean**	**S.D.**
Firm size Firm age Firm type SP location		9.25 5.13 0.77 0.46	9.91 3.61 0.43 0.50

Table 10: Factor analysis for frequency of knowledge transfer

Independent variable		Component	
		1	2
Frequency of knowledge transfer	<u>with business partners:</u>		
	with competitors	0.598	
	with buyers	0.678	
	with suppliers	0.728	
	with consultants	0.676	
	<u>with research partners:</u>		
	with public research labs		0.651
	with universities		0.821
	with sector institutes		0.532

Ordinary multivariate least squares regression was used to test hypotheses 1 to 4. Variables were entered in the models in three steps:

Model 1: Model with only the control variables

Model 2: Model 1 + the two frequency of knowledge transfer variables

Model 3: Model 2 + organisational similarity + technological similarity + learning culture

In Table 11, the Variable Inflation Factor (*VIF*) values associated with variables in the regression models were lower than 10, indicating that serious multicollinearity problems do not exist in these models. In the first model, the main effects of the control variables are shown. Firm size, firm age and firm type do not impact significantly on the usefulness of knowledge received by the recipient firm. Interestingly, the variable SP location was significant at $p < 0.1$, indicating that this version of the model shows that firms located on a science park found the knowledge they received from their partners to be more useful for their innovative activities; whereas firms without a science park location found the knowledge they received from their partners to be less useful. The control variables resulted in an R^2 of 0.062 and an insignificant model (*F*-value change = 0.775, not significant).

Table 11: Regression models

Variables	Dependent variable: Usefulness of knowledge received		
	Model 1	**Model 2**	**Model 3**
Constant	0.932***	1.149***	0.620**
Control variables			
Firm size	-0.047	-0.172**	-0.066
Firm age	0.003	0.088	0.047
Firm type	-0.026	-0.059	0.050
SP location	0.266*	0.136	0.033
Independent variables			
Freq business partners		0.729***	0.360***
Freq research institutes		0.479***	0.196***
Organizational similarity			-0.113*
Technological similarity			-0.086
Technological similarity squared			0.635***
Learning culture			-0.035
R^2	6.2%	77.6%	86.3%
ΔR^2	6.2%	71.4%	8.7%
F-value	0.775	25.946***	25.798***
ΔF-value	0.775	71.629***	6.511***

$^{*}p < 0.10$; $^{**}p < 0.05$; $^{***}p < 0.01$

Frequency of knowledge transfer with business partners and frequency of knowledge transfer with research institutes were added in the second step (Model 2) and these two variables were statistically significant at the $p < 0.01$ level. In this model, the control variable of "firm size" has a negative and significant impact on the usefulness of knowledge received ($p < 0.05$). Model 2 has a better fit compared to Model 1 because the significance of the regression model as a whole improved to R^2 of 0.714 (F-value change = 71.629, $p < 0.01$). The effects of the independent variables in Model 2 accounted for approximately 71.4% of the variance in the usefulness of the knowledge received.

In the third step (Model 3), adding the other four independent variables (organisational similarity, technological similarity, technological similarity squared and learning culture) resulted in an R^2 of 0.863 (F-value change = 6.511, $p < 0.01$). In Model 3, all control variables are not statistically significant. The two variables for frequency of knowledge transfer remain to have positive and significant ($p < 0.01$) impacts on usefulness of knowledge received, which supports the third hypothesis: frequency of knowledge transfer is positively related to usefulness of knowledge received. However, organisational similarity has a negative value with significant level of $p < 0.10$, which implies a rejection of the first hypothesis. Apparently, focal firms find knowledge received from actors who are organisationally more dissimilar from them more useful. Technological similarity has no significant impact, but its squared term positively influences the usefulness of the knowledge received at a significant level of $p < 0.01$ and thus the second hypothesis is rejected. On the contrary, a U-shaped relationship between technological similarity and usefulness of knowledge received was found. In the next section, this finding will be interpreted. Learning culture is not statistically significant and therefore the last hypothesis is rejected.

4.5 Conclusions and recommendations

The open innovation literature embraces the benefits of external knowledge transfer to the generation of innovations but often neglects that interorganisational knowledge transfer faces frictions and barriers due to the fact that knowledge has to cross organisational boundaries. This study acknowledges the possibility of less effective transfer of knowledge when it crosses organisational boundaries and applies a relational approach to explore knowledge transfer between firms and to build and test a theoretical model in which relational characteristics are connected to the effectiveness of knowledge transfer. The study was guided by the following research question: To what extent do characteristics of the relationships between sender and receiver of knowledge influence the effectiveness of knowledge transfer for firms in South Africa? In this section, a summary of the most important findings of this study is provided and some recommendations are given to policy makers and for future research.

To test the hypotheses, multivariate regression model analyses were performed using data collected in South Africa.

Firstly, the findings indicate that the characteristics of the interorganisational relationships between the sender and receiver of knowledge are of importance to the usefulness of the knowledge received. The fact that all three relational variables have a statistically significant impact, although not always as expected, stresses the point that a relational view contributes to the understanding of knowledge transfer processes and that relational features do act as barriers to knowledge transfer.

Secondly, it turns out that only hypothesis 3 is empirically confirmed. The negative and significant impact of organisational proximity indicates that firms interacting with organisationally more dissimilar partners find the knowledge received more useful. Consequently, hypothesis one is rejected. This finding asks for an interpretation. Possibly the finding has to do with the fact that the sample firms are NTBFs that are young and small. This kind of firm is often confronted with a liability of newness and thus encounters two problems: a lack of a large variety of different resources and a lack of external legitimacy (Singh, Tucker and House, 1986). Interacting with more dissimilar, also probably larger, firms would solve both problems for young and small technological firms because these firms will bring them status in the market and are able to provide a variety of useful knowledge. During additional interviews carried out by the authors with sample firms, some expressed their need to interact with larger, dissimilar players in their field. This negative impact of organisational similarity found in this study is actually different from what was found in previous studies (for example, Cummings and Tseng, 2003) where organisational similarity played a positive role. In other words, the South African context seems to bring specific demands in terms of organisational dissimilarity to young technology-based firms.

Technological similarity, the second relational characteristic in the model, turned out to have a U-shaped relationship with the usefulness of the knowledge received. Hence, the second hypothesis is rejected. On the one hand, this finding

showed that the responding South African firms feel that the knowledge they receive from other firms with very similar knowledge bases results in high levels of knowledge usefulness. This may be related to the imitative innovations found among many South African firms (Oerlemans et al., 2004). Generating imitations is relatively easy with external knowledge that is very similar: it is easy to understand and can be applied quickly. In this study it is found, on the other hand, that, in the South African environment, external knowledge from a 'totally different' knowledge base is also perceived to be highly useful. One can interpret this right-hand part of the U-shaped curve as representing a firm that may wish to explore the possibilities of totally different ideas for innovation. Thus, totally new knowledge may bring novel ideas for the receiving firm. The result also suggests that a mixture of external knowledge from similar and distant knowledge bases will result in the lowest level of usefulness. Perhaps if a firm has a mixture (similar and distant) of knowledge, then it is indecisive as to which area it should focus on for its innovative direction. The above interpretations can be validated in the future research by asking open questions to South African firms with regards to the reasons for their choices on various degrees of technologically proximate or distant partners.

The third relational feature in the model, frequency of knowledge transfer, impacts positively on the effectiveness of knowledge transfer, which confirms hypothesis three. This holds in particular for the frequency of interaction with buyers and suppliers. When two partners exchange knowledge more often, they are able to gain more information from their partner, which reduces uncertainty about future behaviour, increases trust, and brings about clarity on how partners will deal with each other. As a result, partners can exchange knowledge more easily and effectively. Similar results were reported in a meta-study by Palmatier, Dant, Grewal and Evans (2006).

Learning culture had no significant impact on the usefulness of knowledge received and thus hypothesis four was not supported. South African firms often innovate by imitating other firms (Oerlemans et. al., 2004). Even though the firms may have, on average, a satisfactory learning culture (for example, they invest in training, have highly qualified staff, and have a context in which sharing knowledge

is valued), the use of these capabilities is often not directed at developing organisational learning, but directed at applying the knowledge developed by others.

Recommendations to policy makers in emerging economies, including South Africa, are threefold. Firstly, the governments were advised to put more efforts into attracting more (key) players from other economies to their targeted regions of technology and science development in order to increase the number of possible partners and thus providing more opportunities to the NTBFs in the region to network. Secondly, from this study it can be concluded that there is a lack of interaction between NTBFs and research institutions such as public research labs or universities where fundamental scientific knowledge lies for radical innovations. Therefore, countries with emerging economies should take the initiative more in linking the industry and the research institutions, not only in a limited manner in the context of science parks, but also in the entire region to enhance regional innovations. Thirdly, the results of the study show that collaborating with technologically similar and organisationally dissimilar partners increases the effectiveness of knowledge transfer. From a managerial perspective, this means that relationship management is important because selecting and maintaining effective relationships with partners is crucial (Rothaermel and Deeds, 2006). Training programmes for developing capabilities for relationship management or appointing network brokers could be beneficial to young, technology-based firms.

This research model focuses on "intentional" knowledge transfer, in other words, both parties are aware that knowledge is been transferred during their interactive activities (for example, during formal or social interactions). However, due to the imitative behaviours of most South African firms, "unintentional" knowledge spillover can be observed. In the previous studies, it was shown that unintentional flow of knowledge also brings innovative benefits to recipient firms (Fallah and Ibrahim, 2004; Oerlemans and Meeus, 2005). One could apply this model by taking "usefulness of unintentional knowledge received" as a dependent variable to explore the knowledge spillover in regions of developing countries.

References

Adobor, H., 2006. Optimal trust? Uncertainty as determinant and limit to trust in inter-firm alliances. *Leadership and Organisation Development Journal*, 27(7), 537-553.

Agarwal, R. and Gort, M., 2002. Firm and product life cycles and firm survival. *The American Economic Review*, 92(2), 184-190.

Ambos, T.C. and Ambos, B., 2009. The impact of distance on knowledge transfer effectiveness in multinational corporations. *Journal of International Management* 15, 1 -14.

Argote, L. and Ingram, P., 2000. Knowledge transfer: a basis for competitive advantage in firms. *Organisational Behavior and Human Decision* Processes, 82(1), 150-169.

Argote, L., McEvily, B. and Reagans, R., 2003. Managing knowledge in organisations: An integrative framework and review of emerging themes. *Management Science,* 49(4), 571-582.

Atuahene-Gima, K. and Li, H., 2002. When does trust matter? Antecedents and contingent effects of supervisee trust on performance in selling new products in China and the United States. *Journal of Marketing*, 66, 61-81.

Baldwin C. and von Hippel, E., 2009. User and open collaborative innovation: ascendant economic models. Working paper 10-038, Harvard Business School.

Baum, J.A.C., Calabrese, T. and Silverman, B.S., 2000. Don't go it alone: alliance network composition and startups' performance in Canadian biotechnology. *Strategic Management Journal*, 21(3), 267-294.

Becker, M. and Knudsen, M.P., 2003. Intra and interorganisational knowledge transfer processes: identifying the missing links. Druid working paper No. 06-32.

Borgatti, S.P. and Foster, P.C., 2003. The network paradigm in organisational research: a review and typology. *Journal of Management*, 29(6), 991-1013.

Boschma, R., 2005. Proximity and innovation: a critical assessment. Regional Studies, 39(1), 61-74.

Brachos, D., Kostopoulos, K., Soderquist, K.E. and Prastacos, G., 2007. Knowledge effectiveness, social context and innovation. *Journal of Knowledge Management,* 11(5), 31- 44.

Bresman, H., Birkinshaw, J.M. and Nobel, R., 1999. Knowledge transfer in international acquisitions. *Journal of International Business Studies*, 30(3), 439-462.

Cantner, U. and Meder, A., 2007. Technological proximity and the choice of cooperation partner. *Journal of Economic Interaction and Coordination*, 2(1), 45-65.

Cassiman, B., Colombo, M.G., Garrone, P. and de Veugelers, R., 2005. The impact of M&A on the R&D process: an empirical analysis of the role of technological- and market-relatedness. *Research Policy,* 34(2), 195-220.

Cavusgil, S.T., Calantone, R.J. and Zhao, Y., 2003. Tacit knowledge transfer and firm innovation capability. *Journal of Business and Industrial Marketing*, 18(1), 6-21.

Chesbrough, H.W., 2006. The era of open innovation. In: D. Mayle, ed. *Managing innovation and change.* London: Sage, 127-13.

Child, J., 2001. Learning through strategic alliance. In: M. Dierkes, A. Berthoin-Antal, J. Child, and I. Nonaka, eds. *Handbook of organisational learning and knowledge.* Oxford: University Press, 657-680.

Cohen, W. and Levinthal, D., 1990. Absorptive capacity: a new perspective on learning and innovation. *Administrative Science Quarterly*, 35, 128-152.

Cummings, J.L. and Teng, B.S., 2003. Transferring R&D knowledge: the key factors affecting knowledge transfer success. *Journal of Engineering and Technology Management*, 20, 39-68.

Easterby-Smith, M., Lyles, M.A. and Tsang, E.W.K., 2008. Interorganisational knowledge transfer: current themes and future prospects. *Journal of Management Studies*, 45(4), 677-690.

Fallah, M.H. and Ibrahim, S., 2004. Knowledge spillover and innovation in technological clusters". 13th International Conference on Management of Technology. April 2004, Washington.

Fukukawa, N., 2005. Characteristics of knowledge interactions between universities and small firms in Japan. *International Small Business* Journal, 23(4), 379-401.

Ganesan, S., Malter, A.J. and Rindfleisch, A., 2005. Does distance still matter? Geographic proximity and new product development. *Journal of Marketing*, 69, 44-60.

Hamel, G., 1991. Competition for competence and inter-partner learning within international strategic alliances. *Strategic Management Journal*, 12 (special issue), 83-103.

Hussinger, K., 2010. On the importance of technological relatedness: SMEs versus large acquisition targets. *Technovation*, 20(1), 57-68.

Ichijo, K. and Nonaka, I., 2007. *Knowledge creation and management: new challenges for managers*. New York: Oxford University Press.

Klein, S. and Wöcke, A., 2009. Protective incubators and South African MNEs, *Thunderbird International Business Review*, 51(4), 341-354.

Knoben, J. and Oerlemans, L.A.G., 2006. Proximity and interorganisational collaboration: a literature review. *International Journal of Management Reviews*, 8, 71-89.

Knoben, J. and Oerlemans, L.A.G., 2008. Ties that spatially bind? A relational account of the causes of spatial firm mobility. *Regional Studies*, 42(3), 385-400.

Koskinen, K.U. and Vanharanta, H. 2002. The role of tacit knowledge in innovation processes of small technology companies. *International Journal of Production Economics*, 80, 57-64.

Koskinen, K.U., Pihlanto, P. and Vanharanta, H., 2003. Tacit knowledge acquisition and sharing in a project work context. *International Journal of Project Management*, 21(4), 281-290.

Lane, P.J. and Lubatkin, M., 1998. Relative absorptive capacity and interorganisational learning. *Strategic Management Journal*, 19(5), 461-477.

Livieratos, A., 2009. Designing a strategy formulation process for new technology-based firms: a knowledge-based approach. *Electronic Journal of Knowledge Management*, 7(2), 245-254.

Laursen, K. and Mahnke, V., 2004. Knowledge strategies, firm types, and complementarities in human-resources practices. *Journal of Management and Governance*, 5(1), 1-27.

Laursen K. and Salter, A., 2006. Open for innovation: the role of openness in explaining innovation performance among U.K. manufacturing firms. *Strategic Management Journal*, 27, 131-150.

Lorentzen, J., 2009. The geography of innovation in South Africa: A first cut. *International Journal of Technological Learning, Innovation and Development*, 2(3), 210-219.

Marcelle, G.M., 2003. Reconsidering technology transfer. *International Journal of Technology Transfer and Commercialisation*, 2(3), 227-248.

Mclnerney, C., 2002. Knowledge management and the dynamic nature of knowledge. *Journal of the American Society for Information and Technology*, 53(12), 1009-1018.

Minbaeva, D., Pedersen, T., Bjorkman, I., Fey, C.F. and Park, H.J., 2003. MNC knowledge transfer, subsidiary absorptive capacity, and HRM. *Journal of International Business Studies*, 34(6), 586-599.

Morris, M., Bessant, J. and Barnes, J., 2006. Using learning networks to enable industrial development – case studies from South Africa. *International Journal of Operations and Production Management*, 26(5), 532-557.

Nietoa, M. and Quevedo, P., 2005. Absorptive capacity, technological opportunity, knowledge spillovers, and innovative effort. *Technovation*, 25, 1141-1157.

Nooteboom, B., Van Haverbeke, W., Duysters, G., Gilsing, V. and Van Den Oord, A., 2007. Optimal cognitive distance and absorptive capacity. *Research Policy*, 36, 1016-1034.

Oerlemans, L.A.G., Pretorius, M.W., Buys, A.J. and Rooks, G., 2004. *Industrial innovation in South Africa, 1998-2000.* Pretoria: University of Pretoria.

Oerlemans, L.A.G., and Meeus, M.T.H., 2005. Do organisational and spatial proximity impact on firm performance?. *Regional Studies*, 39, 89-104.

Palmatier, R.W., Dant, R.P., Grewal, G. and Evans, K.R., 2006. Factors influencing the effectiveness of relationship marketing: A meta analysis. *Journal of Marketing*, 70(4), 136-153.

Persson, M., 2006. The impact of operational structure, lateral integrative mechanisms and control mechanisms on intra-MNE knowledge transfer. *International Business Review*, 15, 547-569.

Pérez-Nordtvedt, L., Kedia, B.L., Datta, D.K. and Rasheed, A.A., 2008. Effectiveness and efficiency of cross-border knowledge transfer: An empirical examination. *Journal of Management Studies*, 45(4), 714-744.

Polanyi, M. 1966. *The tacit dimension*. London: Routledge & Kegan Paul.

Quintana-Garcia, C. and Benavides-Velasco, C.A., 2010. Accessing technological knowledge through R&D alliances: consequences for radical and incremental innovation. DRUID Summer Conference. June 2010 London.

Rebernik M. and Širec, K., 2007. Fostering innovation by unlearning tacit knowledge. *Kybernetes*, 36(3/4), 406-419.

Rosenkopf, L. and Almeida, P., 2003. Overcoming local search through alliances and mobility. *Management Science*, 49(6), 751-766.

Rothaermel, F.T. and Deeds, D.L., 2006. Alliance type, alliance experience and alliance management capability in high-technology ventures. *Journal of Business Venturing*, 21(4), 429-460.

Scarbrough H. and Amaeshi, K., 2009. Knowledge governance for open innovation: Evidence from an EU and R&D Collaboration. In: N.J. Foss and S.

Michailova, eds. *Knowledge governance: processes and perspectives.* New York: Oxford University Press, 220-246.

Schwartz, D.G., 2007. Integrating knowledge transfer and computer-mediated communication: categorizing barriers and possible responses. *Knowledge Management Research and Practice*, 5, 249-259.

Simonin, B., 2004. An empirical investigation of the process of knowledge transfer in international strategic alliances. *Journal of International Business Studies*, 35, 407–423.

Singh, J.V., Tucker, D.J. and House, R.J., 1986. Organisational legitimacy and the liability of newness. *Administrative Science Quarterly*, 31(2), 171-193.

Soo, C.W. and Devinney, T.M., 2004. The role of knowledge quality in firm performance. In: H. Tsoukas and N. Mylonopoulos, eds. *Organisations as knowledge systems: knowledge, learning and dynamic capabilities.* New York: Palgrave Macmillan, 252-275.

Szulanski, G., 1996. Exploring internal stickiness: impediments to the transfer of best practice within the firm. *Strategic Management Journal*, 17, 27-44.

Tang, F., Mu, J. and MacLachlan, D.L., 2008. Implication of network size and structure on organisations' knowledge transfer. *Expert Systems with Applications*, 34, 1109-1114.

Teirlinck P. and Spithoven, A., 2008. The spatial organisation of innovation: open innovation, external knowledge relations and urban structure. *Regional Studies*, 42, 689-704.

Van Wijk, R., Jansen, J.P. and Lyles, M.A., 2008. Inter- and intra-organisational knowledge transfer: a meta-analytic review and assessment of its antecedents and consequences. *Journal of Management Studies*, 45, 815-838.

Van Zyl, A., Amandi-Echendu, J. and Bothma, T.J.D., 2007. Nine drivers of knowledge transfer between universities and industry R&D partners in South Africa. *South African Journal of Information Management*, 9(1), 1-23.

Zahra, S.A. and George, G., 2002. Absorptive capacity: a review, reconceptualisation, and extension. *Academy of Management Review*, 27(2), 185-203.