African Journal of Business Management Vol. 6(11), pp. 3930-3940, 21 March, 2012
Available online at http://www.academicjournals.org/AJBM
DOI: 10.5897/AJBM11.230
ISSN 1993-8233 ©2012 Academic Journals

Full Length Research Paper

A relational view of knowledge transfer effectiveness in small new technology-based firms: An empirical analysis of a South African case

Kai-Ying A. Chan[1]*, Marthinus W. Pretorius[1] and Leon A. G. Oerlemans[1,2,3]

[1]Graduate School of Technology Management, University of Pretoris, Pretoria, South Africa.
[2]Department of Organisation Studies, Tilburg University, Tilburg, Netherlands.
[3]Center for Innovation Research, Tilburg University, Tilburg, Netherlands.

Accepted 15 June, 2011

The open innovation model often neglects the frictions that external knowledge flows could encounter when crossing organisational boundaries. This study recognises such barriers and investigates the impact of these barriers on knowledge transfer effectiveness by using data on small new technology-based firms (NTBFs) located in the emerging South African economy. The empirical results show that the characteristics of inter-organisational knowledge exchange relationships (organisational and 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.

Key words: Open innovation, knowledge transfer, new technology-based firms, South Africa.

INTRODUCTION

Proponents of the so-called open innovation model argue that, for most of the 20th century, firms used an 'old' model of 'closed innovation' where an innovating firm 'generates, develops and commercialises its own ideas' (Chesbrough, 2006). Due to globalisation and the increasing complexity of technological innovation, competition has increased, and in order to remain competitive, firms have shifted to an 'open innovation' model (also called 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 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 searching for knowledge externally 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 might be less unproblematic as proponents of the open innovation model often believe, as firms could encounter frictions such as differences in organisational cultures, structures and knowledge bases inhibiting inter-organisational flows of knowledge. A recent special issue of the Journal of management studies on inter-organisational knowledge transfer (Easterby-Smith et al., 2008) proposes that future research on inter-organisational knowledge transfer should focus on the role of organisational boundaries. It is stated that the arduous relationship between the source and recipient of knowledge is one of the most important barriers to knowledge transfer and that this arduous relationship is more likely to be present between two organisations than between two organisational units. Consequently, conducting a study on the issue of crossing

*Corresponding author. E-mail: alice.chan@up.ac.za.

Abbreviations: NTBFs, New technology-based firms; **IASP**, international association of science parks; **R and D**, research and development; **CEOs**, chief executive officers; **SPSS**, statistical package for the social sciences; **VIF**, variable inflation factor; **SP**, science parks; **MNEs**, multinational enterprises.

boundaries is relevant and timely.

The study of inter-organisational knowledge flows asks for a relational perspective, because the characteristics of the sender and receiver and their dyadic relationship affect 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 (for example, the quality of exchanges, trust or knowledge transfer) are important 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) and was applied in this study, which was conducted in South Africa.

Most empirical studies on inter-organisational knowledge transfer are conducted in developed economies. There is a lack of such studies on small firms in emerging economies in general and in South Africa in particular. In a literature search[1] very few studies were found on knowledge transfer in this emerging economy. The study by Van Zyl et al. (2007) identified 9 factors that drive knowledge transfer for research and development (R and 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 own 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 that were consulted do not directly relate to knowledge transfer per se (because they are focused on technology transfer, South African multinational enterprises (MNEs) and learning networks), but do, however, indicate that firms in South Africa seek and acquire knowledge across organisational boundaries (Marcell, 2003; Morris et al., 2006; Klein and Wöcke, 2009). In Marcell's (2003) study of technological capability accumulation in South Africa, it was found that firms use different mechanisms to acquire codified and tacit knowledge during technology acquisition. Klein and Wöcke (2009) demonstrated how 4 companies from South Africa progressed from their domestic base to become successful MNEs. They 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) reported on the ways in which learning networks were set up. They concluded that the interactive nature of joint cluster activities enables firms to lock into a network of learning. These studies show that knowledge flows are important to South African firms, but due to their specific foci they give only a partial picture of knowledge exchange practices. Moreover, from a methodological point of view, it was observed that most of these studies used small N case study methodologies and that only the study by Van Zyl used descriptive statistical analyses. Consequently, it is hard to draw generalisable conclusions concerning the knowledge exchange behaviour of firms in South Africa because there are no large N studies on inter-organisational knowledge transfer applying more advanced statistical methods.

[1]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, inter-organizational learning.

Research question and objectives

Based on the arguments above, the research question addressed in this study reads: To what extent do the characteristics of inter-organisational relationships between the sender and receiver of knowledge influence the effectiveness of knowledge transfer for new technology-based firms (NTBFs) in South Africa? NTBFs were chosen as 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 who are involved in the development, application and commercial exploitation of an innovative idea based on technological know-how' (Livieratos, 2009).

By answering the above research question, this paper contributes to the field in five ways. Firstly, it adds value to the studies on inter-organisational 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 on knowledge transfer in an inter-organisational 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 was done in this study. Secondly, this empirical study used a relational approach to understand the effectiveness of knowledge transfer. Many studies on inter-organisational 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 focused primarily on knowledge transfers of firms in developed countries such as the USA and the UK. This study will contribute to the studies of knowledge transfer in emerging economies. Fourthly, this study focuses on the knowledge effectiveness in small NTBFs. Effective knowledge inflows are of crucial importance to such firms, these firms often lack valuable (knowledge) resources and the resources to manage a large external network (Baum et al., 2000) due to a liability of smallness in firm sizes. Fifthly, compared to previous studies done in South Africa, which mostly used case studies as research methodologies, this study applies more advanced statistical tools (multivariate regression analyses) to explore the relational aspects of inter-organisational knowledge transfer between firms in South Africa. The last two contributions add to the further generalisability of findings on inter-organisational knowledge transfer.

THEORETICAL FRAMEWORK

Knowledge is often regarded as a type of resource that differs from physical resources (Zander and Kogut, 1995). It does not depreciate quickly and is accumulated over time. 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 recognised knowledge as a valuable resource for firms (Argote and Ingram, 2000; Ichijo and Nonaka, 2007) because knowledge development and application enhance firms' performance and innovativeness (van Wijk, 2008). Compared to intra-firm knowledge transfer, inter-firm knowledge transfer is difficult and complex, mainly because of the arduous relationship between two firms (Easterby-Smith et al., 2008). Inter-organisational knowledge exchange takes place between legally independent organisations and can therefore be viewed as a hybrid arrangement in which the goals, identities and cultures of the exchanging organisations are combined and where 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, complementtarities between exchanging actors could promote learning and synergy as a result of the coming together of experts from different backgrounds. On the negative side, a number of barriers could inhibit effective transfer. For example, too many competitive elements could be present in the exchange relationship, reconciling different organisational identities may turn out to be too complex, levels of receptivity may be too low, or there could be a lack of experience or capacity to acquire and absorb externally acquired knowledge (Child, 2001). These factors impede the harvesting of the benefits of knowledge transfer. In this paper, we focus on a number of these barriers, as they are impediments to effective knowledge transfer (Child, 2001).

We start our theoretical discussion with a description of the dependent variable in our model: the effectiveness of knowledge transfer.

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), 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 determining the effectiveness of knowledge transfer. 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), 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 was used as an indicator to represent the level of effectiveness of knowledge transfer. After discussing the dependent variable of our model, the next sections focus on the independent variables.

Key elements of dyadic relationships and the effectiveness of knowledge transfer

In a relational approach to the transfer of knowledge one can focus on 3 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, we first have to focus on the distinction between so-called

attribute and relational variables. Attribute variables are variables that can take certain values in the absence of inter-organisational 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 inter-organisational relationship exists. Examples of the latter are trust, partner confidence, partner similarities, dependencies and knowledge transfer. Once the relationship ceases to exist, the same happens to a relational variable. In the following subsections, a number of relational and attribute dimensions, namely partner (dis)similarities, frequency of knowledge transfer and learning culture, are discussed and related to our dependent variable.

Partner (dis)similarities as barriers to effective inter-organisational 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)similarities.

Relationships between organisational phenomena are fuelled by the effects of aggregated micro-level processes. Therefore, before specific hypotheses are presented, a general micro-level theoretical mechanism explaining the negative impact of partner dissimilarity on knowledge exchange effectiveness will be 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 his or her 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) 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). When these identities are very dissimilar, the knowledge sent by one party will clash with the mental constructs and norms of conduct of the other (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 will be impeded.

Organisational (dis)similarity is defined as the distance between "the sets of routines – explicit or implicit – which allow coordination without having to define beforehand how to do so. The set of routines incorporates organizational structure, organizational culture, performance measurements systems, language and so on" (Knoben and Oerlemans, 2006,). Lane and Lubatkin (1998) state that similarities between firms' organisational structures and policies contribute to their ability to learn interactively from each other. Firms who are similar organisationally share common language or communication processes and are able to reduce the cost associated with transferring the knowledge (Cohen and Levinthal, 1990). Therefore, such firms 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:

H_1: Organisational similarity is positively related to the usefulness of knowledge received.

Technological (dis)similarity refers to the differences between exchanging actors' technological knowledge; in other words, the level of relatedness of knowledge transferred between them. Transferring knowledge that differs from their technology domains could make it difficult for the recipient to understand and use the knowledge received because it has no relative absorptive capacity. In other words, the recipient's prior knowledge base does not lend itself to further exploration of 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 the common problems and to use the complementary knowledge to solve those innovative challenges. Moreover, engineers may be risk-averse during product developments due to the higher cost associated with risks such as using dissimilar technologies which they are not familiar. Thus, if technological dissimilarity acts as a barrier to effective knowledge transfer, the following hypothesis can be formulated:

H_2: Technological similarity is positively related to usefulness of knowledge received.

Frequency of knowledge transferred as a barrier

The third relational dimension of knowledge transfer is

the frequency with which transfer occurs. Tacit knowledge is more difficult to articulate than explicit knowledge (Polanyi, 1966), because it is difficult to encode in writing and resides 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). Frequent communication allows the receiving firm to better understand the knowledge that it receives (Szulanski, 1996) and increase the chances of the knowledge being useful for the firm's innovation. Moreover, frequent interaction improves 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 et al., 2003). Conversely, infrequent transfers of knowledge inhibit the understanding of tacit knowledge and the development of trust. Thus:

H_3: Frequent knowledge transfer is positively related to usefulness of knowledge received.

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 first 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 divided 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) point 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 suffer from the 'not-invented-here syndrome' that 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 use it for better innovative outcomes, whereas the opposite is proposed for recipient firms lacking such a culture. Thus:

H_4: The learning culture of the recipient is positively related to usefulness of knowledge received.

As depicted in our research framework in Figure 1, the three relational features (frequency of knowledge trans-ferred, organisational proximity and technological proxi-mity) influence the usefulness of knowledge received by the recipient firm. The learning culture of the recipient firm, as an attribute variable, also impacts on the usefulness of knowledge received. Some other attribute variables are included as control variables and described in the methodological section of this paper.

RESEARCH METHODOLOGY

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 are well developed in the South African context (Lorentzen, 2009). This implies that one can expect fairly strong links between 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 with the completion of the questionnaires) with 52 NTBFs located in Gauteng. The chief executive officers (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 was statistically analysed by applying multivariate regression analyses in statistical package for the social sciences (SPSS), which fits our additive research model.

Measurements

Table 1 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 5-point or 7-point Likert scale. Table 2 shows the literature that was sourced to construct our measurements, as well as the reliability statistics (Cronbach's alpha) of the scales used[2]. 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. We controlled for 'firm's size' and 'firm's age', given that these two attributes of firms 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, we include 'firm type' (either a service provider or not) because in certain industries, firms develop specific knowledge strategies and human resource practices (Laursen and Mahnke, 2004) that influence the process of transferr ing knowledge.

Finally, we controlled for 'science park location: yes/no'

[2] 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 2.

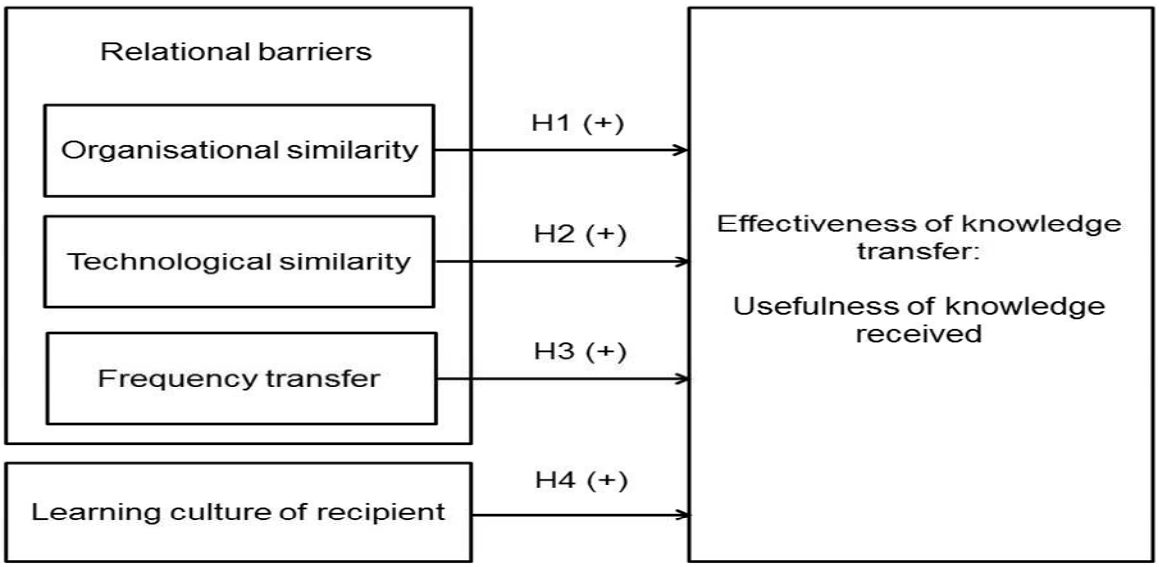

Figure 1. Research model.

Table 1. Item(s) of variables.

Independent variable	Item
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)? (five-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. (five-point Likert scale: 1 = completely disagree, 3 = neither agree nor disagree, 5 = completely agree)
Technological similariy	To what extent is the knowledge your firm receives from the most partners/actors related to your firm's own knowledge? (seven-point Likert scale: 1 = not related to 7 = completely related)
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 own knowledge resources for technological development. (five-point Likert scale: 1 = strongly disagree, 3 = neither agree nor disagree, 5 = strongly agree)
Dependent variable	**Item**
Usefulness of knowledge received	How useful is the knowledge your firm receives from the most important partners with regard to your firm's innovations? (five-point Likert scale: 1 = not useful to 5= completely useful)
Control variable	**Item**
Firm size	Total number of employees, including the CEOs and directors, in 2007.
Firm age	Number of years of existence of the firm.
Firm type	Is this firm a service provider or does it perform other activities?
SP location	Is the firm located in the Innovation Hub (a science park in Gauteng)?

Table 2. Measurements, their sources and reliability statistics.

Variable	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 five-point Likert scale
Organisational similarity	Knoben and Oerlemans (2008)	Average sum score of all three items using five-point Likert scale Cronbach's α = 0.817
Technological similarity	Cassiman et al. (2005)	One item using seven-point Likert scale
Learning culture	Nietoa and Quevedo (2005) Cummings and Teng (2003)	Average sum score of all four items using five-point Likert scale Cronbach's α = 0.613
Usefulness of knowledge received	Soo and Devinney (2004)	One item using five-point Likert scale
Firm's size	Nil	The total number of employees in 2007
Firm's age	Nil	2008 (the year of this research) minus the founding year of the firm

because a location in such a park is thought to be beneficial to innovation. Recent research findings (Chan et al., 2010) show, however, that this is not necessarily the case in the South African context. Of 52 NTBFs (our total sample) that we surveyed, 24 firms were 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 due to co-location are mentioned in the literature. Besides close geographical proximity, these science park firms could also benefit from the support of the science park management when establishing a knowledge link. Thus, a science park plays a role in knowledge transfer between the firms located on the science park premises.

DATA ANALYSIS AND FINDINGS

The means and standard deviations associated with the variables are provided in Table 3. On average, the firms in the sample have received useful knowledge, especially from buyers and suppliers (mean 1.82). The usefulness of knowledge received from public research labs and sector institutes is regarded as being relatively low (mean values of 0.26 and 0.39, respectively). If we explore this table further, 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 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. combined into a single scale, because this would simplify our 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 we decided to take the average sum scores of all 8 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 8 items results in a reliable scale. We entered the items in 'frequency of knowledge transfer' 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 4 shows the results where a new factor analysis was conducted by excluding this item ('frequency of transfer with innovation centres'), as it had a very low communality.

This new factor analysis produced two factors which we 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.

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

Table 3. Means and standard deviations.

Independent variable		Mean	Standard deviation
Frequency of knowledge transfer	with competitors	0.50	0.69
	with buyers	1.35	0.83
	with suppliers	1.30	0.95
	with innovation centre	0.34	0.73
	with public research labs	0.13	0.37
	with university	0.55	0.82
	with consultant	0.88	0.89
	with sector institutes	0.23	0.55
Organisational similarity	same third parties	2.05	1.16
	same routines and values	2.21	1.01
	same structure	1.71	0.99
Technological similarity	with competitors	1.43	1.81
	with buyers	1.89	1.41
	with suppliers	2.14	1.81
	with innovation centre	0.54	1.19
	with public research labs	0.29	0.76
	with university	1.21	1.77
	with consultant	1.54	1.55
	with sector institutes	0.46	1.09
Learning culture	presence of slack	3.60	1.11
	no not-invented-here syndrome	3.94	0.80
	train for retention	3.77	0.83

Dependent variable		Mean	Standard deviation
Usefulness of knowledge received	from competitors	0.99	1.38
	from buyers	1.82	1.21
	from suppliers	1.82	1.44
	from innovation centre	0.48	1.01
	from public research labs	0.26	0.65
	from university	0.94	1.36
	from consultant	1.33	1.25
	from sector institutes	0.39	0.93

Control variable	Mean	Standard deviation
Firm size	9.25	9.91
Firm age	5.13	3.61
Firm type	0.77	0.43
SP location	0.46	0.50

Model 2: Model 1 + the two frequency of knowledge transfer variables
Model 3: Model 2 + organizational similarity + technological similarity + learning culture

In Table 5, the variable inflation factor (VIF) values associated with variables in the regression models were less 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 science parks (SP) location was significant at $p < 0.1$, indicating that this

Table 4. Factor analysis for frequency of knowledge transfer.

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

Table 5. Regression models.

Variable	Dependent variable: Usefulness of knowledge received		
	Model 1	Model 2	Model 3
Constant	0.932**	1.149***	0.487**
Control variable			
Firm size	-0.047	-0.172**	-0.093
Firm age	0.003	0.088	0.079
Firm type	-0.026	-0.059	0.020
SP location	0.266*	0.136	0.056
Independent variable			
Frequency of knowledge transfer with business partners		0.729***	0.419***
Frequency of knowledge transfer with research institutes		0.479***	0.274***
Organisational similarity			-0.128*
Technological similarity			0.443***
Learning culture			-0.027
R^2 (%)	6.2	77.6	83.9
R^2 change (%)	6.2	71.4	6.3
F-value	0.775	25.946 ***	24.329 ***
F-value change	0.775	71.629 ***	5.506 ***
VIF range	1.161 – 1.318	1.039 –1.433	1.210 – 4.758

*****, $p < 0.10$; ******, $p < 0.05$; *******, $p < 0.001$.

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 than knowledge received from firms not located there.

In the analysis, we want to find out if the 8 items in the dependent variables 'usefulness of knowledge received' can be control variables resulted in an R^2 of 0.062 and an insignificant model (*F*-value change=0.775, not significant).

Frequency of knowledge transfer with business partners and 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 than 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 usefulness of knowledge received.

In the third step (Model 3), adding the other three independent variables (organisational similarity, technological

similarity and learning culture) resulted in an R^2 of 0.839 (F-value change = 5.506, $p < 0.01$). In Model 3, all control variables are not statistically significant. The two variables for frequency of knowledge transfer still have positive and significant ($p < 0.01$) impacts on usefulness of knowledge received, which supports our third hypothesis: frequency of knowledge transfer is positively related to usefulness of knowledge received. However, organisational similarity has a negative value with a significant level of $p < 0.10$, which implies a rejection of the first hypothesis. Apparently, responding firms find knowledge received from actors who are organisationally quite dissimilar from them, more useful than knowledge received from similar firms. Technological similarity positively influences the usefulness of knowledge received at a significant level of $p < 0.01$ and thus the second hypothesis is supported. Learning culture is not statistically significant and therefore the last hypothesis is rejected.

CONCLUSIONS AND RECOMMENDATIONS

The open innovation literature embraces the benefits of external knowledge transfer to the generation of innovations but often neglects the fact that inter-organisational knowledge transfer faces frictions and barriers due to the fact that knowledge has to cross organisational boundaries. This study acknowledges the possibility of the transfer of knowledge being less effective when it crosses organisational boundaries. It follows a relational approach to exploring knowledge transfer between firms and to building and testing 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 the characteristics of the relationships between the 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 made for future research and to policy makers.

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

Firstly, our findings indicate that the characteristics of the inter-organisational relationships between the sender and receiver of knowledge have an influence on the usefulness of knowledge received. The fact that all three relational variables have a statistically significant impact, although not always as expected, emphasises our 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 turned out that the majority of our hypotheses were 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. Perhaps our finding has to do with the fact that the sample firms are NTBFs that are young and small. Firms of this kind are often confronted by the liability of newness and thus encounter two problems: a lack of a large variety of different resources and a lack of external legitimacy (Singh et al., 1986). Interaction 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 our model, turned out to have a positive impact on the usefulness of knowledge received. Hence, the second hypothesis is supported. Interacting with partners who share similar knowledge bases allows recipient firms to understand and use knowledge received for incremental innovations. This finding is in line with results reported in other studies. Hussinger (2010) reported that technological similarity was conducive to acquiring a specific firm because it creates an information advantage. Canter and Meder (2007) also confirm the positive influence of technological similarity; in their case, on a firm's choice of collaboration partner.

In conclusion, it can be stated that our South African findings on the positive influence of technological similarity between partners confirm results found in different national economic contexts. The third relational feature in our model, frequency of knowledge transfer, impacts positively on the effectiveness of knowledge transfer, which confirms hypothesis three. This applies in particular to 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 et al. (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 (in other words, they do 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 rather directed at applying the knowledge developed by others.

Recommendations to policy makers in emerging economies, including South Africa, are threefold. Firstly, we advise the governments 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 provide more opportunities to the NTBFs in regions to network. Secondly, it can be concluded from this study that there is a lack of interactions 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 more initiatives in linking the industry and the research institutions, not only limited to the context of science parks, but also for the entire region to enhance regional innovations. Thirdly, the results of our 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 to develop 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 behaviour of most South African firms, unintentional knowledge spill over can be observed. In the past studies, 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 the usefulness of unintentional knowledge received as a dependent variable to explore the knowledge spill over in regions of developing countries.

REFERENCES

Adobor H (2006). Optimal trust? Uncertainty as determinant and limit to trust in inter-firm alliances. Leadersh. Organ. Dev. J., 27(7): 537-553.

Agarwal R, Gort M (2002). Firm and product life cycles and firm survival. Am. Econ. Rev. 92(2): 184-190.

Ambos TC, Ambos B (2009). The impact of distance on knowledge transfer effectiveness in multinational corporations. J. Int. Manag., 15: 1-14.

Argote L, Ingram P (2000). Knowledge transfer: A basis for competitive advantage in firms. Organ. Behav. Hum. Decis., 82(1): 150-169.

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

Atuahene-Gima K, 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. J. Mark., 66: 61-81.

Baldwin C, Von Hippel E (2009). User, and open collaborative innovation: Ascendant economic models. Harv. Bus. School, pp. 10-38.

Baum JAC, Calabrese T, Silverman BS (2000). Don't go it alone: Alliance network composition and startups. Performance in Canadian biotechnology. Strateg. Manage. J., 21(3): 267-294.

Becker M, Knudsen MP (2003). Intra and inter-organizational knowledge transfer processes: Identifying the missing links. Paper presented at the 8th Annual DRUID Conference, Elsinore, Denmark.

Borgatti SP, Foster PC (2003). The network paradigm in organizational research: A review and typology. J. Manage., 29(6): 991-1013.

Brachos D, Kostopoulos K, Soderquist KE, Prastacos G (2007). Knowledge effectiveness, social context and innovation. J. Knowl. Manage., 11(5): 31- 44.

Bresman H, Birkinshaw JM, Nobel R (1999). Knowledge transfer in international acquisitions. J. Int. Bus. Stud., 30(3): 439-462.

Canter U, Meder A (2007). Technological proximity and the choice of cooperation partner. J. Econ. Interact. Coord., 2(1): 45-65.

Cassiman B, Colombo MG, Garrone P, 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. Res. Policy., 34: 195–220.

Cavusgil ST, Calantone RJ, Zhao Y (2003). Tacit knowledge transfer and firm innovation capability. J. Bus. Ind. Mark., 18(1): 6-21.

Chan K-Y, Oerlemans LAG, Pretorius, MW (2010). Knowledge exchange behaviours of science park firms: the innovation hub case. Technol. Anal. Strateg., 22(2): 207-228.

Chesbrough HW (2006). The era of open innovation, in: Managing Innovation and Change. Mayle D (ed). London: Sage, pp. 127-13.

Child J (2001). Learning through strategic alliance, in: Handbook of Organizational Learning and Knowledge. Dierkes M, Berthoin-Antal A, Child J, Nonaka I (eds). Oxford: University Press, pp. 657-680.

Cohen W, Levinthal D (1990). Absorptive capacity: A new perspective on learning and innovation. Adm. Sci. Q., 35: 128-152.

Cummings JL, Teng BS (2003). Transferring R&D knowledge: The key factors affecting knowledge transfer success. J. Eng. Tech. Manage., 20: 39- 68.

Easterby-Smith M, Lyles MA, Tsang EWK (2008). Inter-organizational knowledge transfer: Current themes and future prospects. J. Manage. Stud., 45(4): 677-690.

Fallah MH, Ibrahim S (2004). Knowledge spillovers and innovation in technological clusters. Paper presented at IAMOT, Washington D.C., U.S.A, pp. 3-7.

Fukukawa N (2005). Characteristics of knowledge interactions between universities and small firms in Japan. Int. Small Bus. J., 23(4): 379-401.

Ganesan S, Malter AJ, Rindfleisch A (2005). Does distance still matter? Geographic proximity and new product development. J. Market., 69: 44-60.

Hamel G (1991). Competition for competence and inter-partner learning within international strategic alliances. Strateg. Manage. J., 12: 83-103.

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

Ichijo K, Nonaka I (2007). Knowledge Creation and Management: New Challenges for Managers. New York: Oxford University Press.

Klein S, Wöcke A (2009). Protective Incubators and South African MNEs. Thunderbird. Int. Bus. Rev., 51(4): 341-354.

Knoben J, Oerlemans LAG (2006). Proximity and inter-organizational collaboration: A literature review. Int. J. Manage. Rev., 8: 71-89.

Knoben J, Oerlemans LAG (2008). Ties that spatially bind? A relational account of the causes of spatial firm mobility. Reg. Stud., 42(3): 385-400.

Koskinen KU, Vanharanta H (2002). The role of tacit knowledge in innovation processes of small technology companies. Int. J. Prod. Econ., 80: 57-64.

Koskinen KU, Pihlanto P, Vanharanta H (2003). Tacit knowledge acquisition and sharing in a project work context. Int. J. Proj. Manage., 21(4): 281-290.

Lane PJ, Lubatkin M (1998). Relative absorptive capacity and interorganizational learning. Strateg. Manage. J., 19(5): 461-477.

Livieratos A (2009). Designing a strategy formulation process for new, technology-based firms: A knowledge-based approach. Electr. J. Knowl. Manage., 7(2): 245-254.

Laursen K, Mahnke V (2004). Knowledge strategies, firm types, and complementarities in human-resources practices. J. Manage.

Govern., 5(1): 1-27.
Laursen K, Salter A (2006). Open for innovation: the role of openness in explaining innovation performance among U.K. manufacturing firms. Strateg. Manage. J., 27: 131-150.
Lorentzen J (2009). The geography of innovation in South Africa: A first cut. Int. J. Technol. Learn. Innov. Dev., 2(3): 210-219.
Marcell GM (2003). Reconsidering technology transfer. Int. J. Technol. Tran. Commer., 2(3): 227-248.
Mclnerney C (2002). Knowledge management and the dynamic nature of knowledge. J. Am. Soc. Inform. Technol., 53(12): 1009-1018.
Minbaeva D, Pedersen T, Bjorkman I, Fey CF, Park HJ (2003). MNC knowledge transfer, subsidiary absorptive capacity, and HRM. J. Int. Bus. Stud., 34(6): 586-599.
Morris M, Bessant J, Barnes J (2006). Using learning networks to enable industrial development – Case studies from South Africa. Int. J. Oper. Prod. Manage., 26(5): 532-557.
Nietoa M, Quevedo P (2005). Absorptive capacity, technological opportunity, knowledge spillovers, and innovative effort. Technovation, 25: 1141–1157.
Oerlemans LAG, Pretorius MW, Buys AJ, Rooks G (2004). Industrial innovation in South Africa, 1998-2000. Pretoria: University of Pretoria.
Oerlemans LAG, Meeus MTH (2005). Do organizational and spatial proximity impact on firm performance? Reg. Stud., 39: 89-104.
Palmatier RW, Dant RP, Grewal G, Evans KR (2006). Factors influencing the effectiveness of relationship marketing: A meta analysis. J. Mark., 70(4): 136-153.
Persson M (2006). The impact of operational structure, lateral integrative mechanisms and control mechanisms on intra-MNE knowledge transfer. Int. Bus. Rev., 15: 547-569.
Pérez-Nordtvedt L, Kedia BL, Datta DK, Rasheed AA (2008). Effectiveness and efficiency of cross-border knowledge transfer: An empirical examination. J. Manage. Stud., 45(4): 714-744.
Rebernik M, Širec K (2007). Fostering innovation by unlearning tacit knowledge. Kybernetes, 36(3/4): 406-419.
Polanyi M (1966). The tacit dimension. London: Routledge & Kegan Paul.
Rosenkopf L Almeida P (2003). Overcoming local search through alliances and mobility. Manage. Sci., 49(6): 751-766.
Rothaermel FT, Deeds DL (2006). Alliance type, alliance experience and alliance management capability in high-technology ventures. J. Bus. Venturing, 21(4): 429-460.
Scarbrough H, Amaeshi K (2009). Knowledge governance for open innovation: Evidence from an EU R&D collaboration. in Knowledge governance*:* Processes and perspectives. Foss NJ, Michailova S (eds). New York: Oxford University Press, pp. 220-246.
Schwartz DG (2007). Integrating knowledge transfer and computer-mediated communication: Categorizing barriers and possible responses. Knowl. Manag. Res. Pract., 5: 249-259.
Simonin B (2004). An empirical investigation of the process of knowledge transfer in international strategic alliances. J. Int. Bus. Stud., 35: 407-423.
Singh JV, Tucker DJ, House RJ (1986). Organizational legitimacy and the liability of newness. Adm. Sci. Q., 31(2): 171-193.
Soo CW, Devinney TM (2004). The role of knowledge quality in firm performance. in: Organizations as Knowledge Systems: Knowledge, Learning and Dynamic Capabilities. Tsoukas H, Mylonopoulos N (eds). New York: Palgrave Macmillan, pp. 252-275.
Szulanski G (1996). Exploring internal stickiness: Impediments to the transfer of best practice within the firm. Strateg. Manage. J., 17: 27-44.
Tang F, Mu J, MacLachlan DL (2008). Implication of network size and structure on organizations' knowledge transfer. Expert Syst. Appl., 34: 1109-1114.
Teirlinck P, Spithoven A (2008). The spatial organization of innovation: Open innovation, external knowledge relations and urban structure. Reg. Stud., 42: 689-704.
Van Wijk R, Jansen JP, Lyles MA (2008). Inter- and intra-organizational knowledge transfer: A meta-analytic review and assessment of its antecedents and consequences. J. Manage. Stud., 45: 815-838.
Van Zyl A, Amandi-Echendu J, Bothma TJD (2007). Nine drivers of knowledge transfer between universities and industry R&D partners in South Africa. S. Afr. J. Inform. Manage., 9(1): 1-23.
Zahra SA, George G (2002). Absorptive capacity: A review, reconceptualization, and extension. Acad. Manage. Rev. 27(2): 185-203.
Zander U, Kogut, B (1995). Knowledge and the speed of the transfer and imitation of organizational capabilities: An empirical test. Organ. Sci. 6(1): 76-92.