Domestic and International innovation partnerships: do they matter for innovation outcomes of South African firms?

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Abstract

This paper studies the impact of the diversity of domestic and international innovation partnerships on the innovation outcomes of South African firms. A number of competing hypotheses are formulated and tested empirically using a sample of South African firms in manufacturing and services by applying Ordinary Least Squares regression analyses. Results show that having an innovation partnership, particularly an international partnership, is beneficial to innovation outcomes. However, it also emerges that too diverse a set of international partnerships is detrimental to innovation outcomes. The paper concludes with a discussion and a number of proposals for future research.

1. Introduction

Organisations in emerging economies (EEs) generally attempt to gain access to the technological resources of firms in developed countries (DCs) as a means to becoming more innovative (Zhao, Anand and Mitchell, 2005; Kotabe, Aulakh, Santillán-Salgado and Teegen, 2000) and ultimately more profitable. After all, innovation is one of the driving forces behind a nation's economic development and the competitive advantage of its firms (*e.g.*, Oerlemans, Pretorius, Buys and Rooks, 2003). Central to this paper is the international technology and knowledge transfer from firms in DCs to firms in EEs, specifically to firms in South Africa (SA). In building an elementary model of international technology and knowledge transfer to structure the theoretical discussion and to derive the hypotheses of this research, several dimensions should be taken into account, each of which will be elaborated in this paper.

As is common in communication models, an elementary model should at least consist of a sender and its environment (the organisation in the DC), a recipient and its environment (the firm in the

EE) and a message (the technology or knowledge transferred). The link or conduit through which this knowledge "flows" from sender to recipient is an alliance between the organisations that can take a host of forms ranging from informal collaboration to formal equity-based relations such as International Joint Ventures (IJV) (*e.g.*, Gulati, 1995a). Fig. 1 offers an illustration of such a model.
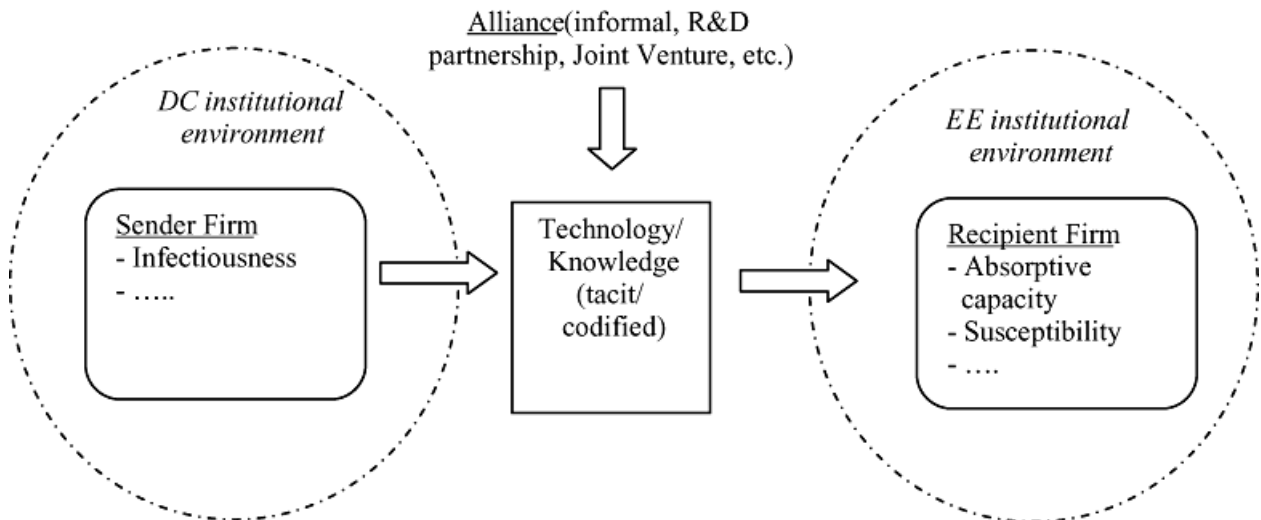
Figure 1. *(Elementary) model of international technology and knowledge transfer* A number of scholars have studied specific actor characteristics of both sender and recipient organisations and how these characteristics affect the knowledge flow between them. For instance, Greve (2005) mentions the source organisation's infectiousness and the recipient organisation's susceptibility as two actor characteristics that influence successful learning between alliance partners. In a similar vein, Lane, Salk and Lyles (2001) build on Cohen and Levinthal's (1990) seminal work on absorptive capacity, which refers to "an organization's ability to recognise the value of new, external information, assimilate it, and apply it for competitive advantage" (Samaddar and Kadiyala, 2006:196). While we do not wish to downplay the importance of these aspects in any way, these characteristics pertain to individual organisations and will therefore be considered only briefly in this paper. This paper rather concentrates on factors that characterise the relation between alliance partners (see also the concept of relative absorptive capacity as proposed by Lane and Lubatkin, 1998), for instance partners' social, cognitive, cultural and geographical proximity, each of which will be elaborated on in the next section. We will also discuss specific characteristics of alliances between firms in DCs and firms in EEs, for instance by acknowledging that they might be asymmetric (Chen and Chen, 2002), and by highlighting how the transfer of knowledge between DCs and EEs differs from the knowledge transfer among DCs. In so doing, we explicitly take into account the macro level institutional environment surrounding firms in DCs and firms in EEs. Finally, on the ego-network level we focus on the diversity of partners in the network in which the recipient firm is embedded. We shall test two rival theories on the network's effects on learning and innovative output, namely the information/decision making perspective *versus* the social categorisation perspective. More specifically, we aim to answer the following research questions:

To what extent do alliances in general, and international alliances between DC and EE firms

versus domestic alliances in particular, impact the innovative output of EE firms?
To what extent does partnership diversity in a firm's inter-organisational network impact its subsequent innovative output?

By answering these questions and explaining our empirical findings from a rich theoretical framework, we believe this paper can contribute significantly to gaining further insight into the extent of the impact of partnership-portfolios on innovative output. Whereas the bulk of research on the effects of national and international alliances on innovation is dominated by studies coming from a DC perspective (Kotabe *et al.*, 2000), this paper seeks to increase our understanding from an EE point of view. The findings of this study can help innovative EE firms design partnership-portfolios with (inter)national partners in such a way that the levels of innovative output are maximised.

In the following section we present the theoretical framework and hypotheses of this study. Next, in the method section, we briefly discuss data collection and describe variables and statistical tests. Finally, we present the most important research results and conclusions.

2. Theoretical framework and hypotheses

Inter-firm collaboration
One of the most significant trends in the industrial organisation of the last decades has been the proliferation of inter-firm collaboration (*e.g.*, Gulati, 1995a; Powell, Koput and Smith-Doerr, 1996; Grant and Baden-Fuller, 2004; Samaddar and Kadiyala, 2006). Historically, firms managed their research and development (R&D) activities mostly internally, only relying on outside sources for "simple" products and services (Powell *et al.*, 1996). Parkhe (1998:417) presents an example of how General Motors Corporation's annual reports in the 1960s contained explicit references to not reaching out to other firms. But the days in which organisations mainly operated alone have long since gone. Nowadays, as large firms in particular increasingly focus on their core businesses (by outsourcing non-core activities), organisations are increasingly cooperating with other organisations in activities outside their business core (Grant and Baden-Fuller, 2004). Today, firms from a wide range of industries execute almost the entire production process through some form of external collaboration (Powell *et al.*, 1996). Collaboration is performed through strategic alliances between firms, where an alliance is defined as "a situation wherein two or more firms unite to pursue a set of agreed-upon goals, in which they share the benefits; and in achieving these goals, partner firms independently control over the performance of assigned tasks and contribute on an ongoing basis in one or more key strategic areas" (Yoshino and Rangan, 1995:5, in Chen and Chen, 2002:1008).

Collaboration between organisations can take very different alliance structures. While the essential governance mode is an informal relational contract (Grant and Baden-Fuller, 2004), strategic alliances can also comprise more formal agreements such as R&D partnerships, (international) equity joint ventures, collaborative manufacturing, co-marketing arrangements, technology exchange, direct investment licensing and many other forms (Gulati, 1995a; Powell *et al.*, 1996; Dacin, Hitt and Levitas, 1997). Practical considerations often mentioned when entering into a strategic alliance include access to markets and technology, risk sharing, pooling

of complimentary skills, achieving economies of scale and obtaining competitive advantage (Powell *et al.*, 1996; Kotabe *et al.*, 2000; Chen and Chen, 2002). Over the years several theoretical positions have been developed to explain why firms cooperate with one another. To very briefly sketch a few of these: in Transaction Cost Economics, the decision to pool resources is largely strategic, motivated by calculations with respect to risk and return (Powell *et al.*, 1996). Neo-Institutional Theory highlights the quest for legitimacy (*e.g.*, Human and Provan, 2000) and local mimetism (*e.g.*, Garcia-Pont and Nohria, 2002), while Resource-based approaches, especially those underlining the function of knowledge, focus on understanding the processes of knowledge generation and coordination occurring within and between organisations (Zhao *et al.*, 2005).

As mentioned, this contribution centres on the relation between firms' embeddedness in (international) strategic alliances and their subsequent innovative output. Innovation in this paper is defined as "a new or substantially improved service, product or process that is introduced on the market or implemented in an organisation" (Oerlemans *et al.*, 2003:108-109), which is in line with the definition applied in the European Community Innovation Survey. Central to these definitions, and sometimes left out of other definitions of innovation, is that the product, process or approach must yield some tangible benefits. Moreover, these definitions include new or improved services, products or processes already introduced by a competitor.

The current body of literature presents several arguments supporting the claim that collaboration is likely to positively impact inter-organisational learning and innovative output. Since it has, as said, become unlikely that firms possess and control all necessary knowledge and skills within the organisational boundaries, one may expect innovating firms, especially with knowledge-intensive products, to form alliances with partners. A good example is the development of an animal model for Alzheimer's disease, as reported by Powell *et al.* (1996:118). Contributing to the subsequent publication of this research breakthrough in Nature (Feb. 9, 1995), were 34 co-authoring scientists, two biotech companies, one pharmaceutical firm, a leading research university, a federal research laboratory and a non-profit research institute. This amply demonstrates the number and diversity of sources that can collaborate in producing a final product.

Indeed, the heavy concentration of alliances in R&D intensive sectors (Grant and Baden-Fuller, 2004), *i.e.*, sectors that rely heavily on innovation and technological development, indicates that the quest for innovation is an important driver behind alliance formation. Grant and Baden-Fuller refer to a wide range of studies of strategic alliances adopting an organisational learning perspective, "assuming that the goal of strategic alliances is to acquire the knowledge of alliance partners" (2004:64). Other studies also highlight access to technology and knowledge as important drivers behind strategic alliance formation (*e.g.*, Kotabe *et al.*, 2000; Chen and Chen, 2002; Lane *et al.*, 2001; Dacin *et al.*, 1997). In addition, Hamel (1991) proposes that collaboration enhances inter-organisational learning, a key ingredient for successful innovation. Finally, Powell *et al.* (1996) report evidence from various studies that R&D intensity (or the level of technological sophistication of an industry) is positively associated with the intensity and number of alliances in that sector. Collaboration thus seems to be central to successful innovation, allowing partners to learn from each other and complementing their resources. More specifically, such a network of strategic alliances between innovating firms enhances innovation

by providing "timely access to knowledge and resources that are otherwise unavailable, while also testing internal expertise and learning capabilities" (Powell *et al.*, 1996:119). Taken together, these arguments lead us to expect that, all other things being equal, firms that engage in collaborative alliances achieve a higher level of innovative output than their non-collaborating counterparts. It follows that:

Hypothesis 1: South African firms collaborating with partners will have higher levels of innovative output compared with South African firms without these partners.

International versus domestic collaboration
International alliances, as a special case of inter-firm collaboration, are "cooperative arrangements, involving cross-border flows and linkages that utilise resources and/or governance structures from autonomous organisations headquartered in two or more countries" (Parkhe, 1991:581). Many studies have looked into what makes international alliances successful, be it trust (Parkhe, 1998), learning from past experiences (Emden, Yaprak and Cavusgil, 2005) or routinisation (Zollo, Reuer and Singh, 2002). Supporting the argument put forward above, that organisations can learn from each other through alliances and therefore can become more innovative, Hamel (1991) viewed inter-organisational learning as one of the most important rationales for the formation of international alliances and as key to their performance. However, it is not clear beforehand to what extent learning that has been found to exist in national (*i.e.*, domestic) alliances is also present on an international level.

Inter-organisational learning has been widely researched, and several models have been developed to explain this dynamic process. For example, Greve (2005) models inter-organisational learning after the diffusion of innovations, which is dependent on the characteristics of the origin and destination of organisations as well as their relationship. The infectiousness of the origin organisation (determined by availability, interpretation and status) and susceptibility of the destination organisation (determined by motivation and capability) are traits of individual organisations. The third factor impacting inter-firm learning is a variable that Greve (2005) refers to as social proximity, which is shaped by the social structure in which organisations function. Organisations in close social proximity are presumed to have higher levels of inter-firm learning than organisations in situations of less social proximity. Three variables positively affecting social proximity are network ties, geographical proximity and organisational similarity (Greve, 2005). In international alliances, these variables may not have a big impact. First, the different national bases of international partners can make efficient network ties between the partners more difficult. Second, international alliances inherently lack geographical proximity, preventing the transfer of tacit knowledge in particular. Third, due to cultural differences, in international alliances organisational similarity is likely to be low. These circumstances combined imply a situation in which international partners are socially distant, thus hindering inter-organisational learning.

Related to social proximity, the concept of cognitive proximity between organisations holds that, for organisations to successfully learn from each other, they need to have complementary knowledge bases. SA can well be regarded as an EE. Oerlemans *et al.* (2003:99) found that international alliances involving SA firms are mostly with organisations in European DCs. Zhao

et al. (2005) studied the inter-organisational transfer of R&D capabilities from organisations located in DCs to their counterparts in EEs, and found that it differs in important respects from transferring capabilities within DCs, thus hindering inter-organisational learning. First, there tend to be large technological gaps between the source and recipient organisations, creating a situation in which partners are cognitively distant. Second, institutional environments surrounding firms in EEs are both socially and culturally distinct from DC environments, implying lower levels of social proximity and cultural proximity (on which we will elaborate later). Of course there are significant differences between the culture of an organisation and the culture of a nation, yet many features of a national culture will nevertheless be imprinted on its organisational cultures. Put differently, while these cultures are not the same, they do tend to overlap. Third, DC and EE networks have evolved in social and economic isolation from each other, which might be especially salient for SA firms due to the apartheid era and the concomitant economic boycotts. Therefore, "unlike DC-to-DC knowledge transfer, DC-to-EE transfers face a paradox – although the need to create knowledge is great, the technological gaps and cultural differences create high barriers that inhibit the knowledge flow" (Zhao *et al.*, 2005:131). These barriers may prevent successful knowledge sharing in international alliances, especially between firms located in EEs and firms in DCs.

To expand on the previously mentioned cultural differences between partners in international alliances: national culture provides the institutional setting within which firms make strategic decisions (Kumar and Nti, 2004). It is generally assumed that when differences in national culture are large (*i.e.* when cultural proximity is low), the alliance is likely to be characterised by lower levels of trust, a higher probability of opportunistic behaviour, and problematic organisational coordination (Kumar & Nti, 2004). A large cultural gap between alliance partners can therefore negatively impact inter-firm learning and innovative output. This is explained by the fact that "managers socialized in different national cultures are likely to have different frames of reference, and it is the differences in frames of reference that may give rise to opportunism and/or coordination problems" (Kumar and Nti, 2004:346). While managers learn organisational practices through organisational socialisation, core beliefs and assumptions lie deeper and are acquired by individuals through nurture long before they are socialised by the firm (Kumar and Nti, 2004). An important consequence is that, although firms may try to not behave as is stereotypical for their country, national culture will continue to play a crucial role in corporate culture (Kumar and Nti, 2004). A number of studies have delivered empirical evidence supporting these assumptions. For instance, in a study of IJVs, Barkema, Bell and Pennings (1996) assert that, when cultural differences between alliance partners are large, the IJV is less likely to succeed. As cultural differences are likely to be larger in international alliances (especially between EE and DC firms) than in domestic alliances, this is likely to result in lower levels of innovative output.

A final argument to expect inter-organisational learning in international alliances to be less successful than in domestic alliances derives from the nature of what needs to be transferred, in order to successfully innovate. Many scholars (for instance Nonaka and Takeuchi, 1995) distinguish two types of knowledge, codified or explicit knowledge (*e.g.*, blueprints, handbooks, procedures, patents) and tacit knowledge (*e.g.*, experience, skills, expertise). Successful innovation largely depends on successfully sharing both types of knowledge. However, codified and tacit knowledge differ in their transferability: whereas "explicit knowledge can be articulated

and easily communicated between individuals and organisations, tacit knowledge [. . .] is manifest only in its application – transferring it from one individual to another is costly and slow" (Grant and Baden-Fuller, 2004:66). In order for tacit knowledge to be shared, the source and the recipient organisation must engage in close inter-organisational contact, ideally involving groups of personnel from both organisations, since transferring tacit knowledge "requires direct interaction and first-hand observations including exposure to the source entity's working environment and socialisation processes" (Zhao *et al.*, 2005:132). Since "close-inter-organizational contact" is likely to be harder to achieve in international than in domestic alliances (for reasons including the lack of social, geographical, cognitive and cultural proximity), this can be interpreted as yet another argument why successful learning and innovation might be hampered in an international alliance. These arguments combine to create hypothesis 2a:

Hypothesis 2a: South African firms that predominantly collaborate with international partners will have lower levels of innovative output than South African firms predominantly collaborating with domestic partners.

Running counter to the logic outlined above, one could also argue that, at least for SA firms, international alliances can in fact yield higher levels of innovative output than domestic alliances. When advancing the argument that international alliances may benefit SA firms more than domestic ones, it is important to first examine the specific setting in which SA firms operate. SA is in many respects the most economically developed sub-Saharan African country (Akinboade and Lalthapersad-Pillay, 2005) with a Gross National Product (GNP) of US$130 billion, equalling the combined GNP of 46 of the 47 countries in sub-Saharan Africa (excluding Nigeria). Furthermore, Arora and Vamvakidis (2005) assert that SA is an engine of growth for the African continent, with a 1% point increase in SA growth being associated with a 0.5-0.75% point increase in the growth of the rest of Africa. However, this cannot obscure the particular hardships and challenges that the African continent has faced, is facing, and will most likely continue to face in the future. Akinboade and Lalthapersad-Pillay (2005) extensively highlight the grave situation in most African countries. For instance, it is estimated that about half of Africa's population has to survive on less than US$1 per day; life expectancy at birth is only 54 years (47 for sub-Saharan countries); and infant mortality below the age of 5 stands at 140 per 1000 inhabitants (Akinboade and Lalthapersad-Pillay, 2005). Other important impediments to intra-African trade are poor infrastructure (Poland is estimated to have more roads than the whole of the African continent), policy mismanagement and internal political tension (Longo and Sekkat, 2004). Although these problems might be less pressing for SA, they do affect SA firms' trading with neighbouring countries and, to a lesser extent, their trading within SA. However, as Longo and Sekkat (2004) point out, the obstacles mentioned are specific to trade among African countries and do not affect trade with DCs, so that, despite the geographical distance, African countries trade more with the European Union than with other African economies (Longo and Sekkat, 2004). Further underpinning this assertion, Rangasamy and Blignaut (2005) mention that, from a macro-economic perspective, the SA economy has indeed become more open to international trade since 1990. Moreover, investing in Africa is highly profitable for DC firms: Africa has the highest rate of return on investment in the world (Akinboade and Lalthapersad-Pillay, 2005). As a consequence of these forces, there are many alliances between especially SA firms and firms in DCs.

Focusing more closely on alliances between EE and DC firms, Chen and Chen (2002) ask why firms in advanced countries, with all their strategic resources, wish to partner with firms from developing countries, which seem to have little to offer in return. The answer, in part, points toward a difference in what the partners expect to get out of the alliance. As Kotabe *et al.* (2000) show for emerging Latin American firms, EE and DC firms have different motives for entering alliances. In general, the most important motive for EE firms to enter an alliance is to gain access to the foreign partner's technological expertise. In contrast, DC firms are interested in resource acquisition, competitive posturing, risk/cost reduction and/or access to local markets. This difference in motivation also holds for Korean (Dacin *et al.*, 1997) and Taiwanese (Chen and Chen, 2002) settings. A further reason for DC firms to ally with EE firms is that such alliances tend to be asymmetric, meaning that the DC firm is likely to dictate the contractual terms and to reap more financial gains (Chen and Chen, 2002). Moreover, EE firms may be forced to perform many relation-specific investments (such as buying equipment used exclusively by their DC counterpart), thereby becoming "hostages" to the alliance (Chen and Chen, 2002:1009). These conditions may partly explain why investment in Africa is so highly profitable for large multinationals (Akinboade and Lalthapersad-Pillay, 2005). Firms in EEs usually have little choice, since they are in high need of technology and knowledge and large multinationals are usually the only players entering foreign markets (Chen and Chen, 2002). On the upside, EE firms do stand to profit from the superior knowledge of DC firms. This is one reason why firms in EEs (at least in a Latin American setting) have much more at stake in collaboration than DC firms (Kotabe *et al.*, 2000).

Since firms in DCs tend to have higher levels of technological sophistication than firms in EEs, including SA firms, the DC firms represent a huge learning opportunity for the EE firms, much more so than their domestic counterparts with lower levels of R&D skills. Moreover, the costs of replicating knowledge tend to be lower than the costs of creating knowledge through an original discovery (Grant and Baden-Fuller, 2004). This enables SA firms to profit from their international alliances by adopting and adapting the knowledge created by DC firms. This applies especially to codified knowledge, which is "costly to produce, but cheap to reproduce" (Shapiro and Varian, 1999:3). Tacit knowledge is more costly to replicate, but these costs are still lower than those incurred in its original creation (Grant and Baden-Fuller, 2004).

Furthermore, a well-designed international alliance can overcome many of the previously described problems affecting the transfer of knowledge, so that many scholars (*e.g.*, Inkpen and Pien, 2006) point to strategic alliances as ideal platforms for learning. An IJV, for instance, can be very useful in sharing knowledge if the IJV is organised flexibly, and if the foreign partners provide training, technology and managerial assistance (Lane *et al.*, 2001). But other, non-equity-based alliances can be important vehicles for learning as well. Whereas explicit knowledge can be transferred relatively easily, for instance through written media like manuals and operating instructions, the transfer of tacit knowledge often requires the transfer of people (Inkpen and Pien, 2006). Both long-term managerial transfer and short-term technical assignments can facilitate this knowledge exchange, for instance through on-the-job learning and training (Inkpen and Pien, 2006). In addition, today's information technology can greatly facilitate inter-organisational learning, lessening the need for geographical proximity between international partners (Scott, 2000).

Altogether, these arguments make it likely that SA firms can benefit from alliances with international DC-based partners by adopting and adapting DC knowledge, more than from alliances with domestic partners. Phrased more formally, this leads to hypothesis 2b, rivalling hypothesis 2a:

Hypothesis 2b: South African firms that collaborate predominantly with international partners will have higher levels of innovative output than South African firms predominantly collaborating with domestic partners.

Partnership diversity
Diversity is a subject that has been widely researched in studies dealing with team composition, especially when determining the effects of a diverse team in terms of group conflict (*e.g.*, Pelled, Eisenhardt and Xin, 1999), shirking, free-riding behaviour (*e.g.*, Eckel and Grossman, 2005) and, ultimately, performance (for a review, see Jackson, Joshi and Erhardt, 2003). In this rich stream of literature, diversity is often defined as "any attribute that people use to tell themselves that another person is different" (Williams and O'Reilly, 1998:81). The academic interest in diversity is mainly fuelled by the rapidly changing composition of the global workforce (Pelled *et al.*, 1999). Increasing collaboration between organisations, particularly when this comprises the exchange of personnel (for instance to stimulate the sharing of tacit knowledge), also increases this workforce diversity. Rather than on team composition and team diversity, this research focuses on the extent of diversity in the network in which SA firms are embedded, *i.e.*, the strategic diversity among partners with which SA firms engage, and the subsequent impact of this diversity on innovative output levels.

In literature, there are many indications suggesting that higher levels of diversity lead to higher levels of innovative output. Following Williams and O'Reilly (1998) and Knippenberg, De Dreu and Homan (2004), we refer to arguments that diversity positively impacts performance in terms of information processing and decision-making. The basic premise is that heterogeneous groups outperform homogeneous groups, as diverse groups (whether people or organisations) "are more likely to possess a broader range of task-relevant knowledge, skills, and abilities that are distinct and non-redundant and to have different opinions and perspectives on the task at hand" (Knippenberg *et al.*, 2004:1009). Besides providing the group with more resources (such as a broader knowledge pool), this can also yield other benefits. For instance, Knippenberg and colleagues (2004:1009) refer to a more thorough processing of task-relevant information, since a diverse group is likely to generate conflicting viewpoints that need to be reconciled, thus preventing any premature choice of action. In addition, exposure to diverging and surprising perspectives may lead to more creative and innovative ideas and solutions (Knippenberg *et al.*, 2004). In fact, there is some empirical evidence that higher levels of diversity in work groups positively affect team performance (Jehn, Northcraft and Neale, 1999). Also, a study by Bantel and Jackson (1989) found that higher levels of diversity positively affect innovation in banking. Similar to how diversity affects teams and work groups, one might expect firms to benefit from a diverse set of inter-organisational partners. The primary argument, similar to the information processing/decision-making perspective given above, is that partner diversity creates a broader knowledge pool, involving organisations with different backgrounds, skills and expertise. This broader knowledge pool could then lead to higher levels of inter-organisational learning, with

firms complementing each other's tangible and intangible knowledge resources. Furthermore, and similar to the work group examples given above, conflicting interests and opinions might lead to a more careful consideration of innovative options and thus to enhanced decision-making, while being exposed to diverging perspectives, knowledge and skills is likely to result in more innovative problem solving and more creative ideas. In addition, networks characterised by higher diversity are likely to display lower levels of social, cultural and cognitive proximity between the alliance partners. This in turn is likely to lead to increased levels of innovative output, as was mentioned above. These arguments combined lead to hypothesis 3a:

Hypothesis 3a: South African firms that engage in alliances with strategically diverse partners will have higher levels of innovative output than South African firms embedded in relatively less diverse networks.

In contrast to the arguments presented above, one can equally well argue that diversity will negatively affect the innovative output of alliance partners. This is, broadly speaking, the social categorisation perspective on diversity in work teams (Williams and O'Reilly, 1998; Knippenberg *et al.*, 2004). This perspective essentially holds that "similarities and differences are used as a basis for categorising self and others into groups, with ensuing categorisations distinguishing between one's own in-group and one or more out-groups" (Knippenberg *et al.*, 2004:1009). Generally, human beings favour their own in-group over out-groups when it comes to affection, trust and cooperation. This indicates "that work group members are more positively inclined toward their group and the people within it if fellow group members are similar rather than dissimilar to the self" (Knippenberg *et al.*, 2004:1009). Highly diverse groups are thus more likely to encounter personal problems, communication problems and the creation of various competing sub-groups. Moreover, homogeneous groups experience higher levels of cohesion, member commitment, and less relational conflicts than heterogeneous groups (Knippenberg *et al.*, 2004). Altogether, these circumstances make it likely for diversity to negatively affect overall group performance.

Similar to how the social categorisation perspective predicts that diversity will negatively affect work group performance at the team level, one might expect diversity to negatively affect innovative performance in an organisation's innovation network if and when the network consists of very diverse partners. There are several arguments to substantiate this statement. First, diversity may lead to all sorts of inter-organisational problems, such as communication problems, a lack of trust and opportunistic behaviour. This can greatly hamper coordination and increase transaction costs, and may even result in various competing sub-networks. In addition, diverse alliance partners may experience lower levels of cohesion and commitment in the network and lower levels of social, cultural and cognitive proximity between their partners. These factors can potentially obstruct inter-organisational learning (especially when it comes to sharing tacit knowledge) and thus eventually result in lower levels of innovative output. These arguments combine to produce our hypothesis 3b, rivalling hypothesis 3a:

Hypothesis 3b: South African firms that engage in alliances with strategically diverse partners will have lower levels of innovative output than South African firms embedded in relatively less diverse networks.

Both hypotheses 3a and 3b suggest a linear relationship between partnership diversity and innovation outcomes. There are, however, sufficient arguments to support a non-monotonic relationship – a higher level of diversity only results in higher innovation outcomes up to a certain point, beyond which even higher partnership diversity levels are associated with lower innovation outcome levels. These arguments include the following. First, there is the myopia argument, which suggests that firms have limited capabilities to develop and value their internal knowledge base, making them blind to the opportunities of external partnering (Miller and Chen, 1994). Second, there is the marginal information value argument (Gulati, 1995b; Chung, Singh and Lee, 2000), which suggests that as the availability and diversity of external knowledge resources grows, so does the probability of diminishing returns of knowledge exchange and knowledge sharing, which in turn decreases the probability of higher outcome levels. This argument is a variation on Burt's (1992) redundant ties argument, which states that increasingly diverse inter-organisational relationships do not necessarily imply additional new knowledge and information (cf. Ahuja, 2000). Third, related to the need to continuously monitor the external actors' knowledge bases, firms have limited capabilities and resources available to manage a diverse set of inter-organisational partnerships. Moreover, the empirical findings of Hansen (1999) point to a non-linear relationship between diversity and innovation outcomes. Hansen argues that firms have to make a trade-off between the number of ties and the depth of ties that a business unit can maintain. He suggests that an organisational unit can either have a higher number of shallow ties or a lower number of deep ties, since shallow ties are less costly to maintain. This implies that the number of inter-organisational relationships that a firm can maintain successfully is limited. From a learning and knowledge perspective, one can argue that overly high levels of diversity will be detrimental to innovation outcomes (cf. Parkhe, 1991). Overly high diversity levels force the innovating firm to cope with very diverse and probably unconnected knowledge bases. Combining these effectively is extremely difficult and can impede the production of innovations. The arguments above suggest that:

Hypothesis 3c: There is an inverted U-shaped relationship between the level of partnership diversity and innovation outcomes.

Having built our theoretical framework and deduced the hypotheses, we now turn to the method of this study and the subsequent testing of our hypotheses.

3. Method

Introduction
To test the hypotheses elaborated in the theoretical framework above, this research relies on data collected by the South African Innovation Survey (SAIS) 2001 (Oerlemans *et al.*, 2003). This section and the next present a short summary of the method applied in the SAIS 2001 survey. SAIS 2001 was one of the first comprehensive innovation surveys conducted in SA. Data was collected during 2001/2002 by the University of Pretoria, in collaboration with the Eindhoven University of Technology in the Netherlands. The questionnaire used was modelled after the European Community Innovation Surveys (CIS) conducted in countries of the European Union since 1994. The purpose of the SAIS study was "to get a representative, nationwide overview of the innovative behaviour and performance of South African firms in manufacturing and services

for the period 1998-2000" (Oerlemans *et al.*, 2003:11).

Sample
In SAIS 2001, a stratified random sample of 7039 firms was selected from a commercial database of SA firms, and their representatives were asked to complete the survey questionnaire. Of these representatives, 617 (or 8.4%) completed the questionnaire. A second survey of 462 non-responding firms was conducted. Questions were asked about specific reasons for the non-response and about firm characteristics such as R&D activities. The response to the non-response survey was very high (90%). The reasons given for the initial non-response fell into two categories. It was either because their organisation had not received the questionnaire (52%), or due to a lack of time (33%). One of the questions put to non-responding firms was whether they had achieved technological innovations in the period 1998-2000 and to what extent their R&D activities were of a continuous nature. The same question was of course also put to the responding organisations. A comparison of the response and non-response groups revealed no statistically significant differences. Therefore, the response group can be considered representative of the total population of SA firms and no sample bias occurred. The survey results were further weighted by the Manufacturing Census 1996 (Statistics South Africa (1998)) firm size distribution figures, to ensure that the findings accurately describe innovation and innovative activities in the entire SA industrial base. The survey found that about 58% of all firms in the sample were manufacturing firms, 23% were service providers and 19% were involved in wholesale activities. The majority of firms were small and medium-sized organisations. Only 7% of the firms employed 250 or more employees in 2000. Notwithstanding an average annual sales growth of +2.3% in national terms (not deflated), employment contracted by about 7% during the period 1998 to 2000. About 11% of firms exported 50% or more of their sales. About 81% of the firms were involved in the production of products and services, and about 73% were involved in the marketing, distribution and sales of their own products or services. Of these, 22% used foreign sources of production technology (*e.g.*, production licenses).

Measurements
To test the hypotheses advanced in the theoretical framework of this paper, scores on items of the SAIS 2001 were analysed. This section describes which measurements were used to test the hypotheses.

Dependent variable
Innovation outcome, the dependent variable in our models, was measured as the percentage of total sales accounted for by either products and/or services that were technologically improved or technologically new. This measurement focuses on the tangible benefits of innovation and yields a variable where a score of 0 holds that a firm does not achieve any sales from technologically improved or new products. Higher scores can take any value between 0% and 100%, corresponding to the percentage of sales that firms generated by products and/or services that were either technologically improved or technologically new, *i.e.*, products that were based on innovation.

Independent variables

To test hypothesis 1, one independent variable was computed. Firms were asked the following question: "Between 1998-2000, did your firm participate in innovative partnerships with organisations located in South Africa?". A score of 0 indicates "no partners in SA", whereas 1 indicates "yes partners in SA". Similarly, SA firms were asked whether they participate in innovative partnerships with organisations located in foreign countries. A similar coding scheme was applied. Next, we added both scores to form a new variable. A score of 0 on this new variable thus indicates that the particular firm has no partners in SA or abroad, a score of 1 indicates that the particular firm has either domestic or foreign partners, and a score of 2 – that the firm has both partners in SA and abroad. This variable was again recoded, such that scores of 0 correspond to "no Partners" and scores 1 and 2 were summed together to a new value 1, corresponding to "yes Partners". The final independent variable thus takes the value 0 indicating that this firm has no partners at all (whether in SA or abroad), or a value 1 indicating that the firm does have partners (either in SA or abroad or both).

In order to test hypothesis 2, we again utilised the items testing hypothesis 1, but this time we did not add them to form one compound variable. This thus yields two dichotomous independent variables, which were recoded such that a 0 score indicates "no partners in SA"/"no foreign partners", respectively, and 1 responds to "yes partners in SA"/"yes foreign partners", respectively.

To devise measures of diversity, needed to test hypothesis 3, firms were asked to indicate with which type of partners they allied nationally and internationally, respectively. Possible options were: partners in their own group, buyers, suppliers, competitors, consultants, research institutes, universities or other partners. Firms that ticked many (ideally: all) of these rows, meaning they have alliance partners in all of these strategic groups, were then considered to have a diverse network of alliance partners. Two variables were computed, one indicating the number of SA innovative partners and one indicating the number of international innovative partners. Both variables were divided by the number of possible ties (8) and thus ranged from 0 to 1, with higher scores indicating higher levels of diversity.

Squared terms of both variables are included in our analyses to identify non-monotonic relationships between these variables and innovation outcomes.

Control variables

Although we aim to isolate the effects of domestic and international relationships on innovative outcomes, our line of reasoning and thus our models, would be seriously flawed if we were to exclude the importance of internal knowledge. There is ample evidence in literature that an internal knowledge base is not only a basic building block of innovation, but also a necessary element to absorb external knowledge (Cohen and Levinthal, 1990). To capture this argument, two control variables were included: R&D intensity (investments in knowledge creation and development) and the percentage of higher educated employees (embodied knowledge). R&D intensity was measured as the proportion of employees in the year 2000 whose tasks are

dedicated to research and development activities. Additionally, firms were asked what percentage of their workforce was educated to a tertiary level. The theoretical arguments to include these variables are straightforward. A stronger internal knowledge base both influences the number of inter-organisational ties a firm can maintain and probably has a positive impact on the level of innovation outcomes.

To control for size effects, a variable reflecting firm size in terms of the number of employees in 2000 was included. We expected larger firms to have more inter-organisational relationships and to be able to produce higher levels of innovation outcomes, for example, due to easier market access and larger marketing funds.

4. Results

To test our hypotheses, Ordinary Least Squares (OLS) regression analysis was applied. Our analyses consisted of five steps, as described below. In the first step, a model including only the control variables was estimated (model 1). Next, we tested whether having innovative inter-organisational relationships impacts innovative outcomes (hypothesis 1). In a third step, we investigated whether having either domestic or international collaborative ties matter for innovation outcomes (hypothesis 2a/2b). The diversity hypothesis was tested in the next two models. Model four focused on the impact of having a diverse set of domestic and international innovative partnerships (hypothesis 3a/3b), whereas the fifth model also included the squared terms to check for non-linear association (hypothesis 3c).

To answer the obvious question – why the partner and diversity variables were not combined in one model – an inclusion would cause serious multicollinearity problems.

All estimated models are statistically significant with R squares ranging from 23.1% (model 1) to 29% for model 5. Multicollinearity tests revealed that no problems occurred: the highest VIF (Variance Inflation Factor) is 1.377, which is far below the problematic level, generally set at 2 (Lewis-Beck, Bryman and Liao, 2004). This was also indicated by correlation analyses that showed that the highest correlation coefficient among the independent variables is 0.39, which is well below the generally accepted level of 0.8 (Lewis-Beck *et al.*, 2004). Moreover, as is shown in the last row of Table 1, each addition of a group of variables improves the quality of the models, as demonstrated by the highly statistically significant F-change values.

Table 1. Linear regression results with innovation outcomes as the dependent variable

Independent Variables	Model 1 Baseline model	Model 2 Hypothesis 1	Model 3 Hypothesis 2a/2b	Model 4 Hypothesis 3a/3b	Model 5 Hypothesis 3c
Control variables:					
R&D intensity	0.10**	0.07*	0.08*	0.07*	0.07*
% Higher educated	0.42***	0.34***	0.34***	0.37***	0.35***
Size (ln)	0.13***	0.07*	0.06	0.07	0.05
Innovative partner?		0.25***			
SA partner			0.08*		
Foreign partner			0.22***		
Diversity SA				0.12***	0.29***
Diversity Foreign				0.14***	0.39**
Diversity SA squared					−0.18
Diversity Foreign squared					−0.25**
N =	492	492	492	492	492
F-value	48.985***	47.453***	38.737***	36.376***	28.294***
F-change	n.a.	33.184***	18.196***	13.657***	6.162***
R square	23.1%	28.0%	28.5%	27.2%	29.0%

* $p < 0.10$; ** $p < 0.05$; *** $p < 0.01$, n.a. = not applicable.

The results can be summarised as follows
The results of model 1 show that having a stronger internal knowledge base does indeed benefit innovation outcomes. Higher R&D intensities, and especially higher percentages of higher educated employees, impact positively on innovation outcomes. Moreover, a size-effect is perceptible – the larger the firm, the higher its innovation outcomes are.

Model 2 reveals that having innovation partnerships is beneficial to SA firms. This result confirms hypothesis 1. In model 3, this effect is further specified as we distinguish between having either domestic or international innovation partnerships. It turns out that having international partnerships in particular is associated with higher levels of innovation outcomes. Having domestic partners is beneficial for innovation outcomes too, however both the level of significance and the magnitude of the effect is much smaller (0.08 *versus* 0.22). It can be concluded from these results that hypothesis 2b is confirmed. For both models, it is found that the presence of higher educated employees in the firm is far more important to producing

innovation outcomes than R&D intensity levels.

Hypotheses 3a and 3b proposed a positive and negative association, respectively between levels of diversity and innovation outcomes. The results of model 4 show that hypothesis 3a is confirmed. In other words, more diverse partnership portfolios with both domestic and international organisations are positively associated with higher innovation outcomes. Interestingly, the magnitude of both effects is more or less the same, whereas in model 3 the effect of having international partners was much stronger. The last section of this paper discusses this finding in more detail.

Model 5 tests for non-linear effects and it shows that there is an inverted U-shaped relationship between the diversity of international partnerships and innovation outcomes. This finding indicates that having a more diverse set of international partners is beneficial to innovation outcomes up to a certain point. Beyond this point, diversity generates lower innovation outcomes. However, a similar effect is not found for diverse partnership portfolios with domestic partners. It can be concluded that hypotheses 3c is confirmed for the partnership diversity of international partnerships only.

Conclusions and discussion
This paper reports on an empirical exploration of the impact of (the diversity of) domestic and international innovation partnerships on the innovation outcomes of SA firms. A number of theoretically informed competing hypotheses were tested using a representative sample of 617 SA firms and applying OLS regression analyses. Our findings are summarised in Table 2.

Table 2. Hypotheses and findings

Hypothesis	Theoretical expectation	Empirical result	Conclusion
1: Having partnerships	+	+	Confirmed
2a: Having SA partnerships Having international partnerships	++ +	+ ++	Rejected
2b: Having SA partnerships Having international partnerships	+ ++	+ ++	Confirmed
3a: Partnership diversity (positive/linear)	+	+	Confirmed
3b: Partnership diversity (negative/linear)	–	+	Rejected
3c: Partnership diversity (non-linear)	Inverted U-shape	Inverted U-shape for international partnership diversity	Partly confirmed

A number of interesting results emerged from our research, requiring some interpretations and discussion. As became clear from model 1 (see Table 1), the strength of the internal knowledge base does indeed matter for innovation outcomes of SA firms. However, contrary to results found in several European countries (see for example: the Netherlands: Oerlemans and Meeus, 2005; UK: Freel, 2003) where R&D efforts are highly important to innovation outcomes, SA firms generally tend to profit far more from their higher educated employees. Firstly, these results point to the importance of embodied knowledge for innovation in SA: innovation is truly a human matter that seems less dependent on formalised R&D activities in SA firms. Secondly, our findings may reflect the effects of low R&D investments by SA firms (Blankley and Kahn (2005) report a figure of about 0.8% of GDP for the period 1998-2000), as well as the impact of the brain drain – the emigration of professionals in particular from SA to other countries. For example, Bhorat, Meyer and Mlatsheni (2002) estimate that in the period 1989 to 1997 about 36,300 professionals left the country, which can be considered a substantial loss for the national knowledge resource base.

Our results from models 2 and 3 (see Table 1) strongly support the view that utilising external knowledge resources, that is, inter-organisational networking, is conducive to innovation outcomes. As such, these results for SA are in line with what is found in literature on the impact of direct ties on innovation outcomes (see for example: Ahuja, 2000; Oerlemans and Meeus, 2005). Interestingly, having international partnerships has a stronger impact on SA firms' innovation outcomes than having domestic ones. In the case of SA firms it thus appears that the arguments concerning proximity and the difficulty of sharing tacit knowledge across great distance (hypothesis 2a) carry less weight than the arguments supporting hypothesis 2b. As we interpret these findings, this is due to a combination of factors. First, the specific SA setting is characterised by a relatively low degree of original discovery, and relatively high degree of knowledge replication (Blankley and Kahn, 2004). As noted before, knowledge replication normally demands less costs than knowledge creation, especially with regard to the transfer and implementation of tacit knowledge (Grant and Baden-Fuller, 2004). This implies that, for the type of innovations and the type of products produced by the SA firms in our sample, relatively little of the "hard-to-transfer" knowledge is required (in any case less than for innovations based on original discovery). Instead, innovations are mainly based on codified knowledge that is more readily transferable from distant DC firms. This reduces the adverse impact of transferring tacit knowledge across great distances to achieve innovations, as proposed by hypothesis 2a. The fact that the measure of innovation applied in this study does not distinguish products that are merely new to the (South) African market (based on knowledge originally developed elsewhere) from products that are new to the global market, corroborates this interpretation of the findings.

In addition to the reflections above, the findings regarding hypotheses 2a and 2b can be interpreted as demonstrating the ability of firms to tap into international knowledge flows and to adapt "foreign" knowledge to local conditions ("absorptive capacity"). This then compensates for an internal lack of technological capabilities (low R&D investments). However, a more pessimistic interpretation of this result is also possible. In a case study of the SA automobile components sector, Barnes and Kaplinsky (2000) found that domestic subsidiaries are being integrated into the global strategic operations of their parent companies. This results increasingly in the foreign sourcing of components, thereby restricting opportunities for locally-owned

component suppliers, and practically barring suppliers that use locally developed technology. The ultimate effect is higher dependency on parent companies, foreign knowledge and volatile exchange rates. The explication of these findings can be extended further by taking the domestic partnerships into account. That these partnerships have a smaller impact on innovation outcomes as compared with international innovation partnerships may be due to a lack of trust. After all, many domestic firms come from an economic boycott environment that fostered a culture of secrecy, resulting in low trust levels between domestic firms. Institutional research (Scott, 2001) indicates that culture change is a difficult and time-consuming process, thus it might be that this culture of secrecy still lingers on in the behaviour of a number of SA firms.

Our results from models 4 and 5 clearly indicate that having many diverse partnerships does not seem to result in higher levels of innovation. In other words, it was found that having good relationships is more important than having a great number of such inter-organisational relationships. This suggests, as argued in the theoretical part of this paper, that there are limits to the number of different innovation partnerships an organisation can manage, both from a cost-benefit and from a knowledge processing perspective. This limit is reached in the case of international partnerships, but not in the case of domestic partnerships. How to explain these findings? We believe that the same mechanisms discussed earlier are at work here, namely the effects of cultural and geographical proximity. Research (Owen-Smith and Powell, 2004; Breschi, 2000; Barkema and Vermeulen, 1997) has shown that it is extremely difficult to transfer tacit knowledge in particular across great distances between culturally different partners. As domestic partners are spatially and, in particular, culturally more proximate, this problem does not occur as easily.

The research presented in this paper has some limitations. First, due to a lack of observations, we were not able to control for the influence of sectors, while there are considerable differences between sectors as to their propensity to form technological alliances. Second, Oerlemans, Meeus and Boekema (1998) argue that firms' networking behaviour depends on the nature of innovations they generate. They present empirical evidence showing that incremental innovators tend to network more compared with firms with radical innovations. This calls for controlling models for the nature of innovations produced by SA firms, which was not done in this research. Third, the research does not include indicators for tie strength. Including these would shed some light on, for example, the intensity of knowledge transfer and the level of trust between actors collaborating in inter-organisational relationships. Fourth, ideally the results of research can be generalised to other contexts and situations. This research cannot state to what extent the SA situation resembles that of other emerging economies.

A number of topics for future research can be identified. A first topic follows directly from the above. Including information on tie strength and the nature of the innovations produced would further deepen our understanding of the network behaviour of SA firms. A second suggestion is to compare the results of this research with findings of other sub-Saharan countries or other, comparable emerging economies, for example in Asia or South America. A third avenue of future research could be to investigate the long-term effects of international alliances. After all, it might be that international technological collaboration improves the learning and technological capabilities of SA firms, which would result in a narrowing of the current technological gap. However, as pointed out by Chen and Chen (2002), most alliances between firms in advanced

and emerging economies are of an asymmetric nature. We find that SA firms can profit from the technological knowledge of firms located in developed economies, but what do they lose in the process? If SA firms only get a small part of the profit and market share from the alliance, to what extent is having international alliances beneficial in the long run? Only research covering longer time intervals can answer these questions. As a final topic for future research, we would like to mention the influence of multinationals on the innovative capacity of SA industry. The example of the automotive components industry mentioned above might be applicable to other parts of the SA economy in which multinational firms play a key role. These studies could provide interesting perspectives on how the SA economy and its innovative capacity are affected by internationalisation.

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