Configurations of knowledge transfer relations: An empirically based taxonomy and its determinants

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ABSTRACT

We focus in this study on sets of inter-organizational relationships (IORs) by applying a configurational approach that includes both the diversity and the intensity of knowledge transfer IORs. We use a latent class cluster analysis to empirically explore the kinds of IORs configurations. We then use antecedents derived from the IOR literature to explain firm membership in those configurations. Our tests allow us to identify four configurations ranging from isolated innovators to innovating firms embedded in diverse and deep sets of IORs. We show that internal knowledge use by firms, and the types of innovative activities in which they engage, are strong predictors of firm membership in different configurations.

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1. Introduction

Innovation is essentially the combining, recombining and developing of knowledge. As firms seldom have within themselves all of the knowledge that they need to innovate, they form inter-organizational relationship (IORs) with other independent organizations in an effort to access what they lack. We call IORs formed to access and transfer information that contributes to innovation, knowledge transfer IORs. The value of the knowledge a firm is able to acquire in this way depends on the types of organizations with which it maintains IORs, and the quality of its IORs (Gulati, 1998). IORs may be formal or informal, reciprocal or not. They can serve both as a search engine for knowledge, and as a conduit for it (Gulati, 1998; Powell et al., 1996).

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Many innovating firms[1] are embedded in multiple sets of knowledge transfer IORs of different configurations (Goerzen and Beamish, 2005; Parise and Casher, 2003). While several researchers have shown that IORs substantially influence firm innovativeness (Capaldo, 2007; Schilling and Phelps, 2007; Ahuja, 2000), with a few notable exceptions, IORs configurations remain understudied (Bensaou and Venkatraman, 1995; Gemünden et al., 1996; Hansen, 1999; Ozcan and Eisenhardt, 2009), and there is little agreement on a systematic classification of different configurations of IORs. We address that gap in the contemporary literature. We do that in two separate steps.

We begin by focusing on configurations of inter-organizational relationships that can be distinguished empirically. To arrive at those configurations, we combine two dimensions of sets of knowledge transfer IORs: diversity and depth. For firms seeking to make technological innovations diversity means links with (groups of) for example buyers, suppliers, competitors, consultants, public research labs, universities, innovation centers, and sectoral institutes. As different actors possess or control different types of knowledge and information the combination of actors within a set affects the value of knowledge that can be obtained from it. By depth we mean the importance of the set of knowledge transfer IORs to the firm, that is, the extrinsic value that the firm attaches to it.

This study of IORs configurations has relevance because an innovating firm embedded in a set that includes multiple and diverse external sources of knowledge has informational advantages and access to a broader pool of technological opportunities It also benefits from synergetic effects (Duysters and Lokshin, forthcoming). On the one hand, forming a tie in one type of linkage can strengthen the effectiveness of the existing knowledge transfer ties. On the other hand, because of the amount of time and attention that they may require, participation in a set of knowledge transfer IORs with diverse and deep ties can result in an increase in managerial costs which might lead to inferior results. In our second step, we draw on the innovation and IOR literature, looking specifically at factors central to IORs formation and innovative behavior, to analyze what explains firm membership in each of the configurations we identify.

We contribute to the literature on IORs in several ways. First and foremost, we add to the emerging empirical work on (the antecedents of membership of) IOR configurations by mapping the configurations that may occur. This is important as there has been some evidence that different IORs portfolios yield different innovative and/or organizational outcomes (Capaldo, 2007). By focusing on IORs configurations rather than on dyads, we answer the call for inter-organizational research beyond the dyadic level (see Provan et al., 2007).

Moreover, by deriving propositions based on factors identified in the IOR and network literature and exploring the influence of those factors on firm membership in each of the IOR configurations we identify, we are able to determine which factors have the greatest explanatory power. Combined these contributions result in insights with a high level of external validity and provide valuable insights in a field that has to date been predominantly explored using case studies.

We also add to the emerging literature on the open innovation model (Chesbrough, 2003). According to that model organizations can develop an external orientation and successfully commercialize ideas whether they are generated and developed internally or externally (Lichtenthaler, 2008). Firms following open innovation strategies are more inclined to have links with other kinds of organizations and to actively involve them in their innovation processes (Tether and Tajar, 2008). Focusing on IOR configurations implies that the production of innovation is regarded as a distributed process.

Finally, in addition to our theoretical contribution we make a methodological one by introducing a relatively new, advanced, and highly suitable methodology into research on IORs, namely latent class cluster analysis. This allows us to combine in a single variable information on the diversity of partners, i.e. the different nodes, with whom a firm collaborates and that on characteristics of those relationships, i.e. the importance the focal firm attaches to them.

We continue with a review of the sparse existing IORs configuration literature, and subsequently, draw on several theoretical perspectives on the formation of innovative IORs (Barringer and Harrison, 2000; Oliver, 1990), to derive propositions on the antecedents that lead to different IORs

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[1] While we recognize the importance of managerial, financial and marketing innovations, our study looks specifically at the technological innovations of firms and the knowledge required to achieve it.

configurations. Next, we empirically identify IORs configurations by conducting a latent class cluster analysis on data from the South African Innovation Survey 2001. Following our latent class cluster analysis, we use a multinomial logit regression to analyze which antecedents explain membership in each of the different configurations. Finally, the results of both analyses will be discussed and implications derived.

2. Literature review, theory, and research propositions

2.1. Configurations of inter-organizational relations

To gain access to the resources they need to generate innovations firms can maintain IORs with different characteristics and with different types of actors. Instead of focusing only on what type of ties might provide more or better access to resources, or whether weaker or stronger ties are preferable, a configurational approach focuses on which *combinations of ties* with different types of actors firms use to gain access to the resources they need.

We adopt Meyer et al. (1993: 1175) definition of a configuration, "any multidimensional constellation of conceptually distinct characteristics that commonly occur together". Configurations can be developed conceptually, i.e. typologies, or derived empirically, i.e. taxonomies, and can be situated at multiple levels of analysis, depicting patterns common across individuals, groups, or networks of organizations. Configurational research has extended the available insights with regard to people, groups and organizations (Sinha and Van de Ven, 2005), but little research has been done on configurations at the inter-organizational level (Meyer et al., 1993). In the IORs context, configurations refer to, for example, patterns of combinations of relations with a diverse set of actors with different intensities (Gemünden et al., 1996). In contrast to the configurational approach of Bensaou and Venkatraman (1995), who focus on constellations of characteristics of individual IORs, our configurational approach builds on the extensive case-study work of Uzzi (1996, 1997), who focuses on the production network of a [single] textile manufacturer. Uzzi studies the characteristics of the ties of that manufacturer with a textile mill, converters, retailers, design studios and others. While he looks at one specific IOR configuration, our study distinguishes different IORs configurations within a large dataset.

Despite the lack of a commonly accepted theoretical framework for such configurations, the literature does offer two useful starting points, namely the distinction between the depth of ties in a firm's IORs configuration, often measured by contact frequency and level of cooperation, and the breadth of its IORs configuration ties, that is, the variety of types of actors with whom ties are maintained, and the tradeoff between those dimensions (Ozcan and Eisenhardt, 2009; Laursen and Salter, 2006). Laursen and Salter develop the concepts of breath or diversity, the number of different external knowledge sources, such as suppliers, buyers, competitors, consultants, commercial research institutes, universities, public research institutes, trade organizations and so on, and the depth, the importance the firm attaches to the relationship, as two indicators of receptiveness of firms to outside knowledge. Their empirical results show that the relationship of both dimensions with innovative firm performance is inversely U-shaped. We adopt a similar approach to the measurement of diversity and depth, with two differences. In contrast to Laursen and Salter, we explore the possibility that innovating firms can have different combinations of ties with different types of actors both in terms of diversity and depth, and we investigate why innovating firms are part of certain IORs configurations.

The network cliques literature is related to the concept of IORs configurations (Pieters, 2009), because cliques are "relatively stable groups of firms, more densely interconnected to one another than to other firms in the industry network, and reproduced over time by repeated interactions among a set of firms" (Rowley et al., 2004: 454). That literature argues, among other things that in terms of diversity and inequality, the internal structure of a clique is significant to the performance of its members. The analysis of both IORs configurations and cliques is at an intermediate level between the firm and the industry and beyond the dyadic level. Moreover, both concepts stress the importance of dimensions of diversity for the behavior of actors (see also: Rowley et al., 2005). At the same time there are clear differences. The IOR configuration approach we develop combines actor characteristics in terms of the diversity of types of external knowledge sources with relational characteristics, i.e. tie

depth, and applies the result to innovation. Moreover, unlike network cliques, we do not take indirect ties into account.

In his seminal work Hansen (1999) explicitly addressed the tradeoff between breadth, (the number of ties), and depth of IORs. He argues that shallow ties are especially useful during the search for codified knowledge and its transfer, but that they impede that of complex knowledge as that tends to require deep ties.[2] From that perspective then, deep ties are preferable to shallow ties as an actor with many deep ties would not benefit from additional shallow ties as they would only serve to access knowledge that would be redundant (e.g. Ahuja, 2000).

Time and resources must be devoted to maintaining relationships and processing knowledge that is received. These costs and efforts are especially high with deep ties as they require frequent interaction, often face-to-face, and a higher level of cooperation overall (Hansen, 1999: 85). Large sets of deep ties are not feasible because of the constraints associated with the processing of knowledge, therefore, a combination of a relatively large number of shallow ties and a small number of deep ties are the most effective IORs configuration for knowledge access (Hansen, 1999). Perks and Jeffery (2006) study of the possibility of maintaining large numbers of deep ties yielded ambiguous results.

Hansen's line of reasoning may also be relevant to the viability of a diverse and deep set of knowledge transfer IORs. It might be the case that a diverse set of deep ties with a variety of actors provides an innovating firm with more technological opportunities, a richer set of ideas, more knowledge and information transfer, and the possibility of monitoring developments in different technological fields. At the same time the management of such diverse sets is very challenging. The more diverse and deep the set of knowledge transfer IORs, the more managerial attention and effort is required and the sooner the informational processing capabilities of the firm will become overstretched. Consequently, the disadvantages of a diverse and deep set of knowledge transfer IORs might outweigh the advantages.

Ozcan and Eisenhardt (2009) find in carrying out a case-study analysis that measures depth of ties by frequency of contact and level of cooperation that there are firms that are able to manage deep ties with a large number and variety of partners of which they distinguish four types. Moreover, they find that firms able to manage IORs characterized by such ties are highly successful in terms of survival and growth. However, large-scale empirical research is lacking. Even though it seems logical and promising to distinguish between the diversity and depth of set of IORs, there is no accepted taxonomy of configurations of IORs. Moreover, there is little insight into which kinds of antecedents explain firm membership in such configurations. Nevertheless, existing theoretical perspectives from the fields of organization and innovation studies can be used to draw inferences on the level of the two dimensions of IORs configurations (see for example: Whitley, 2002).

2.2. The antecedents of configurations of knowledge transfer IORs

Primarily knowledge transfer IORs and networks are formed to exploit complementarities between external and internal resources and to reduce uncertainty, and the type of IORs and networks depends on the innovative activities that a firm conducts (see Barringer and Harrison, 2000; Oliver, 1990).[3] These antecedents are rooted in different organizational theories and can often be traced back to more than one of them. Uncertainty reduction, for example, plays a key role in both resource dependence theory and transaction costs theory, whereas the exploitation of complementarities between internal and external resources is addressed in both the resource-based view of the firm, and the absorptive capacity literature. We do not focus on those theories in this paper, rather, we look at the factors that are likely to influence the configuration of innovative IORs a firm maintains. Those factors are the basis for the propositions that we formulate. The propositions serve to guide both our analysis of the

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[2] Hansen (1999) uses the term 'strong ties'. Ozcan and Eisenhardt (2009) define 'tie depth' in exactly the same way. For the sake of consistency, we use 'tie depth' throughout.

[3] In other contexts factors such as legitimacy or necessity are also listed as determinants of the formation of IORs (see Oliver, 1990). However, in the specific case of knowledge exchange and innovation the factors we give here are the ones most often referred to in the literature.

antecedents of IORs configurations and our interpretation of the results of this analysis. We emphasize, however, that it is not our aim to test the theories that we acknowledge above.

2.2.1. Environmental uncertainty

Uncertainty is an important determinant of IOR formation. According to resource dependence theory, for example, firm performance, even survival, is determined by the extent to which it can gain control over critical resources that are either possessed or controlled by other actors (Pfeffer and Salancik, 1978). The more critical those resources are to the firm, the higher its dependence, and the greater the need to gain control over them. Higher levels of dependency create uncertainty, for instance about the steady supply of resources (Boyd, 1990; Pfeffer, 1972). The higher the level of environmental uncertainty, the greater the need of the firm to reduce that uncertainty. This is especially true when the competitive advantage of the firm is based on knowledge intensive production and products. Resource dependence theory proposes two general strategies to cope with environmental uncertainty: buffering and bridging. The goal of buffering strategies is the strengthening and protecting of organizational boundaries, that is, stockpiling or adjusting the scale of the firm's technical core. In this paper we focus on bridging, which is modifying organizational boundaries through boundary spanning or boundary shifting.

Firms seek to reduce uncertainty about the flow of the resources they need. Bridging can increase the reliability of that flow by linking the firm with exchange partners, competitors, and regulators. The wishes to reduce dependence and increase autonomy are the main motivations to bridge. A higher level of environmental uncertainty leads to a greater need for information and knowledge and correspondingly an increase in the need to control the flow of critical resources required for innovation, which requires deeper ties. Deeper ties allow for better monitoring because actors are closer in these ties. Linking with a diverse set of external actors can result in a reduction in the degree of dependence on any one source. An innovating firm interacting in a small set of IORs risks becoming overly dependent on one, or even a few, partners. A solution is to link with a more diverse set of external actors.

Uncertainty is a factor in transaction costs theory as well. According to that theory, higher levels of uncertainty result in higher transaction costs, because of bounded rationality and opportunism. As transacting actors want to economize on transaction costs, they will select a governance structure most fit to the situation. Assuming that transaction frequency is recurrent and asset specificity is at a moderate level,[4] actors will opt for bilateral governance structures, including IORs. According to Williamson (1979: 238) this is a structure characterized by a 'mini-society with a vast array of norms beyond those centered on the exchange and its immediate processes'. Applying transaction cost theory logic, the argument why innovating firms would prefer deep ties in the face of high levels of environmental uncertainty runs as follows. Higher levels of environmental uncertainty cause actors to experience that they are rationally bounded. Firms want to monitor the behavior of the other organizations with which they interact, and deeper ties, that is closer relationships, make it possible for them to observe them more closely. Why would actors prefer a more diverse set of IORs when there are higher levels of environmental uncertainty? Because higher levels of environmental uncertainty make it more difficult to predict the future value of externally acquired knowledge. Interacting with a more diverse set of external actors, increases the number of different technological options and knowledge redundancy is reduced (Baum et al., 2000). These arguments lead us to make the following proposition:

P1a. *The higher the levels of environmental uncertainty, the deeper and more diverse a firm's configuration of knowledge transfer IORs.*

Environmental uncertainty does not affect all firms in the same way, because their perceptions of uncertainty may differ. Indeed, some firms might not perceive uncertainty regardless of its level, whereas other firms might perceive high levels of uncertainty in relatively certain environments

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[4] This would be a typical knowledge transfer situation. After all, if market governance would be applicable, exchange would concern standardized items of no particular value to innovation, whereas hierarchical governance would imply very high levels of asset specificity. These high levels are unlikely to occur as it means that very specific (core) knowledge would be exchanged between actors. Only a few firms would be willing to transfer this type of knowledge as it would impact significantly on their competitive position.

(Beckman et al., 2004). Following this reasoning one should not focus on (objective) levels of environmental uncertainty, but rather on perceived levels of resource dependence at the level of the firm. This leads us to the following proposition:

P1b. *The higher the perceived level of environmental uncertainty, the deeper and more diverse a firm's configuration of knowledge transfer IORs.*

2.2.2. Complementarities between internal and external knowledge

In contrast to the idea that IORs are formed by firms in an effort to reduce uncertainty growing out of their lack of control over resources, the resource-based view of the firm and the related notion of absorptive capacity begin with the notion that the resources and capabilities controlled by a firm are the determinants of its subsequent performance and enable certain firms to outperform others (Barney, 1991; Barney and Hesterly, 1999; Lichtenthaler, 2008). Originally this perspective focused on the quality of the internal resources of a firm and the effects of those resources on firm performance. More recently attention has shifted towards external resource bases as well including a firm's IORs (Dyer and Singh, 1998; Lavie, 2006). By combining complementary resources, firms can collaboratively perform activities that they could not perform alone, thereby overcoming resource-based constraints on performance (Castiaux, 2007; Combs and Ketchen, 1999; Dyer, 1996).

Not all firms are able to combine resources with other firms effectively. Doing so requires high levels of actor-specific absorptive capacity, relatively similar knowledge bases, and IORs characterized by frequent and intense interaction, i.e. deeper IORs (Dyer and Singh, 1998; Lane and Lubatkin, 1998). Thus, firms require a strong internal knowledge base themselves in order to benefit from IORs resource complementarities (Lavie, 2006). Furthermore, the more unique and difficult to imitate firm resources, i.e. the stronger its internal knowledge base, the greater the opportunities to exploit resource complementarities (Berends et al., 2007), and the greater the potential value of IORs (Barney and Hesterly, 1999: 132). Hence stronger and more diverse internal resource bases are positively associated with a more diverse set of external knowledge sources, and indicate that the innovating firm devotes significant resources to knowledge development throughout the firm. As a result the firm can monitor and acquire knowledge from a diverse set of external actors possessing different types of knowledge. Based on this line of reasoning, we propose the following:

P2. *The stronger a firm's internal resource base, the deeper and more diverse its configuration of knowledge transfer IORs.*

2.2.3. Type of innovative activities

Other approaches that are relevant for explaining configurations of knowledge transfer IORs focus on the type of innovative activities that a firm carries out. Interactive learning theory as developed by Lundvall (1988, 1992) is a good example. Such theories explain the relationship between innovative activities and IORs primarily by the complexity and scope of these innovative activities. Innovation is conceptualized as a knowledge-based commodity, and a (Schumpeterian) transitory interpretation of innovation profits is utilized. Firms need to acquire and protect knowledge to innovate and thus to profit from innovation and so they build IORs to access and have control over knowledge. While interactive learning theory and resource complementarities argument both view knowledge as a resource, the two differ fundamentally differ in the sense that the latter is centered on the possession of knowledge, whereas the former is concerned with the use of knowledge.

The scope of a firm's innovative activities impacts its IOR configuration as not only technical activities but also process, market, and organizational innovations require diverse knowledge inputs. The more diverse a firm's knowledge needs, the lower the likelihood that it or any given individual partner will possess all the required resources (Gopalakrishnan and Bierly, 2001). Thus, firms with a broad set of innovative activities are expected to maintain a more diverse set of IORs configurations. Moreover, besides getting access to a diverse range of knowledge, firms with a broad scope of innovative activities also utilize this knowledge, that is, they are able to find more productive applications for any given knowledge. It is likely that such firms value highly the knowledge that they

obtain from a diverse set of partners and invest in their relationships with them, and in the end form deeper IORs. Based on this reasoning, we propose the following:

P3a. *The broader the scope of the innovative activities of a firm, the deeper and more diverse its configuration of knowledge transfer IORs.*

Besides the scope of the innovative activities of a firm, the level of newness of the innovative activities of a firm will impact on its configuration of IORs as well. More radical types of innovative activities require new communication codes and routines which have to be developed by trial and error. This requires more intense interaction between actors than incremental innovations do (Meeus and Faber, 2006: 74–75). This implies that the more radical the innovative activities of a firm, the more important factors like trust, a common language, frequency of contact, and mutual friendship are (Johnson et al., 2002; Saviotti, 1998). In other words, the more radical the innovative activity of a firm, the greater the need for deep ties for knowledge exchange because the need for more detailed and tacit knowledge is greater. Because innovations are in essence new combinations of knowledge, radical innovations are likely to require especially new knowledge from a variety of different types of partners (Castiaux, 2007). The more diverse the knowledge inputs, the greater the likelihood of very new combinations emerging. Similar to the scope of innovative activities, this line of reasoning brings us to the following proposition:

P3b. *The more radical the innovative activities of a firm, the deeper and more diverse its configuration of knowledge transfer IORs.*

3. Data, measurement, and methodology

3.1. Data

We tested our propositions using data gathered through the South African Innovation Survey 2001 (SAIS2001). The SAIS2001 questionnaire is based on the European Community Innovation Survey, adapted for South Africa (see Oerlemans et al., 2006). The firms in the population surveyed were all South African, in manufacturing and services, had 10 or more employees, and were economically active during the 1998–2000 period. The Reedbase Kompass database (August 2000 version) was used as a sampling frame. The database contains 16,931 South African firms for which the number of employees was known. Stratified sampling was used as a sampling technique. The population of firms was divided into three different size classes (strata): 11–20 employees; 21–50 employees; more than 50 employees.

The survey was mailed to 7,339 firms of which 8.4% responded. This is a low response rate, but not uncommon for organizational research (c.f. Baruch, 1999). Nevertheless, the large number of firms that did not respond raises the question of sample bias. As a follow up, we conducted telephone survey of 462 non-respondents. In those conversations, we asked specifically why the firm chose not to respond to the survey, and also asked about some firm characteristics, for example R&D activity. The response rate to this telephone survey was a very high 90%. These firms were asked whether they had technological innovations during 1998–2000 and with what frequency they conducted R&D. The same information was gathered using the written questionnaire, allowing us to compare firms that responded to the original survey sent by mail and the non-responding firms that were approached by telephone. See Table 1 for the results of that comparison. As shown in the table, there were no statistically significant differences between survey respondents and non-respondents.

Table 1
Non-response analysis.

Variable	Respondents	Non-respondents	Difference	Significance
Continuity of R&D activities				
More or less continuous R&D	37%	40%	3%	0.46[a]
Occasional R&D	29%	29%	0	
No R&D	34%	31%	−3%	
Firms with technological innovations	54%	58%	4%	0.17[b]

[a] Mann–Whitney *U*-test.
[b] Phi-test.

To further substantiate the representativeness of the data, we compared population estimates of the survey with external estimates produced by Statistics South Africa, the South African Central Bureau of Statistics. All of the estimates based on the SAIS-database were very close to the external estimates. In particular, our population estimate of the yearly growth in employment in the period 2000–2003 is 1.2%. This is exactly the same figure as that provided by Statistics South Africa. These findings give us reason to believe that the external validity of our survey results is high. Based on the non-response analysis and the comparison of population estimates, the response group can be considered as representative of the total population of South African firms, which implies that the data is likely to be unbiased despite the relatively low response rate.

Ultimately, our database contains information on 617 firms, and we selected for analysis 322 of them which reported having conducted innovative activities, whether successfully or not. The 322 firms we analyzed were not necessarily engaged in IORs. Only firms with innovative activities were selected because all the theoretical mechanisms discussed earlier use the need to acquire (control over) resources for innovative activities as the driver of IOR configurations. We chose to include firms with innovative activities, but without IORs, based on previous research that has shown that there is a group of innovators that "go it alone" (Oerlemans et al., 1998). This implies an "empty" IOR configuration which serves as a reference group.

3.2. Measurement

To construct IOR configurations, we asked firms to use a list of eight different types of actors, buyers, suppliers, competitors, consultants, public research labs, universities, innovation centers, and sectoral institutes, ranking the importance of each type of actors to their innovative activities. Possible answers ranged from (0) of no importance to (3) very important. On the basis of the responses to this question, the configuration of IORs can be constructed in which relations with (groups of) buyers, suppliers, competitors, consultants, public research labs, universities, innovation centers, and sectoral institutes (to indicate diversity) as well as the depth of these relations (indicated by importance) can be discerned. In essence, the configurations of IORs represent self-reported influence ego-networks. A similar approach was used by Laursen and Salter (2006).

This operationalization of IORs and their intensity entails several limitations. First, it does not allow us to identify individual IORs, but only the aggregated existence of IORs with a certain type of actor. Moreover, at this aggregated level, we only have information on the intensity of IORs with that group of actors, which is only one of the dimensions of tie depth distinguished in the literature. We used this approach, which we adopted from the European Community Innovation Survey, because data collection problems become exceedingly large when firms are asked about characteristics of more than one IOR. Other researchers that have tried to do so, for example by utilizing name generators, have been plagued by dramatically high levels of missing data. Moreover, to keep the survey reasonable in length it was not possible to include questions about all of the possible characteristics of IORs in detail. The research approach we used allowed us to collect large-scale data and, thereby, derive more externally valid results.

Following Boyd (1990), we measured the uncertainty of the organizational environment by the munificence and dynamism of the sector (NACE, 2 digit) in which the firm has its main activities.[5,6] Munificence is a measure of the abundance of resources in the environment of the firm, where greater scarcity of resources, i.e. lower levels of munificence, implies greater uncertainty. Dynamism is a measure of the volatility of the environment of the firm, where higher levels of volatility imply higher levels of uncertainty. Munificence is measured as the regression-coefficient resulting from a regression analysis of time against industry sales divided by the mean value of industry sales, and dynamism by the standard error of the coefficient of the same regression model divided by the mean value of industry sales.

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[5] Boyd (1990) uses an indicator for environmental complexity as well, namely the Herfindahl-index. However, this data is only available for manufacturing sectors in South Africa. We chose not to include environmental complexity as a variable rather than restricting the analysis to manufacturing firms.

[6] We used monthly sales data (corrected for inflation but not seasonally adjusted) on the 2 digit NACE sector level, ranging from 01-01-1998 to 31-12-2000 to estimate these coefficients. These data were obtained from Statistics South Africa (http://www.statssa.gov.za/).

We measured perceived levels of uncertainty by asking respondents whether or not they experienced uncertainty with regard to the access to financial resources, market information, or technological knowledge in their innovative activities.

Furthermore, we use three variables to measure the strength of a firm's resource base, namely the percentage of its total workforce engaged in R&D, the percentage of the workforce with a tertiary or higher education, and the use of internal firm knowledge. This last variable is a standardized sum score of the importance of six different internal knowledge utilization functions ranging from (0) no importance, to (3) very important.[7] Of these three measures, the first two represent the presence of internal knowledge. The share of highly skilled employees is included in addition to R&D intensity because both small firms and service sector firms are less likely to carry out formal R&D (Brouwer and Kleinknecht, 1996). For such firms, the share of highly educated personnel is a more appropriate measure of the presence of internal knowledge. The third measure of the internal knowledge base measures the utilization and diversity, rather than the presence, of the internal knowledge base. That measure is included since simply having access to many resources is not sufficient to generate innovations; their utilization is required as well.

The radicalness of innovative activities is often depicted on a scale ranging from incremental to radical, on which radical stands for paradigmatic technological change impacting on large parts of the economy (Dahlin and Behrens, 2005). Such an approach is not applicable when doing firm-level research for two reasons. First, the generation of truly radical innovations is extremely rare so using that definition could lead to having no observations at the top end of the scale. Second, the definition calls for an "objective" macro perspective in which external experts determine the level of newness of an innovation and the related economic and societal impact. Basically the definition is inapplicable when conducting large-scale firm-level research. Therefore we measure the radicalness of the innovative activities of a firm by a dummy variable that takes the value of '1' if the responding firm has introduced a product that was new to the market as a whole over the last 2 years, and '0' in all other cases.

In addition to the measure of external radicalness, we measure internal radicalness by asking firms the extent to which their innovative activities change existing firm processes and routines. The internal radicalness measure grows out of the argument that especially those innovations that erase existing routines require deep and diverse configurations of IORs.

We measured the scope of the innovative activities of a firm by asking firms whether or not their innovative activities touched upon a wide range of issues, ranging from technological innovation to marketing and reorganizations to which respondents could answer yes or no. We summed the scores of the responses and used that to measure of the scope of firm innovative activities.

The measures of innovative activity, especially those based on innovative output, can introduce some endogeneity issues because the innovative output of a firm both influences, and is influenced by, its IORs configuration. However, that potential endogeneity issue is dampened by the fact that there is a sizeable time-lag between innovation inputs, that is, activities and innovative outputs. Therefore, it is unlikely that the innovative output of a firm, as measured here, is influenced by its current IORs configuration, as both are measured at the same point in time.

Finally, as larger firms generally have stronger cash flows, higher assets as collateral for loan, and wider access to knowledge and human capital skills, we include firm size as a control variable. We measure firm size as the natural logarithm (ln) of its number of employees. Moreover, enter three dummy variables for service firms, as opposed to manufacturing firms, South African-owned firms, as opposed to foreign-owned firms, and affiliated firms, as opposed to independent firms as controls.

3.3. Descriptive statistics and multicollinearity diagnostics

We report the descriptive statistics and all of the bivariate correlations between the variables used in the analyses in Tables 2 and 3. Table 2 reports this information with regard to the variables used to construct the IOR configurations. It shows that knowledge transfer IORs with buyers, suppliers, and

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[7] Namely: (1) purchasing function, (2) marketing function, (3) research function, (4) development function, (5) engineering function, and (6) production function.

Table 2
Descriptive statistics of the IOR-variables.

		Mean	Stdev	Bivariate correlations[*]						
				1	2	3	4	5	6	7
1	Buyers	0.91	1.02	–						
2	Suppliers	1.11	1.07	0.40	–					
3	Competitors	1.23	1.03	0.29	0.35	–				
4	Consultants	0.71	0.95	0.26	0.23	0.18	–			
5	Public research labs	0.43	0.80	0.19	0.17	0.14	0.36	–		
6	Universities	0.44	0.81	0.27	0.26	0.31	0.33	0.51	–	
7	Innovation centers	0.26	0.63	0.26	0.12	0.24	0.29	0.43	0.49	–
8	Sector institutes	0.41	0.74	0.36	0.26	0.27	0.35	0.38	0.35	0.44

[*] All correlations are significant at the 1% level.

competitors are the most important types of IORs for firms as they have the highest mean values. The fact that all of the variables in this table correlate significantly indicates that the depth of IORs with different types of actors are not independent. However, none of the correlations are of such high level that they can be said to measure the same phenomenon.

Table 3 gives descriptive statistics for the independent variables and their bivariate correlations used in the multinomial logistics regression. All bivariate correlations are well below the threshold levels at which multicollinearity becomes a problem (Verbeek, 2004). We found high correlations between the different variables that measure perceived levels of uncertainty at the firm level, but these correlations are not problematic from a multicollinearity perspective. The correlation between "dynamism" and the service sector dummy seems high, but this is largely due to the fact that these variables are measured at the sectoral, rather than at the firm level, and that one of the variables is a dummy. When the appropriate measure for correlations between such variables is used, Eta for nominal by interval for instance, the correlation drops to 0.68, which is not problematic from a multicollinearity perspective.

3.4. Methodology

We use two different statistical techniques to analyze the data. First we performed a latent class cluster analysis on the IOR-variables to construct the dependent variable for the subsequent analyses. Latent class analysis is a statistical method for finding subtypes of related cases (latent classes) from multivariate numeric or categorical data on the basis of a maximum likelihood (Hagenaars and McCutcheon, 2002). This method provides a more reliable estimation of configurations than standard cluster analysis (e.g. Gemünden et al., 1996) as it requires no assumptions about the distribution of the clustering variables. Whereas normal cluster analysis assumes normally distributed continuous variables, latent class cluster analysis can also deal with nominal and ordinal variables. Moreover, standard cluster analysis does not provide an objective measure of the number of clusters that best fit the data. Instead, the user often has to specify either a priori or post hoc the number of appropriate clusters, making such methodologies less suitable for exploratory analyses. In latent class cluster analysis, a ML-algorithm classifies cases into clusters based upon membership probabilities estimated from a parametric model (Magidson and Vermunt, 2004). Therefore, it is highly suitable for the construction of taxonomies of multidimensional concepts, such as configurations of IORs. See Berg Jensen et al. (2007) for another recent application of this methodology.

We performed the latent class cluster analysis by applying LatentGold 3.0 software (Vermunt and Magidson, 2003). The analysis begins by fitting a baseline model for one latent class only. If this one-class solution does not fit the data well, the analysis incrementally adds latent classes to the model until the model fit is adequate. As a result the smallest number of latent (unobservable) classes that is sufficient to account for the relationships among the manifest (observed) variables is found. Model fit is determined on the basis of log likelihood (LL) criterion, in this case the Bayesian information criterion (BIC). The BIC provides information about the explanatory power of a model relative to the

Table 3
Descriptive statistics of the independent variables.

Nr	Variable	Mean	St.dev	Partial Correlations													
				1	2	3	4	5	6	7	8	9	10	11	12	13	14
1	Size (ln)	5.02	1.67	–													
2	Service sector firm	0.25	0.43	−0.02	–												
3	South African firm	0.84	0.37	0.01	0.02	–											
4	Affiliated firm	0.68	0.47	**−0.14**	−0.02	**0.13**	–										
5	Munificence	2.75	1.27	−0.01	0.10	−0.11	−0.03	–									
6	Dynamism	0.94	0.45	−0.05	**−0.78**	−0.02	0.05	0.01	–								
7	Financial uncertainty	0.61	0.96	0.01	0.01	0.06	−0.11	−0.10	0.02	–							
8	Market uncertainty	0.47	0.84	−0.01	0.00	0.06	**−0.12**	−0.07	0.01	**0.65**	–						
9	Knowledge shortage	0.63	0.99	**0.12**	−0.03	0.02	**−0.11**	**−0.12**	0.01	**0.53**	**0.44**	–					
10	R&D intensity	0.00	1.00	**−0.35**	−0.03	0.07	0.03	0.00	−0.01	0.10	**0.12**	0.00	–				
11	Highly educated personnel	0.00	1.00	−0.08	**0.31**	−0.03	−0.04	0.01	**−0.31**	−0.01	0.03	−0.04	**0.26**	–			
12	Internal knowledge utilization	0.61	1.00	**0.13**	**−0.17**	0.02	−0.11	0.00	0.11	0.07	0.10	0.07	0.03	0.00	–		
13	Radical innovative activities (product)	0.43	0.50	−0.11	−0.07	−0.01	−0.05	−0.01	0.09	**0.11**	0.09	0.06	0.08	0.02	**0.19**	–	
14	Radical innovative activities (internal)	5.06	1.89	0.10	−0.06	−0.08	−0.01	0.04	0.08	−0.02	0.06	0.03	0.05	**0.13**	**0.28**	0.09	–
15	Scope of innovative activities	2.60	1.26	**0.24**	0.09	−0.03	−0.10	0.02	−0.06	**0.14**	**0.15**	**0.11**	−0.07	0.01	**0.22**	0.05	**0.30**

Significant correlations presented in bold.

Table 4
Cluster selection.

Number of clusters	Model fit (BIC)
1-Cluster solution	5293,8559
2-Cluster solution	4942,2767
3-Cluster solution	4872,9409
4-Cluster solution	**4872,5662**
5-Cluster solution	4900,4147

number of parameters that has been used. The lower the BIC, the better the fit (Magidson and Vermunt, 2004).

The results of the latent class cluster analysis allow us to assign, firms to IOR configurations. However, since no assumptions about the underlying clustering variable have been made, membership in each of these clusters has to be treated as a separate dependent variable. As there are more than two clusters and they cannot be ranked on a single dimension, multinomial logistic regression has to be used to explain membership in these clusters. Besides the fact that the dependent variable is not restricted to two values, this procedure is highly similar to a (binary) logistic regression.

4. Results

4.1. Dependent variable: configurations of knowledge transfer IORs

Our latent class cluster analysis reveals that a four clusters solution has the lowest BIC (see Table 4) and hence fit the data best.[8] The clusters incorporate 38% (124), 31% (99), 26% (82), and 5% (17) of all firms, respectively. Fig. 1 shows all four configurations with the depth of IORs on the vertical axis and the type of actor on the horizontal axis.

The first configuration incorporates firms that have IORs of moderate depth with buyers, suppliers, and competitors, but virtually no IORs with other actors. It appears that this configuration is preferred by a relatively large number of domestic firms, but we found no clear pattern in firm size or sector. As firms using this configuration are only engaged in IORs, whether vertically or horizontally, in a branch of their own industry, we label it the "business configuration". It can be categorized as non-diverse and shallow.

The second configuration consists of firms that have IORs with almost every type of actor. Almost all of the IORs are of moderate depth, with the exception of IORs with innovation centers and sector institutes which are shallow. Thus we categorize this configuration as the "diverse and shallow configuration". For the most part the relatively large manufacturing firms are likely to have such IORs.

The third configuration consists of firms that are not engaged in IORs, or that have ties with competitors and consultants that are extremely shallow. For the most part these firms "go at it alone". We label the configuration the "lone innovator". Frequently foreign-owned firms have this kind of IORs.

Finally, the fourth configuration is made up of firms that have relatively deep IORs with all types of actors. Even though the depth of the IORs differs somewhat between different types of actors, the ties in this configuration are deeper than in any of the other configurations with the average depth of IORs between this configuration and the "diverse and shallow configuration" being statistically significant for all types of actors. The difference is exactly the same for all type of actors with the exception of the tie depth with universities for which the difference between the two configurations is even larger. We label this configuration the "diverse and deep configuration". This configuration is dominated by relatively large, domestic service firms.

Our findings support those of Ozcan and Eisenhardt (2009), namely that there are firms that maintain diverse and deep configurations of IORs. That such a configuration occurs is an interesting

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[8] This solution has a classification error of 8.3% and an *R*-squared of 81.9%. Even though these criteria provide information regarding the fit of the cluster solution, the goal of a latent class cluster approach is not to minimize classification error or maximize explained variance. For example, a single cluster solution would per definition yield a classification error of 0%.
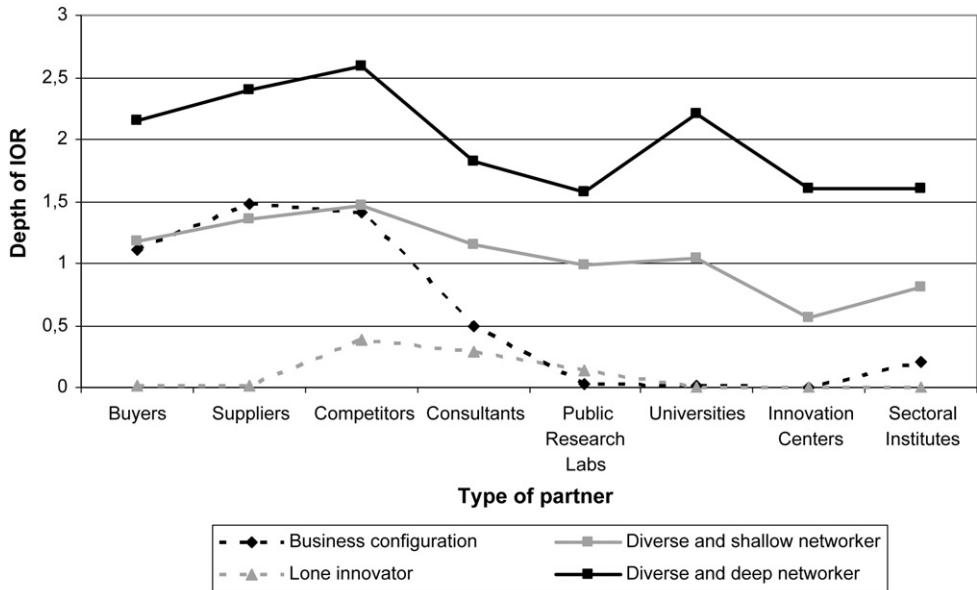
Fig. 1. Configurations of IORs.[9]

finding, nonetheless it does not provide information about what kind of firms use such a configuration. To generate insights regarding this issue, we estimate a multinomial logistic model to explain which antecedents explain firm membership in each of the four configurations.

4.2. The antecedents of membership of configurations of knowledge transfer IORs

Table 5 reports the results of this multinomial logistic regression with the "lone innovator" configuration as the reference group. The model is highly statistically significant with a pseudo R-squared of 42.5%. Whenever differences between configurations other than in comparison to the reference group are discussed, these differences have been checked for significance ($p < 0.05$). For the sake of parsimony we report in this paper only the model with the "lone innovator" as a reference group, and we refer to it simply as "the model". The results of other models are available from the authors.

Our results indicate that while the abundance of resources in the firm's environment, i.e. the level of munificence, has no effect on the configurations of IORs maintained by firms, higher levels of environmental volatility, i.e. dynamism, are positively associated with membership in the "diverse and deep" configuration. However, the effect is limited to the "diverse and deep" configuration. This supports proposition P1a in which we indicate that higher levels of perceived environmental uncertainty are related to more diverse and deeper IOR configurations.

Regarding the effects of perceived levels of uncertainty, the results show that firms that perceive high levels of financial uncertainty are more likely to be members of shallow IOR configurations. This implies that perceived financial uncertainty predominantly induces firms to engage in relatively shallow IORs. It is not surprising that financial uncertainty is not associated with membership of deep(er) IOR configurations, because financial commodities are commonly exchanged in highly regulated markets and contracts, which do not require extensive collaboration between the exchanging parties.

The results provide evidence that higher levels of internal knowledge use are associated with membership in both more diverse and deeper IORs configurations. This is shown by the size of the

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[9] The lines that connect IORs with different types of actors are only included to illustrate the different configurations of IORs and carry no further meaning of their own.

Table 5
Antecedents of firm membership in IOR configurations.

	Configuration 1[a]	Configuration 2[a]	Configuration 4[a]
	Business configuration	Diverse and shallow configuration	Diverse and deep configuration
Constant	−2.196[*]	−2.891[**]	−14.869[***]
Controls			
Size (ln)	0.020	0.230[*]	0.467[*]
Service sector firm	−0.050	−0.732	4.183[***]
South African Firm	1.095[**]	0.703	2.795[**]
Affiliated firm	0.335	−0.224	−1.500[*]
Environmental uncertainty			
Munificence	0.034	0.165	−0.200
Dynamism	0.392	0.163	3.437[***]
Perceived uncertainty			
Financial uncertainty	0.770[***]	0.622[**]	0.012
Market uncertainty	−0.219	−0.121	0.276
Knowledge shortage	−0.318	−0.251	−0.829
Internal knowledge base			
R&D intensity	−0.011	0.135	−0.287
Highly educated personnel	−0.065	0.135	0.710[**]
Internal knowledge utilization	0.817[***]	1.157[***]	2.541[***]
Innovative activities			
Radical innovative activities (product)	−0.016	0.405	0.777
Radical innovative activities (internal)	0.005	−0.029	0.021
Scope of innovative activities	0.050	0.329[**]	1.195[***]
R-Squared[b]			42.5%
−2LL			610,094
−2LL restricted			761,799
Significance			0.000

[a] With cluster 3 (lone innovator) as the reference group.
[b] Nagelkerke's pseudo *R*-square.
[*] Significant at the 10% level.
[**] Significant at the 5% level.
[***] Significant at the 1% level.

coefficient of this variable which monotonically increases over model of the different the configurations. Moreover, higher percentages of highly educated personnel are associated with "diverse and deep" configuration membership. Both of these findings are indications that more diverse and deeper IORs configurations require stronger internal knowledge bases, which is in line with the absorptive capacity and resource complementarities arguments put forward in proposition P2 (Lane et al., 2006). Interestingly, the variable that captures the use of the internal knowledge base, which is "internal knowledge use", has a strong effect on firm membership in the different IORs configurations, whereas the variables that measure the presence of internal knowledge, which are R&D intensity and percentage of highly educated personnel, have a much smaller impact, or none at all. This indicates that having knowledge is not enough to sustain diverse and deep IORs configurations, rather that putting that knowledge to use is also required.

We found no significant results related to the radicalness of innovation. However, our findings do support proposition P3a in which we state that the broader the scope of innovative activities, the more diverse the IORs configurations. The effect is strongest and most significant for membership in the "diverse and deep" configuration, indicating that the scope of innovative activities that a firm carries out is indeed related to both the diversity and depth of its IORs configurations.

Finally, the model reveals that firm size is positively associated with membership in configurations which have diverse IORs, i.e. configurations two and four, but not with membership in the non-diverse configurations. We conclude that larger firms are able to engage in more diverse IORs than their smaller counterparts. Most likely these is because larger firms have more resources at their disposal

and so are able to invest in inter-organizational collaborations, and they also have a larger capacity for processing incoming knowledge than their smaller counterparts. Moreover, the other control variables reveal that service sector firms are more likely to be engaged in a "diverse and deep" configuration while South African-owned firms are more likely to be engaged in "business" and "diverse and deep" configurations. Finally, affiliated firms are less likely to be a member of a "diverse and deep" IOR configuration, probably because affiliated firms are less dependent on external organizations for knowledge as they can tap resources from other members of the group.

The findings about the antecedents of configuration 4 are especially striking. We show in Table 5 that it is highly probable that service sector firms will seek to have diverse and deep IORs configurations, that is, being member in configuration 4. Indeed we found that this is especially true for knowledge intensive business services (Hipp and Grupp, 2005), for instance, firms active in business and management consultancy, R&D and engineering and technology consultancy. The very nature of those activities implies that such firms acquire and process external knowledge which is then transformed into tailor-made research and recommendations for their customers, and this calls for a diverse set of deep IORs.

We discuss the implications of these findings in the following section.

5. Discussion

This research set out to provide a classification of configurations of innovative IORs and the determinants of firm's membership of these IORs configurations. Our configurational approach has yielded new and valuable insights into the existence of IORs configurations and their characteristics. We asked if firms are able to maintain a diverse set of deep IORs and found that in reality there are "diverse and shallow" and "diverse and deep" configurations. A distinction between the two configurations can only be made by an approach in which both the diversity as well as the depth of ties is incorporated in a single dependent variable.

Our results show that the configurational approach can be fruitfully applied to the IORs used for innovation. This approach is especially suitable for dealing with the inherent multidimensionality of this field of research as it allows for the integration of these dimensions into a single, coherent, categorization of configurations. Moreover, the latent class cluster methodology is a suitable technique that makes it possible to use the configurational approach over a broad range of data-types and variables with a minimum number of assumptions.

We conclude that the most significant factor that determines a firm's choice of IORs configuration is the level of internal resource use. We found too that the scope of a firm's innovative activities is also significant. These findings provide strong evidence for a resource complementarity and absorptive capacity explanation of IORs configurations. Thus, a strong internal resource base allows a firm to be an attractive partner and to successfully exchange and utilize knowledge through IORs (Steensma, 1996). Our research, then, provides still more evidence for the relatively recent attention to external resource bases in the resource-based view of the firm (e.g. Lavie, 2006). Furthermore, the fact that firm R&D intensity is not significantly related to any of the configurations indicates that in-house R&D is not required for a strong internal resource base, but that internal knowledge use is required to generate the required absorptive capacity (Cardinal and Hatfield, 2000; Lane et al., 2006).

Our results on the types of innovative activities that a firm carries out reveal that a wider scope of innovative activities requires a wider range of knowledge inputs from various types of actors. The broader the scope of a firm's innovative activities, the more likely it is that the firm will need knowledge from different fields of expertise, and so the more likely that it will seek membership in a "diverse and deep" IORs configuration. In other words, the firm will collaborate with partners which are technologically distant. In order to facilitate successful knowledge exchange in such relationships, deep ties are often necessary (Knoben and Oerlemans, 2006).

High levels of environmental uncertainty are also associated with firm membership in "diverse and deep" configurations. We found that perceived uncertainty over financial issues is associated with membership in "shallow" IORs configurations, whereas other types of perceived uncertainty do not have a significant influence. The relatively small impact of perceived uncertainty on IOR configuration membership is somewhat surprising, as many previous studies on tie formation at the dyadic level

have found uncertainty to be a good predictor of tie formation (e.g. Gulati, 1995, 1999; Van de Ven and Walker, 1984). It is possible that uncertainty triggers dyadic tie formation, but that uncertainty alone is not a sufficient explanation for the sets of IORs in which firms are embedded. It should be noted that forming IORs is only one of the possible mechanisms organizations can use to cope with uncertainty. Therefore, the relatively low explanatory power of uncertainty in this context in no way undermines the theoretical perspectives from which this variable has been derived.

We conclude that the explanatory value of factors that reflect the value of interaction, i.e. resource complementarities, and the types of knowledge that are required for a firm's innovative activities, i.e. broad range of innovative activities, is especially strong in explaining firm membership in certain IORs configurations. Thus, it is not purely the lack of resources or the need for control over resources that determine the overall pattern of IORs maintained by a firm, but rather the desire to access diverse sources of knowledge that are complementary with the knowledge it already possesses. This means that, especially when it comes to innovation, future research should not focus only on a firm's shortcomings or deficiencies but rather on the strength and use of resources that it possess and how they can be complemented by external resources.

6. Limitations and directions for future research

Like all studies, this one has limitations. First, there is some tension between the need to generalize from our empirical results, and the theoretical positions taken by other innovation studies. There are limitations to the extent to which county-specific findings can be generalized because there are national differences in the institutions that impact innovation processes (Lundvall, 1999; Whitley, 2002). Previous research (e.g. Blankley and Kahn, 2005) has shown that the South African system of innovation seems to be characterized by imitation, with local firms improving products and processes with imported technological knowledge and with a considerable part of the revenues flowing to companies outside South Africa, making the country a technology colony. Firms following such imitation strategies are less likely to collaborate with organizations that develop new knowledge such as universities and public research institutes. This is reflected in the data. Relatively few firms reported that universities or other research institutions were very important to their innovative activities, and a low percentage of firms maintain diverse IORs configurations. This is also likely to be behind the relatively large percentage of firms selecting the "business configuration" and also the importance attached to competitors as sources. While some studies found a low propensity to collaborate with universities and research institutions also in the case of highly developed economies (Fontana et al., 2006), it is unclear whether our findings are applicable to highly developed and industrialized countries. Generalization to regions where firms are mostly imitators seems plausible, but replication of this research using data from other regions is required before broader generalizations can be made. This being said, the context of the empirical research also has its strengths. That "diverse and deep" configurations of IORs are found even in the South African context provides strong support for the conclusion that "diverse and deep" IORs configurations are indeed maintained by firms.

Second, the measures of the diversity and depth of IORs in this paper are limited because of the constraints inherent in large-scale data collection by survey. Only groups of direct ties have been measured, and only one dimension of tie depth incorporated. As a result no distinction can be made between firms that have IORs with, for example, one supplier and firms that have IORs with multiple suppliers and as both the number of alters and the ties between alters are unknown, it is impossible to calculate diverse measures of network structure, e.g. centrality. As a result of the latter, the depth of a tie is determined solely by its perceived importance, whereas other factors have been identified in the literature, e.g. trust, contact frequency, and so on. Moreover, the importance of a certain type of actor for a firm's innovative activities is likely to be an aggregate of the importance of several individual actors. Including more dimensions of tie depth and collecting this data for individual IORs would allow for a more fine-grained distinction between different levels of tie depth and so might reveal more subtle differences between configurations of IORs as well.

We believe that obtaining more detailed information on the diversity and depth of sets of IORs would be a particularly fruitful exercise as it would allow for a research approach that merges a relational and a structural approach to IORs. Several researchers have argued that IORs provide

benefits to firms through two distinct mechanisms, namely relational and structural embeddedness (Granovetter, 1992; Gulati, 1998). However, previous research has predominantly focused on either relational or structural embeddedness, rarely on both simultaneously (Borgatti and Foster, 2003), whereas doing so could prove very interesting. For example, future research could find out whether and how the diverse configurations of IORs are linked to other configurations. In this respect, Burt argues that either locally cohesive networks, or diverse external contacts have a positive effect on firm performance, but that a combination of locally cohesive groups, i.e. diverse and deep configurations of IORs, with diverse external contacts yield maximum performance (Burt, 2005: 139). This hypothesis could be tested by linking different configurations of IORs to each other.

Finally, future research could focus on the consequences of membership in different IORs configurations. We have shown that deep and diverse configurations of IORs indeed do exist and also identified what kinds of firms will be members of which kinds of configurations. This does not necessarily imply that such configurations are beneficial to the participating organizations. Moreover, it might be that different configurations of IORs are suitable for different kinds of innovation (Perks and Jeffery, 2006; Whitley, 2002). However, future research might look at the impact of membership in different configurations on organizational outcomes, for instance on different types of innovation. More research is needed to provide conclusive answers to such questions, and many others about the outcomes of membership in different IORs configurations. The results presented in this paper can serve as a foundation for future exploration by providing a theoretically relevant and methodologically sound classification of different IORs configurations.

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