



# The structural, relational and cognitive configuration of innovation networks between SMEs and public research organisations

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## Abstract

This article explores the gap within the extant literature regarding the effectiveness of innovation networks comprising small firms and public research organisations (PROs). By integrating the knowledge-based view, relational view and social capital approach, the article analyses innovation-driven dyadic networks involving SMEs and PROs. Through a multiple case-study method, an examination was undertaken of the structural, relational and cognitive configuration of networks. The study found a co-evolution path between the life-cycle of the relationship, mechanisms of governance and innovation objectives; the existence of a risk of 'inertial trust' and a need to overlap 'basic' knowledge bases and develop shared languages.

## Keywords

innovation, knowledge, network, public research organisations, SMEs, social capital

## Introduction

Scholars and policymakers have underlined the importance of collaboration between small and medium-sized enterprises (SMEs) and public research organisations (PROs) in order to promote innovation processes for the development of both organisations and territories (Johnston and

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Hamilton, 2008; Kodama, 2008). Collaboration between PROs and industry plays a critical role in fostering a knowledge-based economy, as well as constituting a sustainable competitive advantage for small firms. Indeed, most national and regional governments in Europe support knowledge and technology transfer from PROs to SMEs as a key feature of their growth and competitiveness agenda. This occurs for example, through policies that aim to foster academic spin-offs (Wright et al., 2007) to create public–private partnerships for research and development (R&D) (Keeble and Wilkinson, 2000), or to sustain agglomeration parks (science parks, technopoles, technological districts, etc.) which provide opportunities for institutional cooperation between universities and industry (Cooke et al., 2004).

A growing trend in the literature is to identify the most effective knowledge transfer mechanisms and critical success factors in collaboration between PROs and industry (Burnside and Witkin, 2008; Lockett et al., 2009; Pertuze et al., 2010). Recently, Barbolla and Corredera (2009) have shown how technology maturity, well-defined objectives, a shared vision, clarity of roles, personal relationships, absorptive capacity and the ability to integrate new technology into value chains are among the key factors affecting the success or failure of partnerships. In addition, inherent differences in time horizons and objectives, as well as organisational and cultural differences, could affect collaboration mechanisms (Bruneel et al., 2010; Perkmann et al., 2011).

Engaging in relationships with PROs can be particularly relevant for SMEs, since they usually lack the internal resources necessary to compete – especially innovative capabilities. Therefore, they need to collaborate with external partners to innovate and strengthen their competitive position (Chesbrough, 2006; Gassmann, 2006) and draw on their networks to identify missing resources for innovation (Lichtenthaler, 2008; van de Vrande et al., 2006, 2009). Given these considerations, small firms benefit from adopting an open innovation approach, defined as ‘the use of purposive inflows and outflows of knowledge to accelerate internal innovation and to expand the markets for the external use of innovation, respectively’ (Chesbrough et al., 2006: 1).

However, several theoretical and empirical studies have highlighted market failures and constraining factors hindering the transfer and joint creation of knowledge and innovation between PROs, on the one hand, and SMEs, on the other (Huggins and Johnston, 2009; Lockett et al., 2008; Siegel et al., 2004). The literature asserts that SMEs have difficulties in establishing relationships with actors outside their closest social network (family and friends) and their closest economic network (suppliers and customers). More specifically, PROs represent ‘the dark side of the moon’ (Woolgar et al., 1998). Of course, this is an over-simplification, as SMEs do not form a homogeneous group. However, factors hindering such forms of collaboration have been noted, in that SMEs have difficulties in understanding and articulating their internal needs and finding research solutions to fulfil them (Bessant, 1999). Furthermore, there is a reluctance to invest time and money to establish relationships with PROs (Anderson and Boocock, 2002; Macpherson and Holt, 2007). In addition, SMEs tend to exhibit a low absorptive capacity for external knowledge, tend to be risk-averse and tend to consider innovation unimportant in itself, only as a useful means of responding to a specific competitive challenge or market opportunities (Buratti and Penco, 2001; Patton, 2013).

However, PROs do not always consider SMEs to be appropriate partners, as they can be reluctant to engage in projects that are not research-based, and those involving SMEs rarely advance cutting-edge knowledge (Mayer and Blaas, 2002). Moreover, PROs tend to consider SMEs as a homogeneous group, not considering their specific needs and competences and thus, tend to hinder the implementation of effective inter-organisational processes. Overall, SME–PRO relationships represent a current and relevant topic from a theoretical and practical

viewpoint. However, relatively little research has addressed the issue of networking between SMEs and PROs and innovation processes in particular. This article contributes to the debate by providing an exploratory study of effective, innovation-driven dyadic networks involving SMEs and PROs. The aim is to understand the structural, relational and cognitive configurations through which knowledge is created, transferred or shared to sustain innovation within dyadic networks. In order to address this goal, we propose a conceptual framework integrating the knowledge-based view (KBV) and the relational view (RV) with the social capital approach (SCA). Indeed, despite growing interest in the explanatory power of social capital from the stance of network innovation output and several analogies or complementarities with the KBV and RV, the literature still lacks a comprehensive paradigm. Thus, there is limited analysis drawing together these different streams of research to provide a systematic explanation of the effects of inter-organisational networks on SME innovation (Leenders et al., 2001; Ramos-Rodriguez et al., 2010; Vanhaverbeke et al., 2009).

This article is organised as follows. We review the literature on learning and innovation within the inter-organisational network, considering the KBV, RV and SCA. The literature is summarised in order to integrate the different research streams in the conceptual framework, and is adopted to gain a better understanding of the innovation-driven dyadic network that exists between SMEs and PROs. The research method and empirical study are described and the results discussed; finally, concluding remarks are offered to stimulate further research.

## Literature review

### *The knowledge-based view and the relational view*

According to the KBV, knowledge represents one of the most important resources available to firms: the capability to create, transfer and exploit knowledge is the primary source of organisational competitive advantage (Amin and Cohendet, 2004; Hamel, 1991). It is acknowledged that, unlike mere information, 'knowledge' is about action and is a function of a particular stance (Nonaka and Takeuchi, 1995; Patton, 2013); when compared with tangible resources, it shows distinctive characteristics, making it particularly difficult to manage within complex organisations. Indeed, knowledge is indivisible and non-excludable (Grant, 1996); moreover, it is personally and socially embedded (Kogut and Zander, 1992) and takes many different forms such as the distinction between tacit and explicit knowledge (Polanyi, 1967). Polanyi recognises tacit knowledge in terms of its incommunicability: it is difficult to codify and communicate in verbal, written or other symbolic forms; whereas explicit knowledge can be easily described, codified and then transferred (Nonaka and Takeuchi, 1995). Scholars have contended that innovation processes are dependent on a firm's ability to manage, maintain and create knowledge, especially tacit knowledge (Cohen and Levinthal, 1990; Kogut and Zander, 1992), as well as on overcoming the learning barriers that may transform a firm's core knowledge competences into core rigidities (Helfat et al., 2007; Leonard-Barton, 1992).

Over the last decade firms have reconsidered their organisational boundaries, using relationships with external actors as a fulcrum in this strategy, especially when pursuing continuous innovation. Mobilising the multiplicity of actors involved in the same innovation project is the consequence of the growing complexity and variety of resources needed to develop new knowledge. This renders the exchange of resources among partners a key component of innovation, and network relationships become the driving force behind innovative processes (Chesbrough et al., 2006; Grant and Baden-Fuller, 2004; Kale et al., 2002; Wynarczyk et al., 2013). It emerges that inter-organisational relationships can foster organisational learning and innovation processes,

creating opportunities for the creation, sharing and exploitation ('learning alliance') of knowledge. Indeed, it is through networks that firms gain access to heterogeneous external knowledge, combining it with existing knowledge or creating new knowledge (Freeman, 1991; Powell et al., 1996). As innovation often is undertaken across firm boundaries, it is necessary to understand how knowledge is shared among network members (Theyal, 2012). Despite its importance, the flow of knowledge is not obvious, even within a single organisation (Kogut and Zander, 1992). The literature has explored the processes through which knowledge is developed, shared and internalised in an inter-organisational relationship, underlining the complexity that arises concerning tacit knowledge (Dyer and Nobeoka, 2000; Powell et al., 1996).

Inter-organisational sharing and creation of knowledge depends on a partner's will and ability to learn (Hamel, 1991), which is a function of overlapping knowledge bases and interaction routines affecting absorptive capacity (Cohen and Levinthal, 1990; Patton, 2013). Different knowledge bases also offer opportunities to create new learning (Phan and Peridis, 2000), particularly when the differences concern expert or specialist (rather than basic) knowledge (Lane and Lubatkin, 1998). Regarding tacit knowledge, the importance of learning by interacting has been noted (Noteboom, 2000). The role of informal networks has been stressed with 'community of practice' and 'boundary spanning' activities seen to embed trust, resolve conflicts and introduce innovation without destabilising the established competences within each firm (for example, brokers and employee exchanges between firms) (Amin and Cohendet, 2004; Noteboom, 2000).

Exponents of RV, in turn, explain that inter-organisational relationships create idiosyncratic opportunities for knowledge acquisition and exploitation, as they constitute a potential source of 'relational rents' (Dyer and Singh, 1998). From this perspective, competitiveness arises above all from inter-firm sources of advantage (Kale and Singh, 2007; McEvily and Zaheer, 1999; Zaheer and Venkatraman, 1995). This research stream has explored the crucial role of trust: that is, the expectation that the exchange partner will act honestly and in good faith (Ring and Van de Ven 1992). As such, trust alleviates fears of opportunistic behaviour acting as a lubricant and shadow of the future for both social and economic activity (Kachra and White, 2008; Welter, 2012). In addition, several scholars have claimed the importance of steady and trustworthy relationships in helping the inter-firm flow of tacit knowledge and inter-organisational learning (Janowicz-Panjaitan and Noorderhaven, 2009).

### *The social capital approach and innovation networks*

The SCA has highlighted how embeddedness (Granovetter, 1985; Uzzi, 1997) influences economic actions and firm strategy in general, as well as inter-organisational network formation and performance in particular. Gulati (1995, 2007) provides a more socialised account of the behaviour of the organisation. Before analysing in detail the relationships between social capital, knowledge management and innovation in networks, it is necessary to explain what is meant by social capital. Although a number of definitions arise from the same basic inspiration, they do not lead to similar conceptualisations. As has been pointed out, this term is used in such a broad sense that it creates confusion and compromise effective use (Knorringa and Van Staveren, 2007). For clarification, the definition provided by Nahapiet and Ghoshal is adopted here, whereby social capital represents

[t]he sum of the actual and potential resources embedded within, available through and derived from the network of relationships possessed by an individual or social unit. Social capital thus comprises both the network and the assets that may be mobilized through the network. (1998: 243)

As such, our attention is focused here only on the meso-level of analysis (Inkpen and Tsang, 2005), as we examine networks of organisations.<sup>1</sup>

Moving to the issue of innovation-driven inter-organisational networks, one of the main aspects analysed in the social capital studies is the manner in which it influences knowledge-sharing among the actors involved in a network, as well as the network's ability to foster innovation processes (Adler and Kwon, 2002; Inkpen and Tsang, 2005; Nahapiet and Ghoshal, 1998). The effects of the *structural* dimension of social capital (Gulati, 1995) have been explored, which indicate its importance to innovative processes of network configuration and the characteristics of the ties binding the actors, as well as the position of the nodes in the network structure (Ahuja, 2000; Powell et al., 1996; Yli-Renko et al., 2001). However, the literature has not given univocal judgement on which kind of structure engenders greater innovation. On the one hand, it is argued that a closed network – made up of strong, cohesive and redundant ties – represents the ideal type of network which guarantees innovation development, as it stimulates trust, social control and the repetition of exchanges (Ahuja, 2000; Coleman, 1990; Walker et al., 1997). On the other hand, it is suggested that networks of weak ties (Granovetter, 1973) – low reciprocity and intimacy, weak emotional commitment – can provide wider sources of knowledge (social learning mechanism), thus, stimulating more innovation (Tsai, 2000).

Moreover, it has been argued that strong and weak ties are not in conflict; rather, they both contribute to the evolution and efficacy of the network (Capaldo, 2007; Uzzi, 1997); while Ahuja (2000) and Gilsing et al. (2007) suggest considering the issue in relation to the specific purposes of the network. In effect, an ideal structure does not exist; the best configuration for innovation processes must be considered contingent to the specific actions that actors want to facilitate. The structural dimension affects knowledge transfer in terms of the stability of ties within the network: a stable network configuration favours symmetrical learning while reducing a partner's competitive attitude towards learning (Inkpen and Tsang, 2005). Finally, the existence of prior links or third-party referrals contribute to the effectiveness of networks as it helps to set expectations and induces trust in the new relationship (Gulati, 1995).

More recently, along with an examination of the structural issues, scholars have extended the field of analysis, stating that social capital helps the transfer and use of knowledge within networks by influencing the conditions needed to create value in *relational* and *cognitive* terms (Inkpen and Tsang, 2005; Tsai, 2000; Yli-Renko et al., 2001). Therefore, a type of hybridisation between the strands is occurring, as social capital studies are moving towards an interpretive logic that shows complementary features and similarities to the KBV and RV.

The relational dimension of social capital refers to the personal links that develop between the members of organisations involved in the network and the intangible resources rooted in such links: trust, rules, reciprocal obligations and expectations and reputation (Adler and Kwon, 2002; Autio et al., 2004; Tsai and Ghoshal, 1998). From the literature, it emerges that a high level of relational social capital facilitates the transfer of knowledge, because it enhances openness (and reduces the time needed) to exchange sensitive information, while at the same time diminishing transaction costs and the need for formal control (Adler and Kwon, 2002; Autio et al., 2004). A large part of the literature has concentrated on the importance of trust in innovation processes (Nielsen and Nielsen, 2009; Zheng, 2010). Among others, Inkpen and Tsang (2005) point out that in inter-organisational networks, knowledge transfer is possible due to a high level of trust which, on the one hand, reduces opportunistic behaviour, and on the other, promotes long-term shared goals and interaction transparency, acting as a shadow of the future (Axelrod, 1984). Yli-Renko et al. (2001), present a different position; when considering the acquisition of knowledge from a network partner, high trust can reduce, rather than increase, new knowledge acquired due to

over-embeddedness phenomena (Uzzi, 1997). As such, when trust reaches a very high level, the perceived need to monitor diminishes, decreasing the level of conflict and intense information-processing. Yet, while reduced monitoring may reduce the cost of knowledge exchange, it also may lower the amount of new knowledge acquired.

Finally, moving to the cognitive dimension of social capital, effects are divided into two main categories: shared goals and shared culture (Adler and Kwon, 2002; Zheng, 2010). Accordingly, shared goals (or 'shared visions' *à la* Nahapiet and Ghoshal, 1998), allow mutual comprehension and the exchange of ideas and resources within networks, by bringing actor perspectives into line with what they want to achieve. Considering the effects of culture on knowledge transfer within inter-organisational networks, once again the literature shows conflicting argumentation. Inkpen and Tsang (2005) argue that a shared culture allows knowledge transfer, and that managing networks with similar cultural backgrounds is easier. However, it has been argued that the cultural diversity of partner networks could be a driver for knowledge exchange. Cowan et al. (2007), for example, have shown the presence of an inverted U-shape relationship between the cognitive dimension of social capital and the creation of innovation in inter-organisational networks. With regard to partner selection, Cowan et al. assert that if firm knowledge assets are too similar, there is little advantage in sharing; conversely, if they are too different, absorptive capacity may be weak, and communication and integration difficulties arise.

## Synthesis and research questions

This literature review of KBV, RV and SCA shows that learning in organisations is a collective process, and that the outcomes of innovation-driven networks depend on a multiplicity of structural, relational and cognitive factors. However, the review also reveals that the dynamics underpinning learning and innovation within inter-organisational networks still need to be better understood (Vanhaverbeke et al., 2009). Indeed, the above strands are generally considered separately, even though their results could supplement each other and help shed light on innovation-driven networks between SMEs and PROs. In order to fill this gap we combine these different streams, which recently have undergone a process of hybridisation. More precisely, we consider the arguments surrounding KBV, RV and SCA pertaining to innovation within inter-organisational networks jointly, in order to form the basis of a broader conceptual framework (presented in Figure 1). This will be adopted to examine innovation-driven dyadic networks between SMEs and PROs.

The research streams are complementary from the viewpoint of the structural aspects examined only in the social capital literature. As for the relational and cognitive aspects, we merge the similar or overlapping concepts deriving from the previous review, acknowledging the deeper contribution of KBV and RV. Thus, drawing on this conceptual framework, we proceed to analyse networks between SMEs and PROs. In particular, we look at the dyadic network (Larson, 1992): that is, the exchange relationship between the SME and its partnered PRO. We explore the reasons why the innovation-driven dyadic networks analysed have worked, in spite of the difficulties impairing collaboration between SMEs and PROs found in the literature. More specifically, this research explores the following question:

RQ1: What is the structural, relational and cognitive configuration that favours knowledge creation, transfer and sharing between SMEs and PROs, thus promoting innovation, and how does this occur?

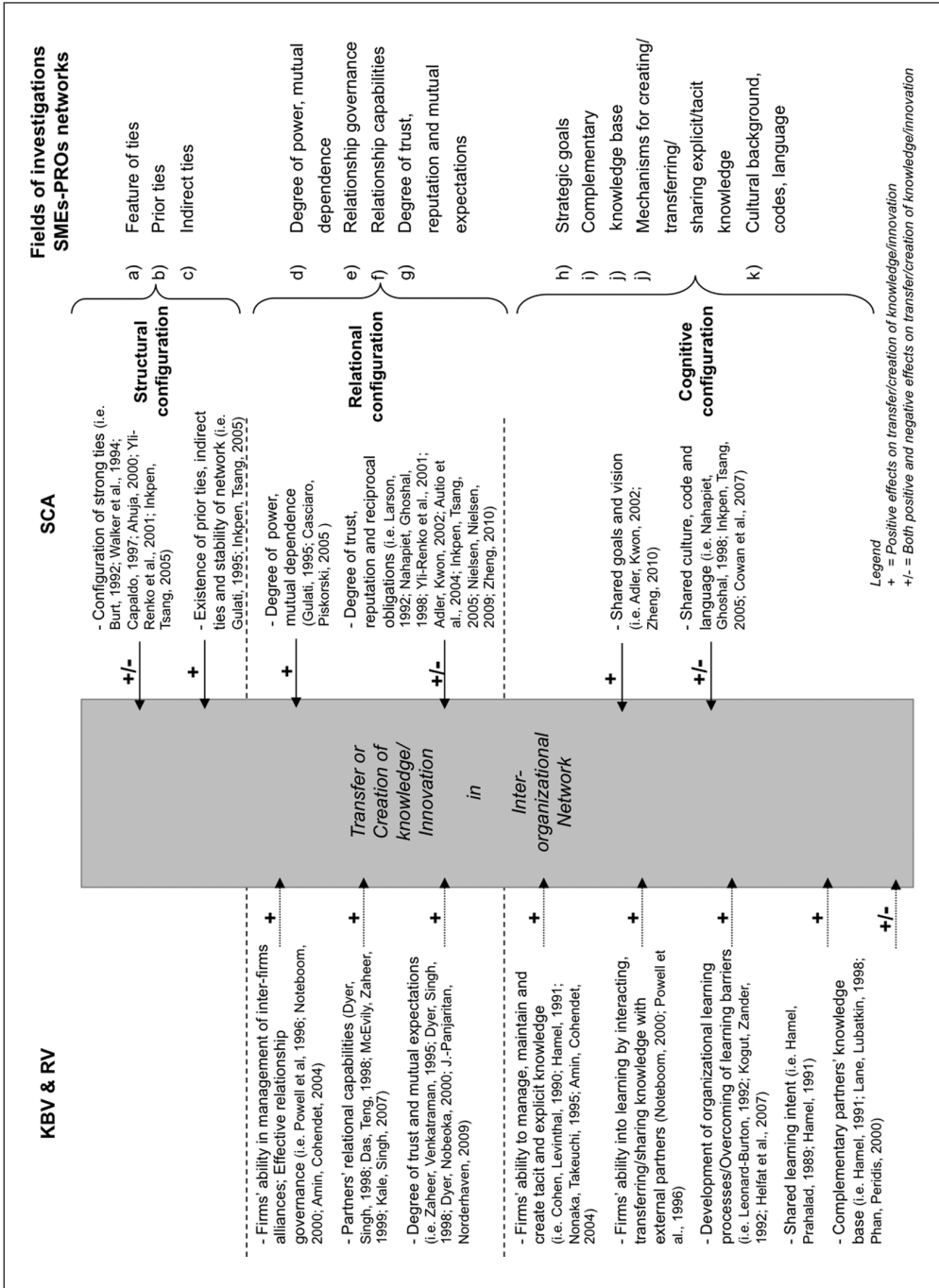


Figure 1. Conceptual framework.

## Method

### Research design

In order to address this research question, an explorative qualitative analysis was conducted using a case study method (Eisenhardt, 1989). The research design is based on multiple case studies enabling the study of patterns common to cases and theory thus, avoiding chance associations whilst it is a method most suited to investigating complex phenomena (Eisenhardt, 1989; Yin, 1994), focusing on the social processes involved (Eisenhardt and Graebner, 2007; Greenwood and Suddaby, 2006). More broadly, qualitative studies are well suited to shedding light on the 'how' questions (Edmondson and McManus, 2007).

In particular, following Weber and Gobel (2010), the research design has two bases: knowledge of both the literature of relationships between SMEs and PROs and the relevant management theories (KBV, RV and SCA); and participant observation. In particular, the proposed hybrid conceptual framework provided a basis for the field of investigations of the survey therefore, the questions included in the questionnaire adopted for the interviews and consequently, a basis for interpreting the results. The questionnaire used for the interview consisted of sections referring to KBV, RV and SCA. As for the element related to SCA, it partially refers to the questionnaire adopted by Larson (1992).

*Relationship* was used as the unit of analysis, investigating and comparing five successful innovation-driven dyadic networks among SMEs and PROs located in Campania, an Italian region unfavourable to innovation.<sup>2</sup> By successful case studies we mean experiences which, according to both SMEs and PROs involved, have led to different kinds of innovation output, and been positively evaluated by both partners (Perkmann et al., 2011). Following the third edition of the Oslo Manual, in this study 'innovation' means:

The implementation of a new or significantly improved product (good or service) or process, a new marketing method or a new organisational method in business practices, workplace organisation or external relations ... the minimum requirement for an innovation is that the product, process, marketing method or organisational method must be new to the firm (or significantly improved). This includes products, processes and methods that firms are the first to develop and those adopted from other firms or organisations. (OECD, 2005: 46)

The study then focuses on the meso-level, even though interactions with the individual level (or micro-level) cannot be excluded considering the topic of analysis. Moreover, all of those involved within the relationships were interviewed in order to overcome one of the most relevant limits of previous studies, which collect information from only one party (Tolstoy and Agndal, 2010). The cases were chosen using replication logic (Yin, 2003). Multiple case studies enable researchers to identify similarities and differences within a group of cases, as well as inter-group similarities and differences (Chetty and Agndal, 2007; Eisenhardt, 1989). The study concentrated on fewer case studies examined in detail (Eisenhardt, 1989), and considered the real world context in which the phenomena occur (Eisenhardt and Graebner, 2007).

### Data collection and analysis

The data were collected from April 2010 to June 2011. Twenty-three semi-structured, face-to-face interviews were undertaken with senior management involved in network relationships, with an average duration of between two and four hours; each was recorded and transcribed. During the



process of data collection, the researchers read and reread the transcriptions; emerging themes were refined as the data were collected. The questionnaire was in five sections: general information about the SME or PRO; innovative activities and organisational modes; dyadic network and origin and evolution; dyadic network and structural and relational configuration; and dyadic network and cognitive configurations.

The interview results were transposed onto documentary evidence in order to obtain triangulation (Pettigrew, 1990; Yin, 2003) and thus, enhance the reliability of data collection. The study sought to verify the existence of innovation outcomes arising from the relationships; some preliminary case studies were sent to the interviewees to check accuracy, then an individual case description and within-case analysis were produced. For the cross-case analysis, the different cases were compared and the similarities and differences between them identified (Yin, 2003). Academic feedback was gained by presenting the interim results at an international conference.

Table 1 provides an overview of the five dyadic networks analysed, and of the interviews carried out for data collection.

## Findings and discussion

### *Network configuration and relationship management: structural and relational embeddedness*

This section discusses the structural configurations within the case studies, as well as relationship management in order to assess factors that have contributed to the efficacy of the collaborations. In particular, it explores the characteristics of the ties, the role of trust and the processes for the generation of relational rents. Table 2 presents a detailed cross-case analysis of the structural and relationship features of the five innovation-driven dyadic networks between SMEs and PROs.

As illustrated, cross-case analysis shows that network structures are characterised by stable ties, with a high degree of reciprocity and frequent interactions which, according to the literature, help the transfer of complex knowledge and the creation of common learning processes. However, the links between organisations rely on low intimacy and weak emotional commitment. Moreover, both partners are involved in many other relationships that are variously stable and frequent. Only in two cases – namely, POL–ICTP and OC–IAMC – are the ties so strong as to determine high intimacy and strong emotional commitment because long-term friendships exist among the actors. It is interesting to highlight that these two cases may determine over-embeddedness (Uzzi, 1997), suggested by a strong dependence of the firm on the relationship with its PROs. Indeed, these two dyads differ significantly from others in terms of the degree of strategic mutual dependence and distribution of power between partners. In other cases, power is distributed equally between partners, while in the POL–ICTP and OC–IAMC dyads, a significant imbalance appears.

At least one of the actors involved in the dyadic networks had experienced prior relationships with other firms or PROs and managed several national or international collaborations, having developed distinctive relational competences that contributed to profitability (relational rents). They also selected the partner (Dyer and Singh, 1998; Powell et al., 1996) to manage research and overcome any problems that arose together, in order to promote the transfer of information and the combination of knowledge, and to create a climate of trust. Moreover, it is interesting that, with the exception of only one case (CO–DiME), the respondents considered that a relationship with the PRO was able to create indirect links; that is, other actors connected only directly with the partner (Gulati, 1995). In this sense, the relationship acts as an idiosyncratic resource that opens up unique strategic opportunities (generally, new market opportunities).

Table 1. Overview of case studies and data collected.

Dyadic network	SME	Employees (2010)	PRO	Activities	Respondent(s)/role	Innovation outcomes of the relationship
Case 1: Arterra- Department of Food Science (ART-DSA)	Arterra Bioscience S.r.l.	18	Department of Food Science, Federico II University	Biotechnologies for agriculture and cosmetics  Research and education on foods, functional food, biochemistry  Wooden and energy sector	Founder and CEO Co-founder and senior manager  Head of the research team, senior researcher  CEO and general manager	Product innovations: 3 new active ingredients for cosmetic applications (1 patented)  Organisational innovation Product innovation: in the initial phase of development of new software and calculating systems aiming to improve the efficiency of small-size power plants
Case 2: Comasa: DiME (CO-DiME)	Comasa S.a.s.	15	Department of Engineering Mechanics and Energy (DiME) Federico II University	Research and education on engineering mechanics and energy  Cover films for agricultural applications	Assistant professor, senior researcher  Founder and CEO	Product improvement and incremental innovations. They are now trying to produce a new cover film composed of innovative and eco-sustainable materials.
Case 3: Polyeur-ICTP (POL-ICTP)	Polyeur S.r.l.	3	Institute of Chemistry and Technology of Polymers (ICTP), National Research Council	Research on chemistry and technology of polymers	Senior researcher	

**Table 1.** (Continued)

Dyadic network	SME	Employees (2010)	PRO	Activities	Respondent(s)/role	Innovation outcomes of the relationship
Case 4: Elettrosannio- IDeAS (EL-IDeAS)	Elettrosannio S.n.c.	25		Photovoltaic, solar thermal, wind, hydroelectric sector	CEO	Product innovations: photovoltaic tiles patented and an innovative shading system, 'Brise Soleil', awaiting patent Organisational innovation: training innovative programmes
Case 5: Oceanix-IAMC (OC-IAMC)	Oceanix S.r.l.	8	Interdepartmental Research Centre of Industrial Design, Environment, History (IDeAS), University of Naples II  Institute for the Coastal Marine Environment (IAMC), National Research Council	Research and education on industrial design, material, eco-innovation  Marine survey and positioning services  Research on biological resources and sustainability, biodiversity of marine ecosystems.	Head of the research team, senior researcher  Co-founder and managing director  Senior researcher	Product improvement and incremental innovations

**Table 2.** Cross-case analysis: structural and relational configuration.

	ART-DSA	CO-DiME	POL-ICTP	EL-IDeAS	OC-IAMC
a) Feature of ties	Stable ties High degree of reciprocity and frequent interactions Low intimacy and weak emotional commitment (combination of 'weak' and 'strong' features)	Stable ties High degree of reciprocity and frequent interactions Low intimacy and weak emotional commitment (combination of 'weak' and 'strong' features)	High, stable and very strong ties High degree of reciprocity, intimacy and emotional commitment Very frequent interactions POL's founders and ICTP head researchers are long-time friends ICTP: 'We meet very often, not only for work issues and we usually take our summer holidays together'	Stable ties High degree of reciprocity and frequent interaction Low intimacy and weak emotional commitment (combination of 'weak' and 'strong' features)	High stable and very strong ties High degree of reciprocity, intimacy and emotional commitment Very frequent interactions OC's founders and IAMC's researchers are friends
b) Prior ties	No prior ties between partners Trigger event to start the relationship: a service contract Initiative of the firm	Existence of prior ties: CO's CEO was a student at DiME and personally knew professors with whom he now collaborates Initiative of the firm	Existence of prior ties: long-time friendship among POL's founders and several ICTP researchers	No prior ties between partners Relationship started through a student who introduced the actors	Existence of prior ties OC's founders are researchers who had already worked with IAMC Prior friendship relationship
c) Indirect ties	ART has access to other PROs linked to DSA. Together Now they are starting another innovative research to create a prototype of 'artificial skin' In turn, DSA has entered the cosmetic industry, diversifying its activities formerly dedicated only to the food industry	No indirect links established before now	Through the relationship with ICTP, POL has been linked to national and international firms and PROs which have been essential for its creation, and that now are essential for its survival and growth	EL has access to other national and international PROs (i.e. Latin Design Network) and firms linked to IDeAS IDeAS: 'The university acts as a gatekeeper in the local environment and allows many small actors to meet and integrate their competencies and interests'	OC has access to other national and international PROs and firms linked to IAMC
d) Degree of power, mutual dependence	Power and mutual dependence equally distributed between partners	Power and mutual dependence equally distributed between partners	POL's activities are highly dependent on collaboration with ICTP and ICTP know-how	Power and mutual dependence equally distributed among partners	OC's activities are highly dependent on collaboration with IAMC (25% of annual turnover)

**Table 2.** (Continued)

	ART-DSA	CO-DiME	POL-ICTP	EL-IDeAS	OC-IAMC
e) Relationship governance	<p>Informal, non-contractual relationship</p> <p>No formal agreements, no specific plans.</p> <p>They are planning to formalise the exploitation of products developed together</p> <p>DSA: 'Our collaboration is free. We are free to creatively innovate without deadlines, plans, etc.'</p>	<p>Informal, non-contractual relationship</p> <p>No formal agreements, no specific plans</p> <p>CO: 'There is only an informal relationship that in this phase we prefer, especially because of the university bureaucracy'</p> <p>DiME: 'There is only a tacit agreement between me (Prof. Gimelli), my superior (Prof. Buono), our research group and CO'</p>	<p>Mainly informal relationship</p> <p>For innovative long-term activities there is an informal link</p> <p>No formal contract</p> <p>When the research stream carried out together evolves into concrete output, the division of revenues is formalised.</p> <p>There are also short-term projects (usually service contracts) regulated by contracts</p>	<p>Mainly informal relationship</p> <p>For innovative long-term activities there is an informal link</p> <p>No formal contract</p> <p>When the research stream carried out together evolves into concrete output, division of revenues is formalised</p>	<p>Mainly informal relationship</p> <p>For innovative long-term activities there is an informal link</p> <p>On specific projects IAMC requires formal contracts</p>
f) Relationship capabilities	<p>Both partners have many past, present, national and international collaborations through which relationship capabilities have developed</p>	<p>Both partner's show many past, present, national and international collaborations through which relationship capabilities have developed.</p> <p>CO's CEO (who also studied at MIT), shows a strong personal orientation towards the firm-university relationship</p>	<p>ICTP is an Italian organisation of great relevance in the field of scientific and technological research handling several national and international collaborations with firms and other PROs</p>	<p>IDeAS shows many past, present, national and international collaborations through which relationship capabilities have developed</p>	<p>Both partners show many past, present, national and international collaborations through which relationship capabilities have developed</p>
g) Degree of trust, reputation and mutual expectations	<p>Very high degree of mutual trust, reputation and expectations</p> <p>ART: 'The relationship with DSA only relies on trust, good sense and honesty ... We trust each other and we are open to share knowledge without hesitation'</p> <p>DSA: 'Trust improves efficiency and efficacy of relationship. You don't need to spend time formalising, controlling, etc.'</p>	<p>Very high degree of mutual trust, reputation and expectations</p> <p>DiME: 'Our relationship only relies on personal mutual trust'</p>	<p>Very high degree of mutual trust, reputation and expectations</p> <p>POL: 'The innovation-driven collaboration we have with other partners are regulated by written formal agreements. We don't need them in the relationship with ICTP' ICTP: 'We are friends, we totally trust each other'</p>	<p>Very high degree of mutual trust, reputation and expectations</p> <p>IDeAS: 'It is only an informal agreement. When there is trust, you keep on working and researching by inertia'</p>	<p>Very high degree of mutual trust, reputation and expectations</p> <p>OC: 'It is a long-time, stable and trustworthy relationship ... There is an underlying friendship that helps to resolve any kind of problem'</p>

In the cases, relational rents are connected strictly to the idiosyncratic investments made by partners, which in turn contribute to enhancing their strategic interdependence. Indeed, the strategic interdependence of partners generally is quite high given the learning processes that have developed over time. In particular, the dyadic networks have prompted research streams resulting from combinations of both the partner's knowledge assets. Therefore, many of the firms would not be able to undertake innovation processes without their respective partners; thus, innovation processes are entrenched in the relationship.

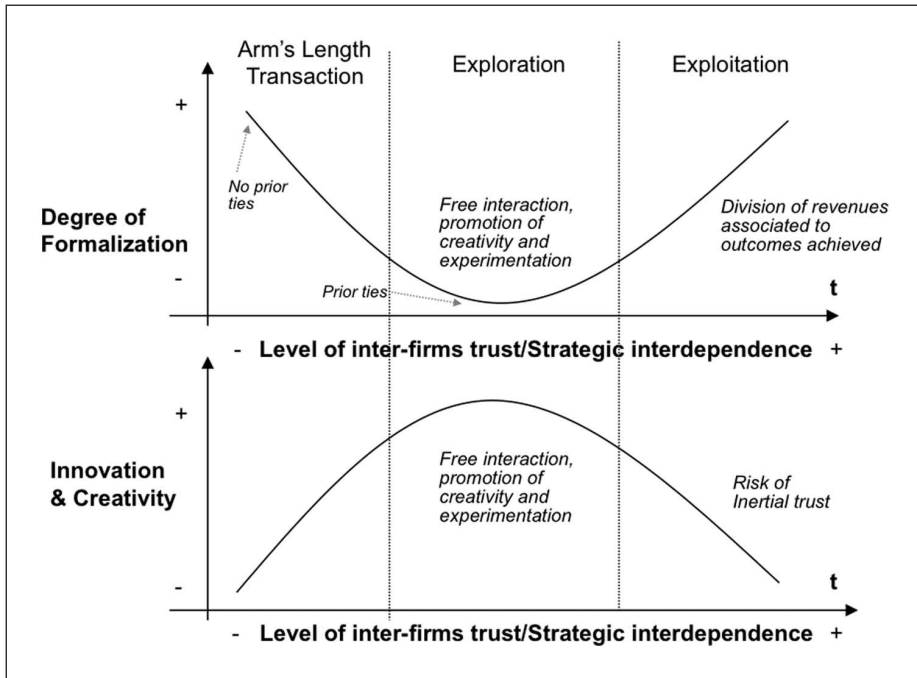
Trust plays a fundamental role in these relationships, acting as the main governance mechanism in all the case studies. Surprisingly, all the dyadic networks have informal and non-contractual linkages. Actors assert that informality helps creativity and the exploration of new ideas (Greve, 2004), so, particularly in order to get round PROs' bureaucracy (considered by SMEs as one of the main obstacles to relationships), they prefer to rely on personal trust and mutual expectations without formalising contracts. This is not an expected result considering the fine-grained (Uzzi, 1997) and sensitive information transferred and shared in the collaborations.

The respondents tended to define a formal agreement only in the final phase of their innovation research projects when revenues associated with the outcomes are shared. In other words, informal and trustworthy relationships seem to be more suitable for exploration, while in the exploitation phase, formal contracts are created. In addition, when collaboration starts with a formal agreement for a specific project (see the ART–DSA case), and this happens when there have been no prior relationships between the partners, and the relationship moves towards becoming innovation-driven, long-range and explorative, linkages become informal. Therefore, a kind of 'life-cycle of the relationship' emerges (Figure 2), which is connected to a trust-building process that improves the effectiveness and efficiency of collaborations, as the respondents stated.

In other words, despite their different origins (i.e. with or without prior ties between partners and/or the dyads coming into being by means of a contract), governance mechanisms evolve throughout SME–PRO relationships and influence the outcome of the innovation process. In particular, even though the phase of more intense innovation, experimentation and creativity is where the more sensitive and valuable resources for the organisation's competitive advantage are rooted, this phase is characterised by informal governance mechanisms and a low degree of formalisation; at the same time, trust becomes essential. In line with other work (Hoffmann et al., 2010), the present analysis shows that inter-organisational trust may function as a social mechanism that drives cooperation independently of cost–benefit calculations. In particular, inter-organisational trust can provide mechanisms for identification, coordination, communication and knowledge-sharing which generate value yet, are not available through market contracting. Trust can be a substitute – at least in part – for some of the merits of belonging to the same firm. From a non-calculative perspective, norms of reciprocity and social proximity which have developed between the organisations can lead to collaborative behaviour, independent of economic considerations. However, this argument sheds light on a potential danger, as firms could slip into a form of 'inertial trust', maintaining a cooperative exchange that is no longer beneficial to them in their strategy of pursuing innovation therefore, negatively influencing their competitiveness and performance.

### *Knowledge transfer, sharing and development: cognitive embeddedness*

This section examines the cognitive embeddedness of dyadic networks, seeking to identify which processes are being developed for tacit knowledge transfer and sharing. Moreover, it evaluates how partner knowledge bases, cultural backgrounds and strategic goals influence their innovative performance. Table 3 presents in detail a cross-case analysis of the knowledge transfer, sharing and development processes.



**Figure 2.** Life-cycle of the relationship.

Cross-case analysis highlights the fact that shared vision and shared goals (Nahapiet and Ghoshal, 1998) play a central role in network dynamics. Actors appear to be in the relationship strategically and emotionally, being driven by the same strategic intent (Hamel and Prahalad, 1989). A shared sense of purpose binds partners together, producing a collective effort in deploying resources and leveraging capabilities to achieve common interests. As the respondents asserted, in their past experience, relationships often did not work mainly due to the gap between the interests of the SMEs and PROs.

The transfer and share of tacit knowledge, as an interviewee asserted, is related to the idea that ‘Knowledge walks on the legs of people’. The preferred mechanisms for the transferral and sharing of tacit knowledge are on-site research visits, employee exchanges between organisations, student placements and teams working together. In one case (EL–IDEAS), spontaneous communities of practice are emerging in common interests, while in others (POL–ICTP), there are boundary-spanning phenomena, with experts in specific activities creating a bridge between the partners. In addition, SMEs and PROs underline the importance of interactions both at the operational and managerial levels, stressing again the necessity for a common strategic intent between the partners and a strong commitment from the highest to the lowest levels of the organisations involved.

In addition, it was found that in the sample collaborations, partners have complementary knowledge bases. Collaboration is geared mainly towards exploration, trying to find new market opportunities and new products or processes through a combination of different but complementary knowledge assets. Some of the respondents stressed that on other occasions, when partner knowledge bases overlap too much, rivalries tended to arise and the collaboration failed. However, the

**Table 3.** Cross-case analysis: cognitive configuration.

	ART-DSA	CO-DIME	POL-ICTP	EL-IDEAS	OC-IAMC
h) Strategic goals	Same goals and strategic intent: a long-term, innovation-driven relationship aiming to discover new effective ingredients for cosmetic application, with a solid scientific basis	Same goals and strategic intent: (i) to set up educational and training activities and combining university's and firm's know-how and facilities ('MIT model'); (ii) a long term, innovation-driven relationship aiming to improve the efficiency of small-size power plants fuelled with renewable sources	Same long-term vision for innovation processes	Same long-term vision for innovation processes Common interest in setting up educational research activities combining universities and firms	Same long-term vision for innovation processes
i) Knowledge-base	Complementary knowledge bases DSA: 'Basically our collaboration works because we do different things' ART: 'The relationship with DSA allows us access to complementary knowledge' 'We are both scientists, so our basic knowledge is common; however we show complementary know-how'	Complementary knowledge bases CO: 'We complement each other. We know the market, the potential industrial applications and the technical aspects. University owns up-to-date theoretical knowledge'	Complementary knowledge bases POL: 'Our know-how is different but complementary. We need ICTP-specific knowledge and ICTP needs our competencies'	Complementary knowledge bases IDEAS: 'We have very different competencies but complementary. At the beginning of the relationship such differences caused difficulties in communications'	Complementary knowledge bases IAMC: 'The relationship with OC helps us to understand what the market wants' OC: 'Working with PROs helps us to avoid exploiting the same technology, trying to find something more up-to-date all the time'



**Table 3.** (Continued)

	ART-DSA	CO-DiME	POL-ICTP	EL-IDeAS	OC-IAMC
j) Transfer/ share mechanisms for tacit knowledge	On-site researchers visits, employee exchanges between organisations, team presentations Interactions both at operational and managerial levels DSA: 'Knowledge walks on the legs of people'	Undergraduate and PhD students exchanges; employee exchanges between organisations CO: 'Knowledge flows above all through the students and their theses'	'Boundary-spanning': professional figures and brokers on specific activities who create a bridge between the two organisations Employee exchanges, common teamwork	On-site researcher visits, employee exchanges between organisations, team presentations, frequently through meetings 'Step-by-step' collaboration modes Creation of common educational and scientific laboratories Among the two organisations spontaneous 'communities of practices' are emerging on common interests	On-site researcher visits, employee exchanges between organisations, common teamwork IAMC: 'In every project 7-8 employees from the firms and as many from the PRO are involved'
k) Cultural background, codes, language	Same cultural background, code and language ART is a science-based firm consisting of scientists, most of whom have had prior experience in PROs and universities DSA is a university department with a strong orientation towards industrial applications	Same cultural background, code and language CO's CEO has had prior experience of collaboration with PROs also in international settings DiME is a university department with a strong orientation towards industrial applications	Same cultural background, code and language POL's founders were academic researchers	Partially different cultural background, code and language, which created problems at the beginning of the collaboration EL: 'At the beginning we did not speak the same language' Over time, a shared code and language have developed	Same cultural background, code and language OC's founders were academic researchers

case studies suggest that partners share the same basic knowledge (Lane and Lubatkin, 1998), while the operative know-how and technical knowledge assets differ. Indeed, in three cases (ART–DSA, POL–ICTP, OC–IAMC) the entrepreneurs are researchers themselves, and have prior experiences in PROs; they speak the same language as academics and share most of the basic knowledge. According to the data, this helps the flow of information and transfer and sharing of knowledge, speeds up the learning processes and contributes to solving project-related problems because it enhances the absorptive capacity of the organisation and contributes to establishing learning routines and/or overcoming learning barriers (Helfat et al., 2007). Some problems did arise in the only case (EL–IDeAS) in which partners showed a gap in cultural background and somewhat different competencies, until a common code and language were developed. This also underlines the importance of shared narratives and backgrounds for a relationship to be effective. From the results, these appear to constitute an essential element in activating a mechanism of socialisation of knowledge.

## Conclusion

Recently, the study of innovation-driven networks between SMEs and PROs has emerged as an important area of enquiry for both scholars and policymakers. However, despite its importance, little theoretical and empirical research has addressed this issue. This explorative study contributes to this gap by analysing the structural, relational and cognitive dynamics underpinning the creation and sharing of knowledge in SME–PRO networks to sustain innovation. The key findings are summarised as follows. First, there is a co-evolution path between the life-cycle of the relationship, mechanisms of governance and innovation objectives. SME–PRO innovation-driven networks follow a life-cycle (Figure 2) that co-evolves with governance mechanisms and this is contingent to the innovation processes that the actors undertake. In particular, informal governance mechanisms and control (trust and personal networks) are predominant in the explorative phase, while formal mechanisms tend to arise in the exploitation phase of the innovation research projects. The low degree of formalisation during the more creative, sensitive and subsequently, valuable phase of the relationship was unexpected and in contrast with the literature. This may depend on some peculiarities of SME–PRO innovation-driven collaboration, such as the ‘learning races’ (Hamel, 1991) that often characterise innovation networks between firms; these are unlikely to occur in the case of SME–PRO relationships, due to the partners’ distant competitive arenas. In addition, the organisational difficulties that small firms encounter when trying to formalise innovative activities with PROs are so high (due to the wide gap in their respective *modus operandi*) that it is not worth the attempt to control the interaction through formal governance mechanisms. Trust, then, becomes crucial and unavoidable in the success of the relationship. This is consistent with other recent studies outside the field of SMEs (Barbolla and Corredera, 2009).

Second, the life-cycle of the relationship is connected to a risk of inertial trust. Indeed, the relational rents associated with the idiosyncratic investments made by the partners during collaboration are linked also to a progressive growth of mutual strategic interdependence which, in turn, can involve partners maintaining cooperative exchanges that are no longer beneficial in terms of innovation outcome. This is particularly true of small firms, since their size (organisational, financial, etc.) makes it more difficult to engage simultaneously in different innovation-driven networks. This issue is connected to the topic of power in the network, (Casciaro and Piskorki, 2005) since the risks are higher when they are not equally distributed between partners. Third, there is a need for an overlapping ‘basic’ knowledge base and to develop shared languages. The success of SME–PRO relationships depends to some extent on overcoming the difficulties arising when trying to

communicate with partners. The results show that partners need cognitive configurations where basic knowledge bases are similar or overlapping (even though the expert or specific knowledge bases differ). In this study, both SMEs and PROs had experienced previous similar relationships that determined a positive learning effect, a corollary being that in SME–PRO relationships, commitment (at all the organisational levels) needs to be very high, since the effort to create innovation outputs has to be directed towards overcoming learning barriers.

### *Limitations of the study and suggestions for future research*

This study has attempted to contribute to theory by shedding light on what has been identified as a salient issue but which, as yet, has received little attention. However, this study presents several limitations: first, by definition, case studies can make no claim to be typical, therefore, the results cannot be generalised. The aim is to provide insights to enrich the acknowledgement of the complex phenomena analysed, but it must be recognised that this research provides only an idiosyncratic understanding. In order to know whether these case studies can tell us about situations beyond the actual cases, further research is needed. In particular, future research should address the transferability of these conclusions to other settings, in order to assess their external validity (Eisenhardt, 1989). Above all, future research should seek to understand how industrial features, as well as environmental and institutional conditions, affect the results obtained. Considering in particular the fundamental role of informal mechanisms of governance in the explorative phase of the innovation process, it is possible to hypothesise that this result is associated with the peculiarities of the Italian context.

Moreover, whereas exploration is linked to informal decision-making processes and methods of control and conflict resolution, the role of the community also appear to be important (Bouty, 2000). This is consistent with other works drawing attention to the importance of selectivity in harmonising inter-organisational relationships (Lockett et al., 2008), and calls for more research on alternative governance mechanisms, styles of leadership, decision-making processes and management of knowledge flows among the groups. In addition, we stated that in some cases the SMEs were made up of former researchers; thus, it is important to understand whether and to what extent the entrepreneurial perspective can integrate or modify the results (Collinson and Gregson, 2003; Stuart and Sorenson, 2007).

### *Implications of the study*

As for the managerial implications, this study points out the importance of SMEs (and PROs) in setting up and maintaining various links (even weak ones) with different external PROs (SMEs). Thus, wide networks – even if made up of weak ties – reduce the risks of inertial trust, while constantly setting up relationships with PROs helps the organisation to develop internally a suitable language for communication with the partner when joint innovation opportunities arise. Regarding policy implications, this article proposes reflection on revising innovation funding programmes (i.e. the EU Framework Programme), bearing in mind the special way that SMEs collaborate with PROs and conduct their innovation processes. In particular, the importance of the individual in the more innovative phases of the collaboration between SMEs and PROs that emerge from this study seems to call for a different approach in sustaining innovation-driven networks between SMEs and PROs, centred more on people and less on the formal, documented and bureaucratic aspects of innovation projects.

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## Notes

1. SCA has been adopted at different levels: the ‘micro-level’ – the level of the individual (*inter alia*, Burt, 1992; Coleman, 1990); the ‘meso-level’ – the level of organisations and networks of organisations (both *intra*-organisations; Tsai, 2002; Tsai and Ghoshal, 1998, and *inter*-organisations); and the ‘macro-level’ – the level of communities, territories and even nations (see *inter alia*, Bourdieu, 1986; Fukuyama, 1995; Putnam, 1993).
2. These innovation-driven networks arise in a context where other works (*inter alia*, Izzo et al., 2011; Izzo and Milella, 2009) show that innovation scarcely occurs, so that the case studies are more relevant (Yin, 1994). In fact, the relationships analysed are not likely to benefit directly and strongly from an external environment favourable to innovation (Asheim and Gertler, 2005; Etzkowitz and Leydesdorff, 2000; OECD, 2001).

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