Paper to be presented at the

DRUID Society Conference 2014, CBS, Copenhagen, June 16-18

Individual performance in an R&D alliance: a micro-level study

Xiao Wang
University of Groningen
Innovation Management & Strategy
xiao.wang@rug.nl

Hans van der Bij
University of Gronignen
Innovation Management & Strategy
j.d.van.der.bij@rug.nl

Wilfred Dolfsma
University of Groningen
Innovation Management & Strategy
w.a.dolfsma@rug.nl

Abstract

Though studies have explained the alliance issues at macro or meso level, the mechanism inside alliances is still not quite clear. Drawing on the theories of social capital and social network?s role in individual knowledge sharing, learning , creating and related work performance, this study investigates the relation between individual social network position and individual work performance, as well as the relation between social interaction, network position and work performance. We found that in the formal network or advice network, the network position has positive effect on work performance, of which the relation is moderated by social interaction frequency in the formal network, but not in the advice network; in the multiplexity which means both of the two networks are involved, the relations between network position, interaction frequency, and work performance are still significant, but positive in the formal network and negative in the advice network.

Jelcodes:L29,-

Individual performance in an R&D alliance: a micro-level study

Abstract: Though studies have explained the alliance issues at macro or meso level, the mechanism inside alliances is still not quite clear. Drawing on the theories of social capital and social network's role in individual knowledge sharing, learning , creating and related work performance, this study investigates the relation between individual social network position and individual work performance, as well as the relation between social interaction, network position and work performance. We found that in the formal network or advice network, the network position has positive effect on work performance, of which the relation is moderated by social interaction frequency in the formal network, but not in the advice network; in the multiplexity which means both of the two networks are involved, the relations between network position, interaction frequency, and work performance are still significant, but positive in the formal network and negative in the advice network.

Introduction

It is a tendency that firms increasingly rely on collaboration with other firms to conduct R&D activities (Gulati, 1995; Powell et al., 1996; Osborn & Hagedoorn, 1997). According to studies, the most strategically important resource is knowledge (e.g. Conner & Prahalad 1996; Grant 1996a, b; Kogut & Zander 1996; Langlois & Foss 1999; Nahapiet & Ghoshal 1998; Spender 1996); and from the view of Resource Based Theory (RBT) and Transaction Cost Theory (TCT), firms will establish alliances with another firm to obtain needed resources when they are unavailable in the markets (Barringer & Harrison, 2000). With alliances, firms have opportunities to internalize others' knowledge, skills or competencies (Hamel, 1991; Mody, 1993; Shan, 1990), share fixed costs, actualize economies of scale in R&D, avoid "wasteful" duplication (Spence, 1984; Katz, 1986; d'Aspremont & Jacquemin, 1988; Motta, 1992; Suzumura, 1992; Ziss, 1994; Salant & Shaffer, 1998), and improve market access (Sakakibara, 2002).

Yet alliances often have not met expectations (e.g., Bleeke & Ernst, 1993; Kogut, 1989). Though there are studies about alliance from different perspectives (Saxton, 1997; Spekman

et. al., 1998; Anand & Khanna, 2000; Ireland et. al., 2002; Draulans et. al., 2003; Oxley & Sampson, 2004; Hoang & Rothaermel, 2005; Dickson et. al., 2006; Sampson, 2007; Heimeriks & Duyster, 2007; Schreiner et. al., 2009; Lai & Chang, 2010; Ernst et. al., 2011), and gave explanations at the firm-level or meso-level, such as alliance experience, capability, routine, mechanism, there still is no explanation about how the factors arise or where the factors are rooted in, which in turn can reveal the radical factors or mechanisms for alliances' success or failure. As an organization, the basic components of the R&D alliance are individuals who eventually actualize every alliance's goals; and the individuals are also confronted with a new working context which is different from regular organizations; moreover, the firm-level and meso-level explanations actually are rooted in individuals' actions (micro level). Little is known about what internal mechanism of an alliance is (Zollow & Winter, 2002), especially the individuals' behaviors, and an alliance has not been explicitly taken as a kind of organization yet. Thus , it is necessary to look into the alliance at a micro level to find a more in-depth explanation of its success or failure. Coleman (1990) argued that explanations that involve the micro-level have the properties of being more stable, fundamental, and general than macro-level explanation.

As an organization, an R&D alliance' success relies on its human capitals, especially their knowledge sharing, learning and creation. Subramaniam and Youndt (2005) found that the value of human capital relies on the value of social capital. In the theory of social capital and knowledge creation, knowledge creation is based on one's knowledge storage and others' knowledge transferred by relational contacts (Smith et. al., 2005). Current knowledge stock determines the scope and direction of the new knowledge searching (Dosi, 1982; McFadyen & Cannella, 2004), and social capital determines access of more and relevant knowledge sources (McFadyen & Cannella, 2004). Social capital involves interpersonal relationships and the resources embedded in it (Burt, 1982). In an R&D alliance, hierarchical relationships do not play rather effective roles in commanding knowledge sharing due to the organizational boundary within the alliance; comparatively, individuals may play parallel roles on transferring knowledge resource, such as a coordinator within one's own organization, and a gatekeeper, or consultant when the knowledge sharing goes across the organizational boundary. Thus, in the R&D alliance, social capitals play roles in a relatively more flexible and irregular way. Nahapiet and Ghoshal (1998) suggested that there are three dimensions about social capital: structural, cognitive and relational. This study will take the social network perspective to analyze the social capital's effect on one's knowledge sharing, creation and performance in an R&D alliance context, since it involves the two dimensions of

social capital, as well as suits the peculiar situation of interpersonal relationship and knowledge transfer in the context of R&D alliance: social network position implies the structural dimension of one's social capital indicating the one's resource access; and interaction frequency with contacts indicates the relational dimension which affects the social network position's role.

In the R&D alliance, there are two social networks playing significant roles: formal network which is composed of formal contacts; and advice network which is composed of advice seekers and providers. Due to different actors and relationships in the two networks, the dimensions of social capitals' effect on knowledge sharing, creation and relevant work performance are different. In this study, we address the following research questions: first, in an R&D alliance, what are the relations between social network positions and individual work performance in different networks? Second, what is social interaction frequency's effect on the relations in the first research question?

Our study firstly contributes to the research and theory of alliance governance. In spite of considerable research on alliance governance at macro or meso level, the question that what exactly is the mechanism inside an alliance is still largely unanswered (Zollo & Winter, 2002). We conduct this study at a micro level which has not been deployed in previous studies, and utilize individual social network perspective to dimensionally analyze individual social capitals' roles in knowledge sharing, creation, and work performance. This study is unique in that we consider an R&D alliance as a kind of organization which is an outcome of its staff's relations and actions, and suggest in such a context social network analysis is suitable for understanding the social capitals' roles in individual performance which is the foundation of meso or macro level issues.

Our study secondly contributes to the research and theory of social capital, knowledge sharing and creation. Different from major studies on social network and knowledge transfer (e.g. Hansen, 1999; Reagans & McEvily, 2003), as well as the few studies about social network and knowledge creation (e.g. McFadyen et. al., 2009), this study argues that social network analysis is a suitable tool to cover the two dimensions of social capital, and deeply as well as dimensionally analyze social capitals' roles in knowledge sharing, creation, and work performance. The uniqueness of this study is that we argue that individual network position which represents the structural dimension of one's social capitals is the objective and key factor of one's work performance in the context of R&D alliances, and the social interaction

frequency which represents the relational dimension of one's social capital is the moderating factor of the relation between network position and work performance.

The third contribution of our study is that it involves the situation of multi-network and challenges the "structural hole's advantage" in the theory of social network. In this theory, a structural hole implies diverse knowledge and more resource since it can connect the actors in the network who cannot be connected without the structural hole (Burt, 1982). But from the discussion of this study's results, in the R&D alliance, when formal network and advice network are both involved, the individual playing as the structural hole in the advice network would not have such an advantage. Thus, in special context, "structural hole" may play a different role; or the "structural hole's advantage" is conditional. The uniqueness of this study is that both formal network and advice network are united as one context; and in this multi-network context, some theories established in single context might need to be improved.

The findings provides a perspective to understand the mechanism of knowledge exchange within R&D alliances, suggests the significance of individual social network status on individual objective advantage to obtain knowledge resource that is the basis of work performance. The following explicitly demonstrates the necessity of deploying social network analysis, as well as the relations among types of social networks, social-network attributes, and individual work performance in R&D alliances, followed by introduction about research methods, variables, measurements, results, as well as the result-based discussion about the theoretical implication, managerial implication, limitation, and further research directions.

Social Network and Network Position

Lea, Yu and Maguluru (2006) defined a social network as a set of people, organizations, or other social entities, connected by a set of socially meaningful relationships, such as friendship, co-working, or information exchange, and interactions to better achieve desired outcomes by sharing expertise, resources, and information. Innovation is novel combination of existing information and work practices and assumes these to be disparate (Burt, 2004; Obstfeld, 2005). Reagans and McEvily (2003) demonstrated that broad networks, by increasing people's perspective, can enhance their ability to convey complex ideas to diverse audiences, and enhance their possibility of tapping into more relevant expertise when framing problems and acquiring information to solve them (Burt, 1992). Studies has focused on the

characteristics of social networks as key predictors of knowledge sharing and knowledge creation (e.g., Burt, 1992; Hansen, 1999, 2002; Cross & Cummings, 2004; Obstfeld, 2005; Fleming et. al., 2007; McFadyen et.al, 2009; Mors, 2010), which are the basis of one's work performance.

Formal Network and Advice Network

Generally, R&D alliances are composed of individuals and the formal relationship among them. Individuals exchange information and knowledge with formal contacts and through formal channels which consists the formal social network. According to previous studies (e.g. Mehra et al. 2001; Gulati & Puraman 2009), the formal network is defined as the prescribed roles and linkages between roles, which are reflected in job descriptions and reporting relationships. Formal structures allocate responsibility, and may subsequently reduce conflict and ambiguity (Adler & Borys 1996). In the formal network, because of the prescribed roles and linkages among them, individuals are required to share knowledge as their responsibility. In addition to the routine or simple knowledge related with better cooperation with each other, individuals are also involved in tacit or complex knowledge sharing because of their work requirement and work context. Hence, when individual work performance is studied, the formal network should be taken into consideration. In the formal network, since contacts and reporting relations are mandated based on one's expertise and knowledge, sharing range is confined.

Apart from formal network, there is another important network existing in organizations—advice network. Advice network is composed of relations through which individuals share resources, such as the information, assistance, and guidance that are related to the completion of their work (Ibarra, 1993; Sparrowe et al., 2001). Essentially, advice network is a specific form of informal network; and informal networks are important for obtaining information to finish work when organizations are more decentralized, cross-functional, or virtual (Cross & Prusak, 2002). The advice network is a mean of accessing resources that are instrumental for enhancing individual work performance beyond formal networks (Sparrowe et al., 2001). Employees can obtain information in formal networks, but informal relationships with coworkers often provide the same or better information (Morrison, 1993). In a knowledge-

intensive context, especially an R&D alliance, advice network is a complement of formal network on knowledge sharing when employees encounter difficulties and cannot attain useful or enough knowledge from their formal networks. However, the transferred knowledge in this network usually is not quite specific, it might be the possible options or solutions towards a problem. Individuals usually cannot directly utilize it; individuals usually are inspired from it to finish relevant work and achieve a level of work performance. Thus, the knowledge from different channels may mutually prove, or more effectively inspire one.

Network Position

The centrality of an employee's network position is a frequently studied (Sparrowe et.al., 2001) since network centrality represents major channels of knowledge in networks. Employees in central network positions can be defined as those that have many ties (Wasserman & Faust, 1994; Reinholt et al., 2011). Their numerous network ties mean that they can access abundant information, and they are focal the points of communication (Freeman, 1979; Reinholt et al., 2011). This implies many knowledge-sharing opportunities and individuals' engagement in knowledge sharing (Anderson, 2008). In contrast, employees who are not centrally positioned in the social network would be isolated, and have little advantage on knowledge access (Wasserman & Faust, 1994; Reinholt et al., 2011). Generally, social network centrality has three types: degree centrality, closeness centrality, and betweenness centrality. Degree centrality is defined as the number of links incident upon a node (i.e., the number of ties that a node has) (Freeman, 1979; Borgatti, 2005). Closeness centrality of a given node is defined as the length of the shortest path from one node to another, or the sum of graph-theoretical distance from all other nodes (Freeman, 1979). Betweenness centrality is defined as the share of times that a node i needs a node k (whose centrality is being measured) in order to reach a node j via the shortest path (Borgatti, 2005). Essentially, degree centrality describes the direct interactions between one and other individuals; closeness centrality describes the distance between one and others, which in turn implies a kind of influence power; betweenness centrality describes the level of mediator role between individuals or groups, which in turn implies information diversity and possible control (Wasserman & Faust, 1994; Borgatti, 2005).

Centralities and the Two Networks

In the formal network, specific knowledge in a certain professional field is transferred. Contacts are mandated and required to transfer the specific knowledge according to their expertise and relevant knowledge basis. It implies one relatively cannot change the network position regularly. Besides, it implies the knowledge shared among mandated contacts is not supposed to be shared with others. In other words, formal network determines the formal relationship among contacts, as well as boundaries of knowledge sharing range; so the knowledge sharing range is constrained in the formal network. Thus, closeness centrality and betweenness centrality that are more relevant with unconstrained knowledge sharing range in the network are not suitable for this study in the formal network.

Comparatively, in the advice network, contacts are not mandated and required to share knowledge, it implies that sharing knowledge to others in this network is a sort of extra role, and one has more freedom or control of his or her network position. Thus, closeness centrality or betweenness centrality that are more relevant with unconstrained knowledge sharing are relatively more suitable in advice network than degree centrality. However, the transferred knowledge in this network usually is not quite specific, it might be the possible options or solutions towards a problem, and usually is difficult or impossible to be transferred in the formal network. The knowledge from different channels may mutually prove, or more effectively inspire one, thus the one who can access more diverse knowledge will probably have better work performance. Thus, compared with closeness centrality which indicates a kind of influence power, betweenness centrality is more suitable for this study in the advice network, since it implies the diversity of the knowledge one can access, and the one's controlling over the knowledge sharing flow.

Hypothesis Development

Formal network, degree centrality, and work performance

In R&D alliance's formal network, contacts are mandated based on their expertise and knowledge or experience level, and the transferred knowledge usually is the specific knowledge in a certain field, thus, the one with higher degree centrality usually is an expert with higher level, and has many opportunities to get involved in exchanging assistance with coworkers as well as solving relevant problems (Sparrowe et al., 2001), and can more

effectively influence his or her formal contacts. According to power theory (e.g. Raven, 1993; Erchul & Raven, 1997; Bruins, 1999), this implies the one with higher degree centrality has higher level of positional power and expert power. With positional power and expert power, the one can influence the contacts with the relevant and valid knowledge and expertise. Formal relationship also requires the one's contacts to feed back in the form of report, seminar, meeting, etc. With the two-way communication sustained, the individual with high centrality has more opportunities to obtain more knowledge than others who do not; he or she can obtain more information or knowledge that may cover different niches in his or her specific work field. Besides, according to Matthew effect theory in the research field (Merton, 1968), more power coming from more knowledge or experience usually incurs more attention from others and interactions, subsequently leads to accessing more knowledge resources that is the basis of better work performance.

Apart from influence, according to power-feeling-action theory (e.g. Keltner et al., 2003; Galinsky et.al., 2003), power is also associated with positive feeling, attention to rewards, automatic information processing, and disinhibited behavior. The individual with high-level power enjoys good feeling and motivation for better achievement, then will subconsciously or automatically do more information analysis, work-related discussion and knowledge development. In the R&D alliance formal network, the one with higher level of positional power and expert power to influence contacts will have better feeling. This will cause a higher expectation for achievement, reputation and rewards, which in turn will result in relevant actions, such as paying more attention to contacts' information, ideas, or developed knowledge, and integrating the knowledge (possessed and obtained), to achieve better work performance. Therefore, in the formal network, the individual with higher degree centrality will have better work performance.

Hypothesis 1: Degree centrality in formal network is positively associated with individual work performance.

Interaction between degree centrality and tie strength

In addition to network position, connection strength among nodes (tie strength) is also significant for resource or knowledge exchange in the network. Tie strength is defined as the frequency of interaction, as well as the knowledge exchange embedded in those interaction relationships (McFadyen & Cannella, 2004). Tie strength is actually a demonstration of social

relation's intensity, which can be determined by contact frequency, intimacy, and depth of affection (Granovetter, 1973). Researchers have inferred tie strength's effect on knowledge transfer (Uzzi, 1996, 1997; Hansen, 1999). Knowledge transfer takes time (Hansen, 1999), according to communication theory, data usually is separately coded and transferred in a sequence, as well as separately received, decoded and assembled in an order; besides, the feedback of data reception status and problem is also important for the successful transfer. In contrast, little time, one-way (without feedback) and disordered communication will cause loss, disorder, and uselessness of data, since there is little time and chance to send data in order and sequence, or to receive it in order or completeness, as well as many problems may happen during the transfer but without feeding back, knowing and solving.

Strong ties, say, frequent interactions with contact, will provide good articulation, cognition, as well as feedback mechanism and in-time problem solving, which in turn eases the knowledge transfer (Hansen, 1999; Reagans & McEvily, 2003). In the R&D alliance's formal network, one's formal contacts probably come from different firms, thus there will be differences in culture, knowledge transfer mode, and intellectual property concerns among them. Besides, R&D cooperation means the knowledge resource is important, complex, and cannot be acquired in other ways. Strong ties provide enough time to articulate, as well as two-way interaction (Leonard-Barton & Sinha, 1993) that contributes to solving emerging problems and assimilating the transferred knowledge. Frequent interaction or communication also develops relationship-specific heuristics and specialized language for conveying complex knowledge (Uzzi, 1997; Reagans & McEvily, 2003). This shared cognition improves the effect of knowledge sharing and lowers the cost of complex knowledge exchanging (Gargiulo, et al., 2009). Therefore, strong ties in formal network will enhance the efficiency and quality of knowledge transfer. This will enhance the positional power, expert power and Matthew effect from the degree centrality, and also will enhance the one's positive feeling and achievement expectation, from which the one will pay more attention to assimilate and process the information or knowledge coming from the contacts, as well as find more possibly emerging problems in job and try to solve them. This will lead to a better work performance, since the one has efficiently and qualitatively transferred knowledge, and more chances to predict drawbacks and improve them.

Hypothesis 2: Tie strength positively moderates the relation between degree centrality and individual work performance.

Advice network, betweenness centrality, and work performance

In the alliance's advice network, individuals usually seek advice since they cannot obtain relevant knowledge to solve work-related problems. Broad networks facilitate people to discuss and exchange ideas with different audience (Reagans & McEvily, 2003); it also indicates useful knowledge can be transferred, acquired and absorbed. However, due to the organizational boundary between partners within the alliance, and the uneasily transferred trick or inexplicit information which is usually involved in the advice, actors in the advice network usually do not transfer knowledge directly. Thus, the one who locates at a "crossing" position probably has high chances of obtaining various useful knowledge. Further, the person who are on the shortest information path to connect others who are not connected, namely with highest betweenness centrality, has high chance to access more relevant and useful knowledge to solve problems efficiently and effectively (Mehra et al., 2001). Essentially, betweenness centrality represents a type of advantageous position with which the individual can connect others who cannot be connected without this individual (Wasserman & Faust, 1994; Borgatti, 2005). This means the abundant information which may verify or complement each other going through this individual, as well as his or her strong power to control the communication or the information exchange between the unconnected individuals (Freeman, 1979; Borgatti, 2005). Thus, the social network position with high betweenness centrality will provide high chance of "picking up" more information or knowledge which cannot be acquired in the formal network.

According to power theory (e.g. Raven, 1993; Erchul & Raven, 1997; Bruins, 1999), this implies high level of informational power and positional power. With informational power, the individual can provide contact(s) "tricky" information that is obtained from other contact(s). With later discussion, the individual with high betweenness centrality confronts with new process, knowledge development or problem of the contact(s) provided with "tricky" information. Meanwhile, with the positional power, the individual has the control over organizational resource such as information or knowledge (Lines, 2007); in other words, he or she can either completely or partly transfer the information or knowledge from the sender to the receiver according to his or her preference, judgment, comprehension, or other motives. Substantially, the individual with high betweenness centrality in the advice network has more knowledge than others, which in turn promotes better work performance. Meanwhile, according to power-feeling-action theory (e.g. Keltner, et al., 2003; Galinsky,

et.al., 2003), both informational power and positional power bring the individual a kind of advantageous feeling stemming from the network position, which in turn will cause stronger incentive to access knowledge, more attention to the information received from various channels, and related automatic information processing and absorption. This mechanism also contributes to achieve a better performance. Therefore, in the advice network, the individual with higher betweenness centrality will have better work performance.

Hypothesis 3: Betweenness centrality in advice network is positively associated with individual work performance.

Interaction between betweenness centrality and tie strength

Network position in the advice network provides the number of knowledge source or channels of transferring knowledge, but the entire process of sharing knowledge is finished by the interactions between individuals with direct and indirect relations. Due to the organizational boundary and inexplicit knowledge in advice network discussed above, the effective knowledge transfer in the advice network is not only finished between one actor and the direct contacts, but also between the direct contacts and the direct contacts' direct contacts, since the actor probably obtains knowledge from direct contacts who may obtain their knowledge from their direct contacts who are the indirect contacts of the actor. Frequent interaction between people is not only necessary to establish trust, emotional attachment, and shared cognition to ease the knowledge transfer (Hansen, 1999; Reagans & McEvily, 2003; Gargiulo et al., 2009), but also increases the opportunity to obtain the knowledge which the contact(s) acquired from others, which in turn enhances the betweenness centrality's advantage: brings more diverse channels for knowledge access and possibility of control. This strengthens the foundation of one's informational power and positional power which are vital for one's knowledge resource obtaining, as well as enhances better feeling, expectation, and relevant actions which are rather significant for the one's knowledge resource utilization to achieve better work performance. Hence, strong tie strengthens the relation between betweenness centrality and individual work performance.

Hypothesis 4a: Tie strength positively moderates the relation between betweenness centrality and individual work performance.

However, with respect to gender, age, race, occupation, social status, and other demographics, people prefer to interact with similar others (Byrne, 1971; Lakin & Chartrand, 2003). Similarity enhances interaction between people, and with the enforcement of exchanging similar opinions, ideas, or knowledge, similarity is again strengthened (Erickson, 1988; Zhou et al., 2009). Thus, strong ties more likely bring redundant information, and exclude the chances of connecting other social circles and accessing other information of knowledge (Granovetter, 1973). Comparatively, weak ties avoid the similarity and exclusiveness issue; it more likely provide non-redundant knowledge (Hansen, 1999). In the advice network, betweenness centrality is an advantageous position to have abundant and various knowledge as well as control knowledge flow, and with weak ties, this advantage can be enhanced. First, weak ties avoid social connection exclusiveness, and serve to have connection with more individuals who may connect to more people and provide more knowledge. Second, weak ties can avoid the redundant information stemming from similarity of contacts and their knowledge; or they can decrease the frequency and depth of repeating similar knowledge from different people who have overlaps in their fields. Thus, the actor with betweenness centrality and access to more contacts with less overlaps in their contacts and relevant knowledge resources. Third, when the actor with betweenness centrality does not intend to share the knowledge received from a contact coming from one party of the alliance to another contact coming from another party for some reasons, weak ties decrease the opportunities of leaking such knowledge. Hence, weak ties strengthen the actor's informational power and positional power which can bring one more knowledge resource and more possibility to control knowledge flow, as well as strengthen advantageous work feeling, expectation, and relevant actions which are rather important for the one's knowledge accumulation and work performance; as a whole, it strengthens the relation between betweenness centrality and individual work performance.

Hypothesis 4b: Tie strength negatively moderates the relation between betweenness centrality and individual work performance.

The conceptual model for this study is presented in Figure 1. Since one's centralities in the two networks of an R&D alliance implies different powers and Mathew's effect with which the one can obtain more knowledge resources from others, as well as with which the one has different sorts of positive feelings, further expectations, relevant actions, and eventually good performance, the hypothesis 1 and 3 are developed with the independent variables (centralities) and dependent variables (individual work performance). Besides, one's connection strength

with others affect the relations of hypothesis 1 and 3, since it affects the quality, efficiency, diversity of one's received knowledge and thus the one's levels of powers, feelings, expectations, and actions. Thus the hypothesis 2, 4a and 4b are developed with moderating variables (tie strengths in formal network and advice network). Control variables include: major and diploma, representing one's general work-related knowledge and experience; job title, tenure, and rank, indicating one's specific work-related knowledge and experience.

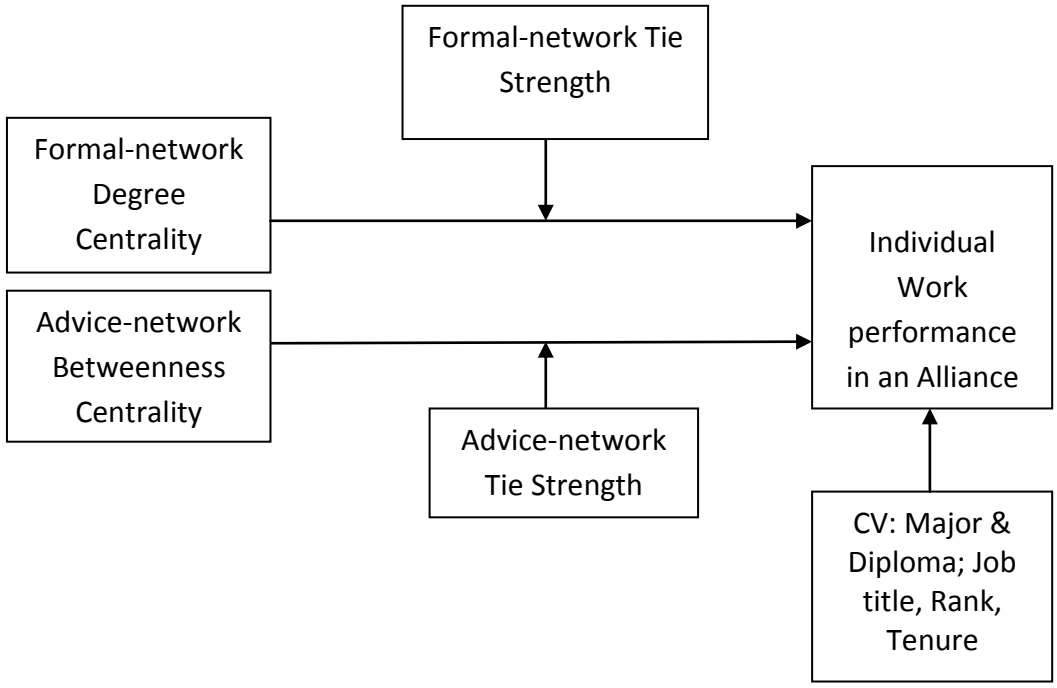


Figure1 The conceptual model

Method and Data

1. Organizational settings

In order to find more empirical support for the importance of network position and connections in the alliance's context from the theoretical perspective, this paper collected data from an alliance composed of a firm and a research institute. We have collected data about the full network of individuals involved in transferring knowledge. As working in the alliance is part of the employees' work, say, they also have work to do in their own organizations, the individuals involved in the alliance are smaller than the total number of individuals employed

in the two partners. It is common to work on analysis from such small networks (e.g. Tichy et al., 1979, Albrecht & Hall, 1991; Dholakia et al., 2004; Aalbers et al., 2013), and centrality analysis on such a scale or even sampled network data have been proven to be robust (Costenbader & Valente, 2003; Aalbers et al., 2013).

One company studied is a leading company producing fuel cell in China (the company), the other is a leading research institute focusing on chemical physics (the institutes), of which an important division is focusing on fuel cell research.

The company is a leading company focusing on the development and commercialization of fuel cells. It was founded in 2001, which now has 150 employees. The company is organized with unit structure with intensive cooperation among units. In the last year, the company also was trying to provide integrated technical solutions to customers as part of its strategies. For the reason that fuel cell is a pioneering field in China, and the company has no long history of relevant knowledge accumulation, it has been cooperating with the chemical physics research institute (with a form of alliance) that is good at the basic research of fuel cell. Through several interviews with the business manager, the selection of the units is completed based on their relevance and contribution to the alliance's performance.

The institute is the most authoritative and influential research organization in the field of chemical physics in China; it has several divisions, and the fuel cell division (50 employees) is one of them, which is also characterized with unit structure. Till 1999, the institute has made significant breakthrough in the field of fuel cell, achieved a fuel cell system with independent property right, as well as generated 26 highly influential patents and several proprietary technology. Declaring national and international major project that requires the data about research utility value, namely, the technology application data from basic research, as well as generating income from technology transfer and industrialization to support the basic research, the institute form the alliance with the company which is good at converting basic research into applicable technology. Through the interviews with the director in charge of the alliance cooperation, the selection unites from the fuel cell lab is completed according to their relevance and contribution to the alliance's performance.

The R&D Alliance (the alliance) is established in 2001, Dalian, China. It focuses on fuel cell technology development and application. It is organized by units which are divided by modules and coordinated by leaders and directors from both sides. Besides technology

seminar (introduction and discussion about international frontiers), personnel training (e.g. technology or technique consulting and training; testing method and standard consulting and training), consigned research, and consigned processing (technique development), the alliance also declares several national projects: (1) From basic research to technology application, such as the "advanced transportation system project"; (2) from the technology of hydrogen production to the relevant technology of fuel cell production, such as the "advanced energy project" (back-up battery for public facility and power station). For the reason that the company has other alliances such with automobile corporation, and the institute also has alliances with other companies, this study only selected all the staff and their relationship within the fuel cell alliance (the alliance) as the sample.

2. Data collection process

In order to test the formulated hypothesis, data on individual work performance in the alliance is collected with rating by the alliance's directors from both sides. Data on the social relations within both sides of the alliance are gathered from the individuals involved in the social networks of knowledge transfer, including formal network and advice network. This study follows Farace et al. (1977)'s definition about social network which is the repetitive patterns of interaction among members in an organization. Data at the individual level of the social networks of knowledge transfer within the alliance is collected through semi-structured interviews with managers and other employees as well as by means of an ego centric network survey. The interviews served a two purposes: first, to be familiar with the organizational setting and thus gain useful information for the design of the network survey; second, to determine the appropriate response group within the alliance. This study uses snowball methodology to complete this survey. Snowball sampling is especially useful when the population is not clear from the beginning (Marsden, 1990, 2002; Wasserman & Faust, 1994), which is the case for the alliance composed of part of the two organizations' employees, especially the unclear individuals in the advice network since contacts are not mandated. Snowball sampling involves several rounds of surveying or interviewing. The first round helps to determine who will be the respondent in the second round, and so forth.

The survey was first tested with a small sample of respondents whom had been personally informed of the study's purpose to enhance their cooperation. The final version of the survey was sent in three rounds in both of the organizations of the alliance. The respondents (26 and 24) of formal network and advice network involved in the alliance from the company by this

first round named the respondents for the second round (5 and 4), who named another round of respondents. Similarly, the respondents (20 and 21) of formal network and advice network involved in the alliance from the institute by this first round named the respondents for the second round (11 and 9), who named another round of respondents. After the third round, the survey was closed.

The total respondent within the alliance in each network are 66. The formal network has 312 knowledge transfer ties, and the advice network has 273 knowledge transfer ties. The final response rate on the company side is 97%, only 3% did not respond to the first mailing and the later three reminder mailings; the response rate on the institute side is 100%.
The invitation to participate in the survey was distributed by each partner's director of the alliance with e-mail to each of the organizations, accompanied by the introduction of the survey and the hyperlink to the online survey. An online survey was chosen to reduce the time needed to complete the questionnaire. We provided a guideline of naming seven employees to make sure that only the most important contacts per employee were mentioned. To reduce ambiguity regarding the interpretation of the questions by the respondents, the network questions were formulated in the native language.

Variables

The formal network was measured by asking individual respondents to whom they are supposed to discuss ideas, solutions at work; the advice network was measured by asking individual respondents to whom they ask for advice besides the formal contacts when they meet problems at work (Borgatti & Cross, 2003; Cross & Prusak, 2002; Rodan, 2010). Based on the network data gained via the survey, the dependent variables and moderating variables were calculated by using Ucinet 6.0 (Borgatti et al., 2002; Freeman, 1979).

1 Dependent variable

Individual work performance is measured by means of "Likert 7 Scale" in an ascending order, which means higher rating, better performance. The work performance includes five dimensions: individual work quality, efficiency, innovativeness, knowledge, and interpersonal capability (Barrick, et al., 1993; Welbourne, et al., 1998; Rodan & Galunic, 2004; Cross & Cummings, 2004; Steward, et al., 2012). The five dimensions are rather significant for

indicating one's work performance in the R&D alliance, for the reasons as the follows: first, R&D alliance usually is established to develop feasible and basic technology or platform for future competitiveness and development in a long term, which in turn implies the evaluation of individual performance should involve work quality; second, the developed technology and platform is frontier, which requires individual innovativeness and knowledge; third, the alliance usually is a temporary organization, and potential rivals probably are also investing the same frontier field, thus individual work efficiency is also critical; forth, alliance is composed of two and above partners that probably have different strategy, culture and knowledge sharing mode, which in turn implies that interpersonal capability is vital in the cooperation and knowledge transfer.

2 Independent variables

2.1 Degree centrality

Degree centrality was calculated by counting how many contacts one has (Brass, 1984; Balkundi & Harrison, 2006; Bono & Anderson, 2005; Mehra et al., 1998, Cross & Cummings, 2004). It focuses on the direct contacts of one, and has been identified as the direct description of one's communication status (Freeman, 1979). The higher degree centrality one has, the more contacts he or she has, and more knowledge sharing with others in the R&D context, especially in the formal network in which one's contacts are mandated.

2.2 Betweenness centrality

Betweenness centrality was calculated by how many contacts one has when he or she plays the mediator role (Freeman, 1979; Wasserman & Faust, 1994; Borgatti, 2005). It involves the structural position of actors in the whole network, and focuses the actor's position as a mediator in the whole network. It has been identified as a significant indicator describing one's information diversity and communication control (Freeman, 1979; Borgatti, 2005). Betweenness centrality measures how important one occupies a network position in the information flow. Thus, the higher betweenness centrality, the more important position the actor has, which in turn means more actors have to interact with others through this actor. This study prefers betweenness centrality to degree centrality in the advice network for the reason that in the advice network contacts are not mandated, as well as the advice seeker and the final advice provider usually do not know each other very well. Hence, assuming that the advice seeking is a constant attempt for obtaining the relevant information for solving one's

problem at work, the one with high betweenness centrality has more diverse information flow and more power to control the flow.

3 Moderating variable

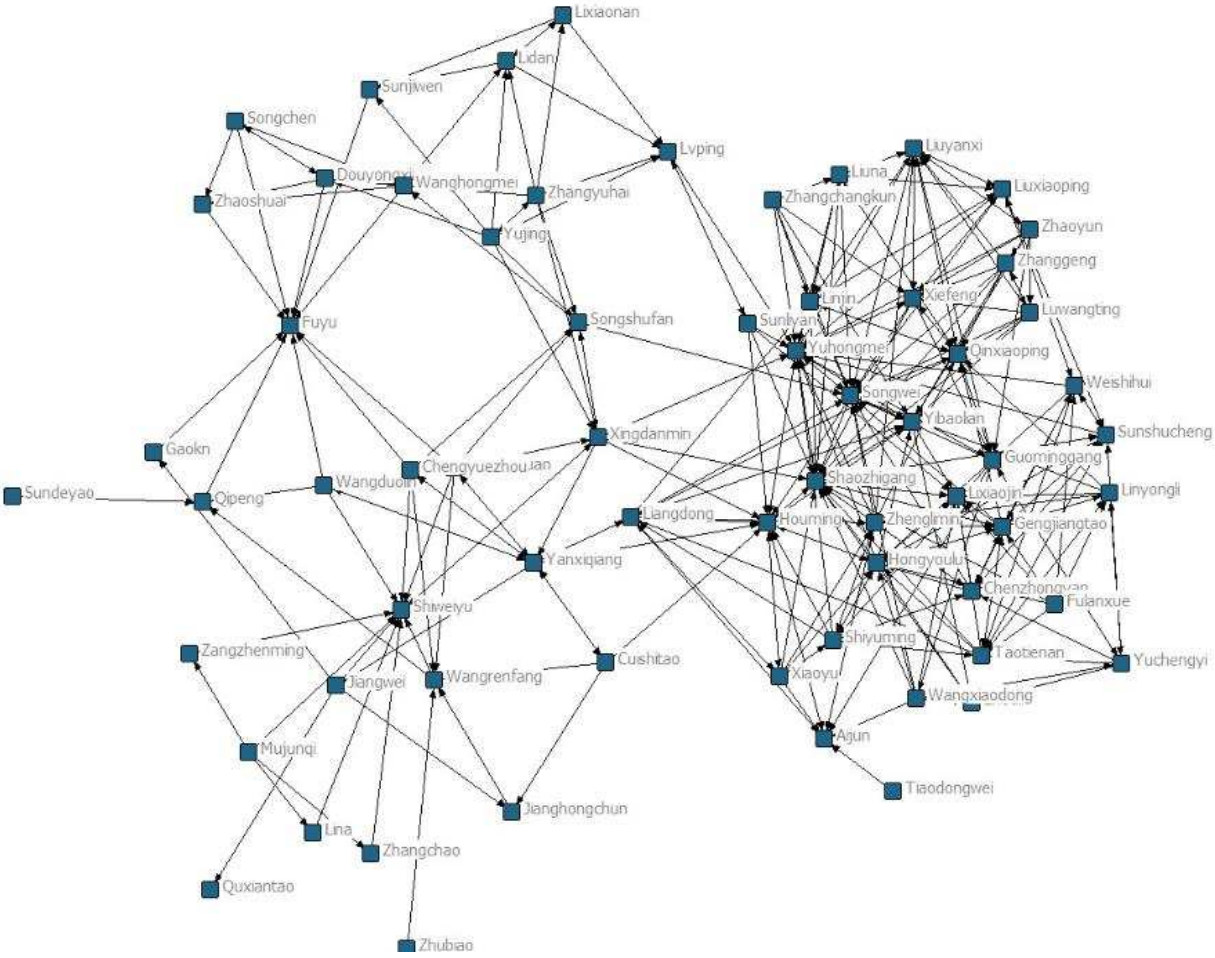
Tie strength is calculated by means of "7 Grade Scale" about interaction frequency in an ascending order, which means higher grade, higher tie strength (Hansen, 1999; Levin & Cross, 2004). Tie strength focuses on how frequent actors interact with each other within a time phase, and has been used commonly as the way for describing the actors' intimacy in a network. In the R&D alliance networks, higher tie strength means more interaction with others and more knowledge exchange.

4 Control variables

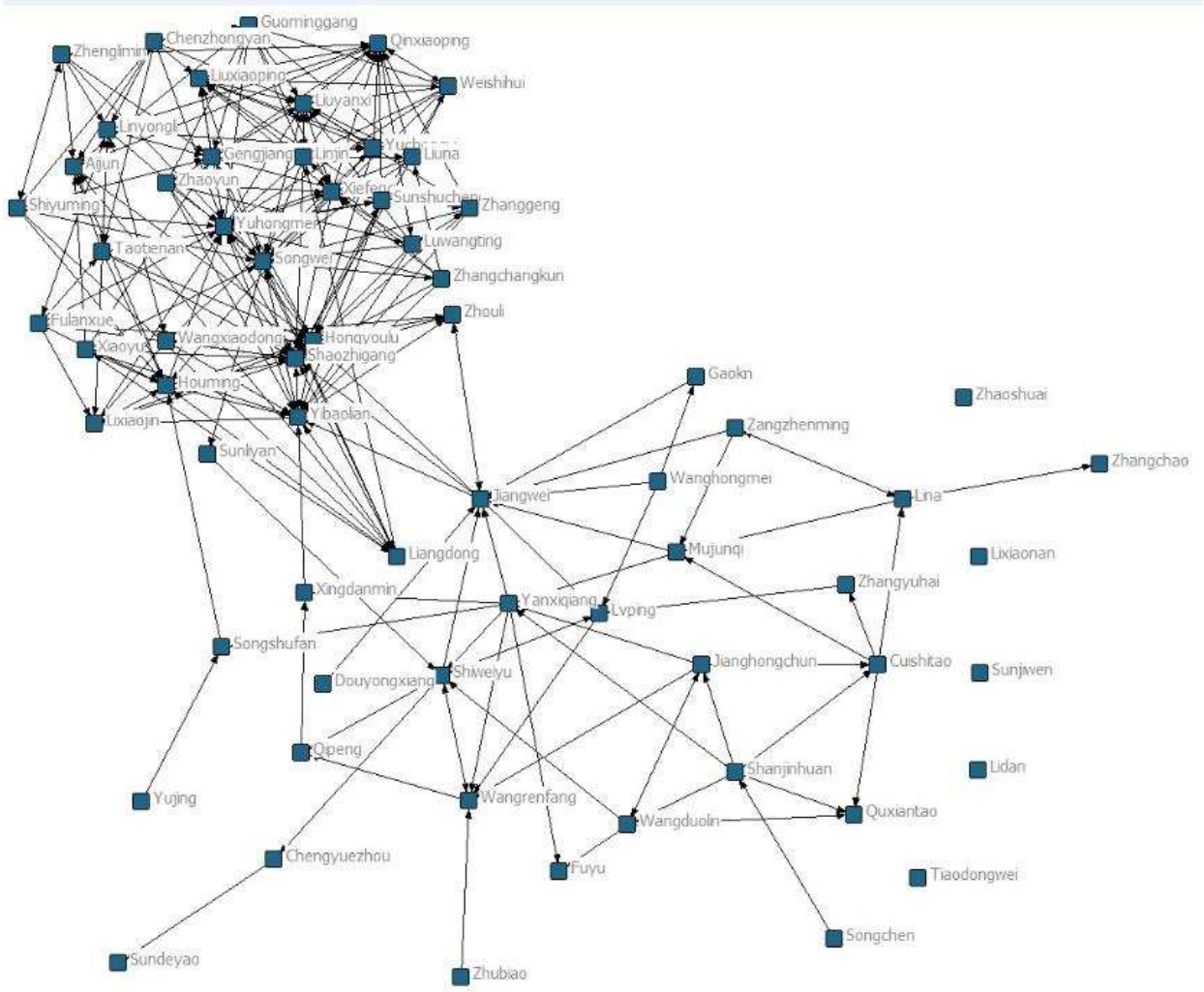
Two aspects are involved as controls: education and specific knowledge in work. Education includes major and diploma which are respectively measured with nominal variable (different numbers represent different majors) and ordinal variable (from 1 to 5, every number represents a diploma degree in ascending order) indicating one's general study field and time length of studying in it. Specific knowledge in work involves job title, rank and tenure which are respectively measured with nominal variable (0 or 1 represent job titles indirectly or directly relevant with R&D work), ordinal variable (from 1 to 5, every number represents every job rank in ascending order), and interval variable (number of months) indicating one's specific work content, career achievement, and time length of working in the specific field.

Analysis

General connection status of formal network and advice network are presented in Graph 1 and 2. Descriptive results are presented in Table 1 which shows the means, standard deviations, and zero-order correlations of each of the variables in the two networks. Table 2 reports the factor analysis of dependent variable.



Graph 1 The formal network



Graph 2 The advice network

Table 1 Descriptive statistics

	Variable	Means, standard deviation and correlations										
		Mean	Std.dev.	1	2	3	4	5	6	7	8	9
1	Major	2.55	2.60									
2	Diploma	3.58	1.11	-0.32**								
3	Job title	0.92	0.27	-0.12	0.10							
4	Rank	1.98	1.26	0.12	0.37**	0.09						
5	Tenure	62.94	57.00	0.15	-0.04	0.04	0.57**					
6	Work performance	5.94	0.69	-0.19	0.39**	-0.01	0.47**	0.38**				
7	Degree centrality	11.74	6.93	-0.24	0.30*	0.11	0.26*	0.14	0.60**			
8	Betweenness centrality	2.06	3.15	-0.22	0.26*	-0.09	0.36**	0.19	0.42**	0.52**		
9	Formal-network tie strength	5.39	1.06	-0.12	0.04	-0.05	-0.10	-0.14	0.11	0.06	0.00	
10	Advice-network tie strength	4.44	1.89	-0.21	0.16	0.14	-0.18	-0.22	0.07	0.22	0.11	0.32**

N=66.

* A significance level of 5%.

** A significance level of 1%.

*** A significance level of .1%.

Table 2 Factor analysis of dependent variable

Construct item	Item wording	Factor loadings and Cronbach's α
Individual work performance		α =0.868
1	He or she did contribution to the alliance's performance with his or her work output quality	0.866
2	He or she did contribution to the alliance's performance with his or her work efficiency	0.879
3	He or she did contribution to the alliance's performance with his or her innovativeness	0.915
4	He or she did contribution to the alliance's performance with his or her job knowledge	0.786
5	He or she did contribution to the alliance's performance with interpersonal ability	0.597

This study utilizes the ordinary least squares multiple regression to test the hypotheses (Table 3). We involve 66 observations of the formal network, and 66 observations of the advice network. With bootstrapping, we first examine the control variables' effects on individual work performance in the two networks, in model A0. Then we add the main factor of degree centrality in formal network and betweenness centrality in advice network, in models A1 and B1, respectively. Afterwards, tie strength in the two networks are involved in separately to test its moderating effects, in models A2 and B2, respectively. Then the effect of main factors and moderating factors are tested when the two networks are involved simultaneously, in models C1 and C2. As suggested by Kenny and Judd (1984) and Aiken and West (1991), all the variables are mean centered to avoid multicollinearity before the regressions, and the results shows that there is no multicollinear problem—the VIF value is below 2.393.

Results

The multiple regression analysis in table 3 displays the findings with regard to hypothesis 1 and 2, 3 and 4. Running the models with solely control variables in model A0, model A1 and model B1 respectively introduce degree centrality and betweenness centrality as independent variables of the two networks. Formal-network tie strength and advice-network tie strength are involved as moderating variables in model A2 and B2. Table 3 also presents the results of the multiple regression analysis, introducing independent and moderating variables in a multiple network context: from model C1 to model C2, independent variables and moderating variables are involved respectively. The involvement of independent and moderating variables significantly increase model fitness of the two networks, especially in models C1 and C2 (Model C1: F-test for ΔR^2=11.214, p<.001; Model C2: F-test for ΔR^2=4.014, p<.01). As hypothesis 1 suggests, an individual's degree centrality in the formal network significantly enhances work performance: hypothesis 1 is supported in model A1, C1 and C2. Hypothesis 2 suggests that tie strength enhances degree centrality's effect on work performance: hypothesis 2 is supported in model A2 and C2 . However, good positioning in the advice network, by having what should be a favorable betweenness centrality, does not play a significant role in individual work performance: hypothesis 3 cannot be unilaterally supported. The beta in model B1 is positive (beta = 0.249, p<.05); the beta in model C2 however is negative (beta = -0.226, p<.05). Besides, the moderating effect in the advice network is significant in model C2, but not significant in model B2: contrary to what we expected in hypothesis 4a, the hypothesis 4b is supported in model C2; neither hypothesis 4a nor 4b is supported in model B2.

Table 3 Centrality, tie strength, and work performance

D.V.	A 0	A 1	A 2	B 1	B 2	C 1	C 2
Controls							
Major	-0.192*	-0.094	-0.088	-0.130	-0.124	-0.098	-0.101
Diploma	0.252	0.178	0.201*	0.217*	0.200	0.188	0.193
Job title	-0.090	-0.112	-0.106	-0.049	-0.066	-0.114	-0.143*
Rank	0.243	0.160	0.183	0.168	0.195	0.134	0.237
Tenure	0.279*	0.246*	0.268*	0.240*	0.251*	0.261*	0.270*
IVs							
Degree centrality (FN)		0.463**	0.451***			0.457***	0.657***
Betweenness centrality (AN)				0.249*	0.231*	0.013	-0.226*
MV							
Tie strength (FN)			0.182**				0.233***
Tie strength (AN)					-0.032		-0.340**
N	66	66	66	66	66	66	66
F-value	6.537***	11.226***	9.514***	6.489***	4.901***	9.463***	8.733***
R^2	0.353	0.533	0.572	0.398	0.408	0.533	0.640
Adjusted R^2	0.299	0.486	0.512	0.336	0.324	0.477	0.567
F-test for ΔR^2		22.797***	2.577	4.400*	0.478	11.214***	4.014**

* p<.05.

** p<.01.

*** p<.001.

Discussion

Though alliance study has become a hot issue, and has attracted many scholars attention, the situation inside alliances is still not clear (Zollo & Winter, 2002). This study investigated the individual work performance based on knowledge sharing and creation within the alliance. Suggested by literatures about social capital, knowledge sharing, knowledge creation and individual work performance in single organizations, social network analysis (SNA) is deployed to dimensionally explore the social capitals' effect on individual work performance in the context of R&D alliances, for the reason that SNA involves the three dimensions of social capital and better suits R&D alliance context that has an apparent organizational boundary and is relatively flexibly organized. We empirically investigated the relation among individual social network position, social interaction frequency, and work performance. From the results we find that individual network position and interaction frequency with contacts do have effects on work performance, especially in the formal network; but in the advice network, social interaction frequency' effect is not so obvious. Besides, when the two networks are integrated, the advice-network position's effect will be significantly negative, which in turn is quite beyond expectation.

Theoretical contributions and implications

Nahapiet and Ghoshal (1998) suggested that social capital has three dimensions: structural, cognitive, and relational, which are respectively embedded in social network configuration, shared visions and narratives, and trust and reciprocity (Nahapiet & Ghoshal, 1998; Tsai & Ghoshal, 1998; Inpken & Tsang, 2005; Wasko & Faraj, 2005; Chiu et al., 2006). Wasko and Faraj (2005) found that centrality based structural capital has positive effect on knowledge contribution while reciprocity based relational capital does not. However, in specific contexts, the bases of the two kinds of social capitals are different. Our study contributes to the theory about bases of structural capital and relational capital in the specific contexts of different social networks of an R&D alliance. Previous studies suggested that structural capital and relational capital are instrumental for knowledge exchange, creation and related work performance (Tsai & Goshal, 1998; Nahapiet & Ghoshal, 1998; Wasko & Faraj, 2005; Chiu et al., 2006), but it is not clear about what the mechanism is. Out study contributes to the theories of social capitals' roles in different social-network contexts of R&D alliances, and learning mechanism within R&D alliances. Besides, Tsai and Ghoshal (1998) found the structural dimension has positive relation with the relational dimension, but our study concluded differently with different capital bases in the R&D alliance context. Last, our study

challenged the theory of structural hole advantage, suggesting that the advantage is conditional when more than one kind of social networks are involved.

Social capital and formal network

Social network position implies structural dimension of one's social capital. Studies suggested that the structural capital is based on centrality (Wasko & Faraj, 2005; Tsai & Ghoshal, 1998). But in the context of formal network of R&D alliance, since the formal network is formed through mandating based on individual expertise, degree centrality will be the explicit base of the structural capital, which in turn means the individual with excellent expertise in one field will have high degree centrality in the network. Thus, the structural capital based on degree centrality brings the individual positional power which also gives rise to the actor's expert power; with the powers and through the required interaction between contacts in the formal network, the actor can access more knowledge resource, since every contact has to discuss and share knowledge with the actor. The powers are related to positive feeling, work expectation, and actions (obtain, absorb and create knowledge), leading to better work performance. The relational capital base on interaction frequency indicated by tie strength in the formal network enhances the structural capital's advantage, since more interaction with contacts enables the individual stronger powers and more in-depth access to knowledge. Apart from the roles, there are relations between the capitals. Tsai and Ghoshal (1998) found that structural capital has positive effect on relational capital. From our findings, the relational capital also has moderating effect on structural capital's effect in the formal network of R&D alliance, since it strengthen or weaken the structural capital's role. However, in the formal network, the social capitals' dimensions are formed under the conditions of mandating, thus it is necessary to study if the weights and relations of social capitals' dimensions are different under other conditions.

Social capital and advice network

Different from formal network, the formation of advice network is based on reputation admiration, expertise relevance, and non-explicit knowledge which cannot easily be shared in the formal network. However, in the context of R&D alliance, the organizational boundary between partners exist, meaning that the actor playing the roles such as gatekeeper will have a central position connecting other actors who cannot be connected without the actor, and the contacts may be working in different areas of one or several project(s). Thus, betweenness centrality indicating such advantageous network position is the base of the structural capital in

the context of advice network. The structural capital based on betweenness centrality give rise to the positional power as well as the informational power which enable the individual obtaining diverse knowledge and even controlling the knowledge flow. The powers associates with advantageous feeling, further work expectation, and actions for accessing and processing much and diverse knowledge, which in turn also leads to better work performance. Meanwhile, the relational dimension plays a different role. Studies suggested the relational capital is based on interaction between direct contacts (Wasko & Faraj, 2005; Nahapiet & Ghoshal, 1998). However, unlike the one in the formal network, the relational capital in the advice network is based on both the interaction frequency with direct contacts and the interaction frequency between direct contacts and indirect contacts, since the actor with high betweenness centrality obtains knowledge from direct contacts who may obtain their knowledge from their direct contacts who are the indirect contacts of the actor. Thus, as the results show that the tie strength which normally only indicate the interaction frequency with direct contacts cannot significantly moderate the relation between betweenness centrality and work performance. Hence, in the advice network, the relational capital cannot strengthen or weaken the structural capital's roles if the relational capitals with two bases are not both involved. Thus, in different contexts, the two dimensions of social capitals link with each other and play roles with different bases: structural dimension may have two bases--degree centrality and betweennes centrality; relational dimension may also have two bases interaction frequency with direct contacts and interaction frequency between direct and indirect contacts. For further study, it is necessary to investigate how the combination of the two relational capitals affect the structural capital's roles, as well as what combination of the them will maximize their roles in enhancing the structural capital's roles.

Multiplexity

In the R&D alliance, due to the organizational boundary between partners within the alliance, job requirements about knowledge sharing obligations, and the limited working hours, if one individual has high degree centrality in the formal network as well as high betweenness centrality in the advice network, knowledge will be more likely transferred in the formal network, which in turn means the degree centrality and tie strength in formal network will have stronger and more significant effect on the individual work performance. Thus, in an R&D alliance, an individual with high degree centrality in the formal network, low betweenness centrality in the advice network, or vice versa, will have feasible chances to utilize the powers to obtain and create knowledge to achieve better work performance within

the time constraints. This means in the context of multiplexity, one's structural and relational capitals play conditional roles, and their relationships are also conditional.

Specifically, if one actor has high level of structural capitals based both on degree centrality and betweenness centrality, say, the individual has high level of degree centrality in the formal network and betweenness centrality in the advice network, for the objective reasons suggested above, finally the degree centrality based capital will play a significant and positive role in one's learning and work performance. However, if one individual has high level of structural capital with one base and low level with the other, the constraints will be weak, and the roles of either structural capital will be significant and positive. Thus, in the multiplexity which is more realistic in R&D alliances, structural capital will play positive and significant roles with only one primary base.

As discussed above, due to the constraints, when one actor has high level of the two structural capitals in both formal network and advice network, knowledge will more likely be transferred in the formal network, thus only the relational capital based on the interaction frequency with direct contacts will positively and significantly strengthen the relation between the structural capital and individual work performance. When one actor has low level of degree centrality in the formal network and high level of betweenness centrality in the advice network, the relational capitals based on the interaction frequency with indirect contacts as well as the interaction frequency between direct contacts and indirect contacts will play roles in the advice network by strengthening or weakening the structural capitals' roles. However, high level of relational capitals with one base and low level of relational capitals with the other, or vice versa, could both strengthen the other two social capitals' effect since either combination could enhance the structural capitals' roles within a limited work time frame. Thus, it is necessary to further study if the two combinations' effects are same, and which one is stronger if they are not.

Furthermore, from the results, we can notice that social capitals with different bases may have conflicts and competitions with each other: if the degree centrality based and betweenness centrality based structural capitals are both at high level, they will not coexist for the reasons of constraints discussed above, and finally the former will take over the latter; the situation is similar when it comes to relational capitals. In the multiplexity, when the proportion of the same dimensional social capitals with different bases is adequate, the two differently based capitals in the same dimension will not compete with each other but rather coexist.

The results also questioned the general theory about the advantages of structural hole. In the theory (Burt, 1982), structural hole implies the chance for exchanging needed or valuable resources in the social network. From the perspective of social network position, the actor who has high betweenness centrality will play as a structural hole which connecting the other actors who cannot be connected without the actor. However, in the R&D alliance, when both formal network and advice network are involved, and one actor has high level of both degree centrality and betweenness centrality in the two networks, knowledge will mostly flow in the formal network, which in turn that the structural hole's advantage indicated by betweenness centrality in the advice network will not exist. On the contrary, if one actor has high betweenness centrality in advice network, and low degree centrality in formal network, there will be diverse knowledge flowing through the actor and the advantage of structural hole will be reflected. It is reasonable to suggest that when more than one type of social network is involved, the advantage of structural hole is conditional; it depends on the specific context.

Managerial implications

This study explored the two social capitals' roles (structural and relational) in individual knowledge sharing, learning, creating, and work performance in different social networks (formal network, advice network, and multi-network) of an R&D alliance. We found how different social capitals affect one's learning and work performance in different dimensions, and how they give rise to powers and consequences to achieve good work performance. Management should pay more attention to one's social network profile within the alliance which could give many hints for the one's social capitals and possible routes to improve the one's work performance. Besides, this study also found the two dimensions of social capitals have their own bases, and the social capitals' roles and relations will be different if the status of bases changes. This could provide more detailed clues about the mechanisms and principles of improving individual performance in an R&D alliance.

Limitations and directions for future research

This study is distinctive at deploying SNA to dimensionally study social capitals' roles in individual learning mechanism and work performance inside an R&D alliance at individual level, as well as the relevant empirical analysis, thus firmer conclusions could be drawn about alliance governance than the ones stemming from relatively macro-level study which takes alliance as an "individual". Nevertheless, there still are limitations in this paper: first, considering this is a case study, we need more R&D alliances to test if the theory developed

by this paper is tenable to alliances in different industries. Second, this study is a cross-section study without time variable; thus time factor should be included to comprehensively analyze the different social capitals' roles and relations in individual learning and work performance within an R&D alliance. Besides, the effects of the different combinations of relational capitals with the two bases in R&D alliances' advice network are left for further research.

References

Aalbers, R., Dolfsma, W., & Koppius, O. (2013). Individual connectedness in innovation networks: On the role of individual motivation. Research Policy, 42(3), 624-634.

Adler PS, Borys B. 1996. Two types of bureaucracy: Enabling and coercive. Administrative Science Quarterly,41: 61-89.

Aiken, L. S., & West, S. G. 1991. Multiple regression: Testing and interpreting interactions. California: Sage.

Albrecht, T. L., & Hall, B. J. (1991). Facilitating talk about new ideas: The role of personal relationships in organizational innovation. Communications Monographs, 58(3), 273-288.

Anand, B. N., & Khanna, T. (2000). Do firms learn to create value? The case of alliances. Strategic management journal, 21(3), 295-315.

Anderson, M. H. 2008. Social networks and the cognitive motivation to realize network opportunities: A study of managers' information gathering behaviors. Journal of Organizational Behavior, 29: 51–78.

Balkundi & Harrison, 2006. Ties, Leaders, and Time in Teams: Strong inference about network structure's effects on team viability and performance. Academy of Management Journal, 49(1): 49-68.

Barrick, M. R., Mount, M. K., & Strauss, J. P. (1993). Conscientiousness and performance of sales representatives: Test of the mediating effects of goal setting. Journal of Applied Psychology, 78(5), 715-722.

Barringer and Harrison, 2000. Walking a tightrope: Creating value through inter-organizational relationships. Journal of Management, 26: 367-403.

Bleeke, J., & Ernst, D. 1993. Collaborating to compete. New York: Wiley.

Bono & Anderson, 2005. The advice and influence networks of transformational leaders. Journal of Applied Psychology, 90(6):1306-14

Borgatti, S. P. (2005). Centrality and network flow. Social Networks, 27(1), 55-71.

Borgatti, S. P., & Cross, R. (2003). A relational view of information seeking and learning in social networks. Management science, 49(4), 432-445.

Borgatti, S. P., Everett, M. G., & Freeman, L. C. (2002). UCINET 6 for Windows. Harvard: Analytic Technologies.

Brass, 1984. Being in the right place: A structural analysis of individual influence in an organization. Administrative Science Quarterly, 29(4): 518-539.

Bruins, J. (1999). Social power and influence tactics: A theoretical introduction. Journal of Social Issues, 55(1), 7-14.

Burt, R. S. 1982. Toward a structural theory of action. New York: Academic Press.

Burt, R. S. 1992. Structural holes: The social structure of competition. Cambridge, MA: Harvard University Press.

Burt R. 2004. Structural holes and good ideas. American Journal of Sociologym,110: 349–399.

Chiu, C. M., Hsu, M. H., & Wang, E. T. (2006). Understanding knowledge sharing in virtual communities: An integration of social capital and social cognitive theories. Decision Support Systems, 42(3), 1872-1888.

Coleman, J. S. 1990. Foundations of social theory. Cambridge, MA: Belknap.

Coff, R., & Kryscynski, D. 2011. Drilling for micro-foundations of human capital based competitive advantages. Journal of Management, 37: 1429-1443.

Conner, K. R., C. K. Prahalad. 1996. A resource-based theory of the firm: Knowledge versus opportunism. Organization Science, 7(5): 477-501.

Costenbader, E., & Valente, T. W. (2003). The stability of centrality measures when networks are sampled. Social Networks, 25(4), 283-307.

Cross, R., Cummings, J. N., 2004. Tie and Network Correlates of Individual Performance in Knowledge-Intensive Work. Academy of Management Journal, 47: 928-937.

Cross, R., & Prusak, L. (2002). The people who make organizations go-or stop. Harvard Business Review, 80(6), 104-112.

D'Aspremont and Jacquemin, 1988. Cooperative and noncooperative R&D in duopoly with spillovers. American Economic Review, 78: 1133–1137.

Dholakia, U. M., Bagozzi, R. P., & Pearo, L. K. (2004). A social influence model of consumer participation in network-and small-group-based virtual communities. International Journal of Research in Marketing, 21(3), 241-263.

Dickson, P. H., Weaver, K. M., & Hoy, F. (2006). Opportunism in the R&D alliances of SMEs: The roles of the institutional environment and SME size. Journal of Business Venturing, 21(4), 487-513.

Dosi, G. (1982). Technological paradigms and technological trajectories: a suggested interpretation of the determinants and directions of technical change. Research policy, 11(3), 147-162.

Draulans, J., DeMan, A. P., & Volberda, H. W. (2003). Building alliance capability: Management techniques for superior alliance performance. Long Range Planning, 36(2), 151-166.

Erchul, W. P., & Raven, B. H. (1997). Social power in school consultation: A contemporary view of French and Raven's bases of power model. Journal of School Psychology, 35(2), 137-171.

Ernst, H., Lichtenthaler, U., Vogt, C., 2011. The Impact of Accumulating and Reactivating Technological Experience on R&D Alliance Performance. Journal of Management Studies, 48: 1194-1216.

Farace, R. V., Monge, P. R., & Russell, H. M. (1977). Communicating and organizing (Vol. 1077). Reading, MA: Addison-Wesley.

Fleming, L., Mingo, S., & Chen, D. 2007. Collaborative brokerage, generative creativity, and creative success. Administrative Science Quarterly, 52: 443–475.

Freeman, L. C. 1979. Centrality in social networks: Conceptual clarification. Social Networks, 1: 215–239.

Galinsky, A. D., Gruenfeld, D. H., & Magee, J. C. (2003). From power to action.Journal of personality and social psychology, 85(3), 453.

Gargiulo, M., Ertug, G., & Galunic, C. (2009). The two faces of control: Network closure and individual performance among knowledge workers. Administrative Science Quarterly, 54(2), 299-333.

Gavetti, G. 2005. Cognition and hierarchy: Rethinking the microfoundations of capabilities' development. Organization Science, 16: 599-617.

Granovetter, M. S. 1973. The strength of weak ties. American Journal of Sociology, 78: 1360–1380.

Grant, R. M. (1996) a. Towards a knowledge-based theory of the firm. Strategic Management Journal, 17, 109–22.

Grant, R. M. (1996) b. Prospering in dynamically-competitive environments: Organizational capability as knowledge integration. Organization Science, 7(4), 375-387.

Stewart, G. L., Courtright, S. H., & Barrick, M. R. (2012). Peer-based control in self-managing teams: Linking rational and normative influence with individual and group performance. Journal of Applied Psychology, 97(2), 435–447.

Gulati, 1995. Social structure and alliance formation patterns: a longitudinal analysis. Administrative Science Quarterly, 40: 619–652.

Gulati R, Puranam P. 2009. Renewal through reorganization: the value of inconsistencies between formal and informal organization. Organization Science, 20(2): 422-440.

Hamel, 1991. Competition for competence and inter-partner learning within international strategic alliances. Strategic Management Journal, 12: 83–103.

Hansen, M. T. 1999. The search-transfer problem: the role of weak ties in sharing knowledge across organizational subunits. Administrative Science Quarterly, 44: 82-111.

Hansen, M. T. 2002. Knowledge networks: Explaining effective knowledge sharing in multiunit companies. Organization Science, 13: 232–248.

Heimeriks, K.H., Duysters, G., 2007. Alliance capability as a mediator between experience and alliance performance: An empirical investigation into the alliance capability development process. Journal of Management Studies, 44: 25-49.

Hoang, H. and Rothaermel, F. T. (2005). The effect of general and partner-specific alliance experience on joint R&D project performance. Academy of Management Journal, 48, 332–345.

Ibarra, H. (1993). Network centrality, power, and innovation involvement: Determinants of technical and administrative roles. Academy of Management Journal, 36(3), 471-501.

Inkpen, A. C., & Tsang, E. W. (2005). Social capital, networks, and knowledge transfer. Academy of Management Review, 30(1), 146-165.

Ireland, R. D., Hitt, M. A., & Vaidyanath, D. (2002). Alliance management as a source of competitive advantage. Journal of Management, 28(3), 413-446.

Johnson, G., Melin, L., Whittington, R., 2003. Micro strategy and strategizing: Towards an activity-based view. Journal of Management Studies, 40: 3-22.

Katz ML. 1986. An analysis of cooperative research and development. RAND Journal of Economics, 17: 527–543.

Keltner, D., Gruenfeld, D. H., & Anderson, C. (2003). Power, approach, and inhibition. Psychological Review, 110(2), 265-284.

Kenny, D. A., & Judd, C. M. (1984). Estimating the nonlinear and interactive effects of latent variables. Psychological Bulletin, 96(1), 201-210.

Kogut, B. 1989. The stability of joint ventures: Reciprocity and competitive rivalry. Journal of Industrial Economics, 38(2): 183–198.

Kogut, B., U. Zander. 1996. What firms do? Coordination, identity, and learning. Organization Science, 7(5): 502-518.

Lai, W. H., & Chang, P. L. (2010). Corporate motivation and performance in R&D alliances. Journal of Business Research, 63(5), 490-496.

Langlois, R. N., N. J. Foss. 1999. Capabilities and governance: The rebirth of production in the theory of economic organization. Kyklos, 52(2): 201-218.

Lea, B. R., Yu, W. B., Maguluru, N., & Nichols, M. (2006). Enhancing business networks using social network based virtual communities. Industrial Management & Data Systems, 106(1), 121-138.

Leonard-Barton, D., & Sinha, D. K. (1993). Developer-user interaction and user satisfaction in internal technology transfer. Academy of Management Journal, 36(5), 1125-1139.

Lines, R. (2007). Using power to install strategy: the relationships between expert power, position power, influence tactics and implementation success. Journal of Change Management, 7(2), 143-170.

Marsden, P. V. (1990). Network data and measurement. Annual Review of Sociology, 16, 435-463.

Marsden, P. V. (2002). Egocentric and sociocentric measures of network centrality. Social Networks, 24(4), 407-422.

McFadyen, M. A., & Cannella, A. A. (2004). Social capital and knowledge creation: Diminishing returns of the number and strength of exchange relationships. Academy of Management Journal, 47(5), 735-746.

McFadyen, M. A., Semadeni, M., & Cannella Jr, A. A. (2009). Value of strong ties to disconnected others: Examining knowledge creation in biomedicine. Organization Science, 20(3), 552-564.

Mehra, A., Kilduff, M., & Brass, D. J. (1998). At the margins: A distinctiveness approach to the social identity and social networks of underrepresented groups. Academy of Management Journal, 41(4), 441-452.

Mehra, A., Kilduff, M., & Brass, D. J. (2001). The social networks of high and low self-monitors: Implications for workplace performance. Administrative Science Quarterly, 46(1), 121-146.

Merton, R. K. (1968). The Matthew effect in science. Science, 159(3810), 56-63.

Mody, 1993. Learning through alliances. Journal of Economic Behavior and Organization, 20: 151–170.

Morrison, E. W. (1993). Longitudinal study of the effects of information seeking on newcomer socialization. Journal of Applied Psychology, 78(2), 173-183.

Mors, M. L., 2010. Innovation in a global consulting firm: When the problem is too much diversity. Strategic Management Journal, 31: 841-872.

Motta, 1992. Cooperative R&D and vertical product differentiation. International Journal of Industrial Organization, 10: 643–661.

Nahapiet, J., S. Ghoshal. 1998. Social capital, intellectual capital and the organizational advantage. Academy of Management Review, 23: 242- 266.

Osborn and Hagedoorn, 1997. The institutionalization and evolutionary dynamics of inter-organizational alliances and networks. Academy of Management Journal, 40: 261–278.

Obstfeld, D. (2005). Social networks, the tertius iungens orientation, and involvement in innovation. Administrative Science Quarterly, 50(1), 100-130.

Oxley, J. E., & Sampson, R. C. (2004). The scope and governance of international R&D alliances. Strategic Management Journal, 25(8-9), 723-749.

Powell, Koput and Smith-Doerr, 1996. Inter-organizational collaboration and the locus of innovation: networks of learning in biotechnology. Administrative Science Quarterly, 41: 116–145.

Raven, B. H. (1993). The bases of power: Origins and recent developments. Journal of Social issues, 49(4), 227-251.

Reagans R, McEvily B. 2003. Network structure and knowledge transfer: the effects of cohesion and range. Administrative Science Quarterly, 48: 240–268.

Reinholt, M., Pedersen, T., Foss, N. J. 2011. Why a central network position isn't enough: the role of motivation and ability for knowledge sharing in employee networks. Academy of Management Journal, 54: 1277–1297.

Rodan, S. (2010). Structural holes and managerial performance: Identifying the underlying mechanisms. Social Networks, 32(3), 168-179.

Rodan, S., & Galunic, C. (2004). More than network structure: how knowledge heterogeneity influences managerial performance and innovativeness. Strategic Management Journal, 25(6), 541-562.

Sakakibara, M. (2002). Formation of R&D consortia: Industry and company effects. Strategic Management Journal, 23(11), 1033-1050.

Salant and Shaffer, 1998. Strategic R&D with spillovers, collusion and welfare. Journal of Industrial Economics, 42: 375–393.

Sampson, R. C. (2007). R&D alliances and firm performance: the impact of technological diversity and alliance organization on innovation. Academy of Management Journal, 50(2), 364-386.

Saxton, T. (1997). The effects of partner and relationship characteristics on alliance outcomes. Academy of Management Journal, 40(2), 443-461.

Schreiner, M., Kale, P., & Corsten, D. (2009). What really is alliance management capability and how does it impact alliance outcomes and success?. Strategic Management Journal, 30(13), 1395-1419.

Shan, 1990. An empirical analysis of organizational strategies by entrepreneurial high-technology firms. Strategic Management Journal, 11: 129–139.

Smith, K. G., Collins, C. J., & Clark, K. D. (2005). Existing knowledge, knowledge creation capability, and the rate of new product introduction in high-technology firms. Academy of Management Journal, 48(2), 346-357.

Sparrowe, R. T., Liden, R. C., & Kraimer, M. L. 2001. Social networks and the performance of individuals and groups. Academy of Management Journal, 44: 316–325.

MacAvoy, S. F. I. I., Robert, E., Theodore, M., Lynn, A., & Thomas, C. (1998). Alliance management: a view from the past and a look to the future. Journal of Management studies, 35(6), 747-772.

Spence, 1984. Cost reduction, competition, and industry performance. Econometrica, 52: 101–121.

Spender, J. C. (1996). Making knowledge the basis of a dynamic theory of the firm. Strategic management journal, 17, 45-62.

Subramaniam, M., & Youndt, M. A. (2005). The influence of intellectual capital on the types of innovative capabilities. Academy of Management Journal, 48(3), 450-463.

Suzumura, 1992. Cooperative and non-cooperative R&D in an oligopoly with spillovers. American Economic Review, 82: 1307–1320.

Tichy, N. M., Tushman, M. L., & Fombrun, C. (1979). Social network analysis for organizations. Academy of management review, 4(4), 507-519.

Tsai, W., & Ghoshal, S. (1998). Social capital and value creation: The role of intrafirm networks. Academy of Management Journal, 41(4), 464-476.

Uzzi, B. (1996). The sources and consequences of embeddedness for the economic performance of organizations: The network effect. American sociological review, 674-698.

Uzzi, B. (1997). Social structure and competition in interfirm networks: The paradox of embeddedness. Administrative science quarterly, 35-67.

Wasko, M. M., & Faraj, S. (2005). Why should I share? Examining social capital and knowledge contribution in electronic networks of practice. MIS Quarterly, 29(1), 35-57.

Wasserman, S., & Faust, K. 1994. Social network analysis: Methods and applications. New York: Cambridge University Press.

Welbourne, T. M., Johnson, D. E., & Erez, A. (1998). The role-based performance scale: Validity analysis of a theory-based measure. Academy of management journal, 41(5), 540-555.

Ziss, 1994. Strategic R&D with spillovers, collusion and welfare. Journal of Industrial Economics, 42: 375–393.

Zollo, M., & Winter, S. G. (2002). Deliberate learning and the evolution of dynamic capabilities. Organization Science, 13(3), 339-351.