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Essay on the internal dynamics of an R&D alliance

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Essays on the internal dynamics of an R&D alliance – what determines the individuals' contribution to the alliance?

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Essay on the internal dynamics of an R&D alliance

What determines the individuals' contribution to the alliance?

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Contents

Chapter 1

Introduction

1.1 R&D alliance

It is a tendency that firms increasingly ally with other firms to conduct R&D activities (Gulati, 1995; Osborn and Hagedoorn, 1997; Powell, Koput and Smith-Doerr, 1996). Resource based theory (RBT) and transaction cost theory (TCT) both specify that firms with resource deficits reach into external environment to obtain needed resources (Barringer and Harrison, 2000), and firms will try to obtain needed resources via alliances when the resources are not available in markets. R&D alliance is defined as the technical cooperation between two and above firms (organizations), via knowledge exchange and related collaboration to achieve certain targets (Gulati, 1995). In an R&D alliance, with the knowledge and technology complementarity, a firm has opportunities of internalizing the knowledge, skills or competencies of the other(s) to create next-generation competencies (Hamel, 1991; Mody, 1993; Shan, 1990). In addition, an R&D alliance implies sharing fixed costs among R&D participants, realizing economies of scale in R&D, and avoiding "wasteful" duplication (d'Aspremont and Jacquemin, 1988; Katz, 1986; Motta, 1992; Spence, 1984; Suzumura, 1992; Ziss, 1994). Moreover, an alliance improves market access through risk sharing among partners and collection of government subsidies (Sakakibara, 2002).

Despite alliance activity in many firms grows, the performance of these alliances often do not meet expectations (e.g. Bleeke and Ernst, 1993; Kogut, 1989), and about 50% of the alliances fail yet (Ernst et al., 2011). Toward this phenomenon, a sum of studies provided different explanations. They tried to study alliances from several perspectives, such as

structure, routines, capabilities, and culture (Anand and Khanna, 2000; Dickson et. al., 2006; Draulans et. al., 2003; Ernst et. al., 2011; Heimeriks and Duysters, 2007; Hoang and Rothaermel, 2005; Ireland et. al., 2002; Lai and Chang, 2010; Michelfelder and Kratzer, 2013; Oxley and Sampson, 2004; Sampson, 2007; Saxton, 1997; Schreiner et. al., 2009; Spekman et. al., 1998). However, most of them are focusing on firm-, or group-level. Although Das (2012) pointed out that close and vigorous interactions among alliance members are vital for synergies, the explanation based on internal dynamics, namely, more micro-level based study, is rare (Zollo et al., 2002). Essentially, alliance-internal dynamics on the individual level is the basis of alliance experience, alliance capabilities, learning mechanism, routines, and an alliance's eventual outcome; and it regulates how the experience, capabilities, mechanism and routines form. Thus, explaining alliance success or failure remains elusive, and it is necessary to look into the internal dynamics from a micro perspective to complement the current explanations. To develop an in-depth explanation, the key has to do with components of the alliance-internal dynamics as well as their relationships, interactions, and relevant outcomes on the individual level. Accordingly, the global research question of this study is: What explains individuals' performance in and contribution to R&D alliances?

1.2 Knowledge sharing

Mostly, an R&D alliance's goal is integrating each others' knowledge to solve a complex technical problem or establishing a technical platform for further product development. Joint patenting often is a positive outcome of such R&D collaboration, which is often deployed as a measurement of alliance performance (Kim and Song, 2007). Joint patenting cannot be accomplished by only one; it implies that researchers from different firms communicate face-to-face, exchange ideas, and jointly solve problems. Thus, knowledge sharing among alliance members is rather significant for alliance's success. Knowledge sharing usually is defined as

the exchange of task information, know-how, and feedback on a product or a procedure (cf. Hansen, 1999; Foss, Husted, and Michailova, 2010). Individuals' knowledge sharing is the key element of alliance-internal dynamics, which makes the cooperation and relevant achievement become possible.

However, successful knowledge sharing is far from easy; usually there is stickiness hindering efficient and effective knowledge transfer (Szulanski, 1996; 2000). Despite studies found that causal ambiguity, motivation, and absorptive capacity play significant roles in the mechanism of knowledge sharing and stickiness (Szulanski, 1996; 2000), in the new context of an R&D alliance, their impacts and relations could be different: in an R&D alliance, on the one hand, members are confronted with new tasks and challenges, and they need to share knowledge with each other to obtain necessary information to accomplish tasks; on the other hand, the alliance partners have overlaps in their domains, implying that they are potential rivals, and there will be appropriability issues in the knowledge sharing. Therefore, the knowledge sharing mechanism could be different in the new co-opetitive R&D context.

1.3 Social network perspective

Generally, the transfer of new knowledge by individuals is extra-role to a large extent, and managers cannot easily require individual employees to do it (e.g. Burt, 1992; Connelly and Kelloway, 2003; Granovetter, 1973; Hansen, 1999; Reagans and McEvily, 2003). Sharing knowledge across division boundaries is difficult, let alone sharing knowledge across alliance partner boundaries. Thus hierarchical relationships may not play a big role, whereas social network which relatively is a flexible way to organize people will be the channel for exchanging knowledge. Social network is defined as a set of people, organizations, or other social entities, connected by a set of socially meaningful relationships, such as friendship or

co-working, and interactions to better achieve desired outcomes by sharing expertise, resources, and information (e.g. Lea et al., 2006). Broad networks broaden people's horizons, enhance their abilities to exchange ideas with others, and increase their chance to obtain useful information to solve problems (Burt, 1992; Reagans and McEvily, 2003). Studies have found out some characteristics of social network are key predictors of knowledge sharing, such as network type, position, and connection strength (e.g. Burt, 1992; Cross and Cummings, 2004; Cross and Prusak, 2002; Hansen, 1999, 2002; Fleming et.al., 2007; McFadyen et.al., 2009; Mehra et al., 2001; Mors, 2010; Obstfeld, 2005; Sparrowe et al., 2001).

Usually, there are two kinds of social networks in an R&D context: formal network and advice network. Formal network is defined as the prescribed roles and linkages between roles, which are reflected in job descriptions and reporting relationships (e.g. Aalbers et al. 2014, Gulati and Puraman 2009, Mehra et al. 2001). Advice network is composed of relations with 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). Since sharing knowledge is extra-role, requiring much effort, time and mutual trust (e.g. Burt, 1992; Connelly and Kelloway, 2003; Granovetter, 1973; Reagans and McEvily, 2003), and formal relationships based on mandated work content can hardly meet the requirements, it was found that formal network does not significantly contribute to knowledge sharing (e.g. Allen, James and Gamlen, 2007; Cross and Parker, 2004; Gulati and Puranam, 2009; Hansen, 1999; Mehra, Kilduff, and Brass, 2001). Comparatively, the advice network is a mean of accessing resources that are instrumental for enhancing individual work performance beyond formal networks (Sparrowe et al., 2001). Essentially, advice network is a specific form of informal network in which knowledge is exchanged via advice seeking and providing. If an organization is more decentralized, cross-functional, or virtual, informal networks are

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important for obtaining information to finish work (Cross and Prusak, 2002), as they usually provide same and even better information for task completion than what formal networks do (Morrison, 1993).

However, in the context of an R&D alliance, on the one hand, staff come from different alliance partners with different cultures and cooperation modes, thus responsibility allocation is important for their cooperation and relevant knowledge transfer; moreover, because of the potential competition, appropriability might hinder knowledge sharing. Formal relationship thus may play an indispensable role since it allocates responsibility, and may subsequently reduce conflict and ambiguity (Adler and Borys, 1996), as well as help overcoming constraints to transfer both simple and complex knowledge. On the other hand, R&D alliance is a temporary, decentralized and cross-functional organization, implying that advice network may play an indispensable role too. Hence, one of this study's expectations is to find out: what roles are the formal network and the advice network playing respectively on knowledge sharing in the context of an R&D alliance? Are they different from the previous findings in the context of a single firm?

Network types indicate how the actors in the networks are connected (mandated or self-initiated), yet an individual's position in the networks indicates the individual's resource accessibility. According to previous studies, centrality is a frequently deployed variable which indicates individual network position and relevant information or resource accessibility (e.g. Borgatti, 2005; Freeman, 1979; Reinholt et al., 2011; Sparrowe et al., 2001; Wasserman and Faust, 1994). Generally, social network centrality has three types: degree centrality, closeness centrality, and betweenness centrality. Degree centrality is defined as the number of links or incidents upon a node (i.e., the number of ties that a node has) (Borgatti, 2005; Freeman,

1979). 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). Basically, degree centrality describes the direct interactions between one and other individuals; closeness centrality describes the distance between one and others, implying influence power; and betweenness centrality describes the level of mediator role between individuals or groups, implying information diversity and possible control (Borgatti, 2005; Wasserman and Faust, 1994). In the context of an R&D alliance, the formal network and the advice network have different basis, thus different kinds of network position may have different fitness for the two kinds of social network. This study expects to find out: Which centrality does play a significant role in the formal network and the advice network respectively?

If an individual with advantageous network position has weak connections with others, the network position's advantage could be weakened. Thus, in addition to network position, the variable of connection strength is also widely used by scholars as a complementary indicator studying social network's impact. Tie strength, which is the mostly used indicator of connection strength, is defined as the frequency of interaction and the relevant knowledge exchange (McFadyen and Cannella, 2004). Tie strength basically is a demonstration of social relation's intensity, being determined by contact frequency, intimacy, and depth of affection (Granovetter, 1973). It is believed that strong ties (frequent interactions with contact) bring about information redundancy and hinder knowledge exchange in a wider range (Granovetter, 1973), and weak ties more likely provide non-redundant knowledge and bring more diverse knowledge sources (Hansen, 1999). However, in the context of an R&D alliance, members are from different alliance partners, and they have different knowledge sharing modes and

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cultures. Establishing mutual trust and understanding takes time, and it requires intensive interactions. This implies that in the context of an R&D alliance, and in the two different networks, tie strength may not play the same role as usual. This study thus also expects to find out: With the effect of tie strength, does a central position in the formal network have a different effect on the individuals' contribution to the R&D alliance compared to a central position in the advice network?

1.4 Work performance theory

If the social network can be considered as the frame of alliance-internal dynamics on the individual level, the work performance will be the dynamics' outcome. Taking the entire R&D alliance as an organization, every member's work performance is vital for its success. According to work performance theory (e.g. Blumberg and Pringle, 1982), there are three determinants of individual work performance: capacity, opportunity, and willingness. Essentially, capacity is composed of relevant knowledge which is acquired via education or specific work. However, R&D alliances usually have forward-looking but specific goals, implying the alliance partners' employees who have relevant and specific knowledge would be preferred being involved in the alliances. Thus, job experience, which indicates the time length of working in a specific field and relevant accumulated knowledge, would be a rather important indicator of individuals' capacity. Meanwhile, in the R&D alliance, individuals are confronted with new tasks and challenges, implying they do not only rely on their own knowledge to make progress, but also have to comprehend the new context and requirements with the knowledge transferred by others. Thus, to what extent the job experience is helpful for one's work performance in the new context, would be another sub-divided research question of this study.

According to the capacity-opportunity-willingness theory (e.g. Blumberg and Pringle, 1982), opportunity includes several items. In the new co-opetitive R&D context, as mentioned above, it is rather important to obtain information or knowledge about the new context, and social networks being composed of individual connections would play a rather important role in knowledge sharing. Thus they largely represent the opportunity for achieving certain work performance. Different kinds of social network attributes, such as relation basis and network position, have different impacts on performance, and have different relationships with the job experience. Accordingly, this study expects to find out: what social-network attribute(s) promote the individual work performance within an R&D alliance? Furthermore, what is the relationship between the social-network attribute(s) and the job experience?

Talking about the willingness in the work performance theory, motivation is one of the willingness' indicators (e.g. Blumberg and Pringle, 1982; Reinholt et al., 2011). Usually there are two kinds of motivations: intrinsic motivation and extrinsic motivation. In general, intrinsic motivation is believed to have long-turn effect, while extrinsic motivation is believed to have short-turn effect. Additionally, extrinsic motivation usually has insignificant or negative effect on knowledge sharing (Bock et al., 2005; Lin, 2007; Wasko and Faraj, 2000). In the context of an R&D alliance, on the one hand, sharing knowledge is a kind of extra role, and it requires time and energy as well as mutual trust (e.g. Burt, 1992; Connelly and Kelloway, 2003; Granovetter, 1973; Reagans and McEvily, 2003). Thus intrinsic motivation would be rather important for knowledge sharing within an R&D alliance for a long run. On the other hand, alliance partners have overlaps in markets, and because of working in similar domains, they mostly are potential rivals. Sharing knowledge among alliance members thus will have appropriability issues. For the reasons of knowledge resource exchange or compensation, extrinsic motivation may play a significant role too. Accordingly, in such a co-opetitive R&D context, this study also expects to find: Which kind of motivation does play a

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more significant role in knowledge sharing and work performance? And what is the relationship between motivation, social-network attribute(s) and job experience?

In addition to motivation, willingness also involves recognizing the significance of the knowledge transferred by others. It is related to the items discussed in the literature of work performance theory, such as attitude, ego involvement (Blumberg and Pringle, 1982). If individuals consider others' knowledge as useless for the alliance's welfare, transferring knowledge relevant with the alliance's success could be rather difficult. As a result, the individuals cannot look at a "big picture", cannot accomplish the new tasks properly, and finally cannot have good work performance. This problem refers to stickiness issues in knowledge transfer on the individual level, and the key of decreasing stickiness on this level is recognizing the value of others' knowledge. Additionally, value recognition of transferred knowledge also relates to the recipient building connections between the knowledge at hand and the knowledge transferred, which in turn concerns relevance theory. According to the stickiness theory and the relevance theory (e.g. Schulz, 2003; Szulanski, 1996; 2000), individual job experience or absorptive capacity and relations with others are significant factors, while motivation is a less influential factor in the theory of stickiness (Szulanski, 1996; 2000). However, in the setting of an R&D alliance, because of new tasks, challenges and contexts, the prior-accumulated job experience may have limited functions. Moreover, it takes time to establish mutual trust and shared culture, thus compared to a single-firm setting, the status of relationship with others could play a different role. Furthermore, as mentioned previously, the roles of intrinsic motivation and extrinsic motivation could be different in the new setting, implying their impact on knowledge recognition could be different too. Hence, finding out the roles of the three variables in perceived knowledge relevance, as well as the relationships among them in the new setting would be the last expectation of this study.

1.5 Outline

The main part of this thesis is composed of three chapters. Chapter 2 takes the social network perspective to analyze how social connections in the formal and the advice networks in an R&D alliance impact individual performance. This chapter involves two kinds of social network in the alliance, and mainly deploys power theory (e.g. Bruins, 1999; Erchul and Raven, 1997; Raven, 1993) as well as power-feeling-action theory (e.g. Galinsky et al., 2003; Keltner et al., 2003) to test the effects of individual's network position and connection strength on individual work performance. It finds out: First, in the R&D alliance, formal network is much more influential than advice network; second, the network position significantly affects the alliance-related work performance. The theoretical and managerial implications as well as limitations and future research are discussed in this chapter's rest parts.

Chapter 3 deploys capacity-opportunity-willingness theory (Blumberg and Pringle, 1982; Reinholt et al., 2011) to analyze the three variables' roles and relationships in the context of an R&D alliance. Specifically, what is the job experience's role in the new co-opetitive R&D context? What is the role of social network attribute? What is the role of motivation and which kind of motivation does play a more significant role? This study finds out: First, extrinsic motivation plays a positive and influential role, and has crowding-out effect in this co-opetitive R&D context. Second, contrary to most studies, formal contacts significantly contribute to knowledge exchange and work performance. Third, there is a concrete and systematic relationship among the variables of capacity, opportunity and willingness in the setting of an R&D alliance. The findings have several implications for motivation theory, social network theory, and work performance theory. They are discussed in the rest part of this chapter, followed by the discussion about managerial implications, limitations and future research

Building on stickiness theory (Szulanski, 1996; 2000) and relevance theory (Schulz, 2003), Chapter 4 studies the individual perceived knowledge relevance in the context of an R&D alliance. With the research question about the roles of job experience, social network position, and motivation in perceiving knowledge relevance, it finds out: First, contrary to most findings, job experience has a negative effect on perceived knowledge relevance; Second, central network position has a direct and positive impact on the recognition of knowledge relevance, and it also has a positive moderating effect on the relationship between job experience and perceived knowledge relevance; Third, intrinsic and extrinsic motivations have strong, positive, and direct impacts on the recognition of relevant knowledge, whereas the moderating effect of intrinsic motivation is insignificant and the moderating effect of extrinsic motivation is (weakly) negative. The findings have several implications to stickiness theory and relevance theory, which are discussed in this chapter, followed by the discussion of managerial implications, limitations and future research.

Chapter 5 concludes with a discussion on the theoretical implications of this entire dissertation, including social network theory, motivation theory, stickiness theory and relevance theory, as well as the limitations, and the directions of future research.

Chapter 2

Individuals collaborating in an R&D alliance: What determines their contribution?

2.1 Introduction

Firms increasingly ally to overcome competitive challenges, including the challenge to be innovative (Gulati 1995, Osborn and Hagedoorn, 1997, Powell et al. 1996). Developing new knowledge is a key yet elusive goal of alliances (e.g. Conner and Prahalad 1996, Grant 1996a, b, Kogut and Zander 1996, Langlois and Foss 1999, Nahapiet and Ghoshal 1998, Spender 1996), as the resource based theory (RBT) and transaction cost theory (TCT) predict (Barringer and Harrison 2000). Firms may internalize each other's knowledge, skills or competencies (Hamel 1991, Mody 1993, Shan 1990), and can also jointly develop new knowledge. Firms thus benefit from sharing fixed costs, reaching economies of scale in R&D that might be unattainable by themselves, while avoiding "wasteful" duplication (d'Aspremont and Jacquemin 1988, Katz 1986, Motta 1992, Spence 1984, Suzumura 1992, Ziss 1994). An alliance may also provide access to new markets (Sakakibara 2002).

Yet alliances often do not meet expectations (e.g. Bleeke and Ernst 1993, Kogut 1989). Though there are studies about alliance from different perspectives (Anand and Khanna 2000, Berends et al. 2011, Davis and Eisenhardt 2011, Dickson et al. 2006, Draulans et al. 2003, Ernst et al. 2011, Heimeriks and Duysters 2007, Hoang and Rothaermel 2005, Ireland et al. 2002, Lai and Chang 2010, Michelfelder and Kratzer 2013, Oxley and Sampson 2004, Sampson 2007, Saxton 1997, Schreiner et al. 2009, Spekman et. al. 1998, Walter et al. 2007), providing firm-, or group-level analyses, no understanding of the alliance-internal dynamics on an individual level exists to date. Close and vigorous interactions among alliance members

are vital for fruitful collaboration (Das, 2012), and the alliance-internal dynamics on the individual level is what gives rise to alliance experience, capabilities, and the development of specific routines for alliance management. Thus alliance success or failure is still largely left unexplained.

Alliances in general, and R&D alliances in particular, consist of individuals actualizing the alliances' goals by newly collaborating with employees of the alliances' partners. Little is known about to what extent individuals collaborating can make them perform better, thus being able to contribute to the alliance's success as well (Zollo et al. 2002, Michelfelder and Kratzer 2013). It is necessary to look into the inside of an (R&D) alliance, adopting a micro perspective, for a more in-depth explanation of alliance success or failure. An individual-level explanation of the inner workings of an (R&D) alliance is likely to provide a stable and also readily generalizable explanation (Coleman 1990).

Knowledge created in an R&D alliance is the result of combining and recombining existing and new knowledge, as is the case generally for knowledge creation (Dosi 1982, McFadyen and Cannella 2004, Schumpeter 1942). Combining and recombining knowledge results from efforts of individuals transferring their knowledge to others (Burt 1982, Smith et al. 2005). It is the expectation that the process of combining and recombining knowledge is expedited in an alliance when employees are expected to collaborate. This study will take a social network perspective to analyze the contacts between individuals involved in an R&D alliance as they collaborate to transfer knowledge between each other. A social network approach to study the knowledge sharing in an R&D alliance thus combines the structural and relational dimensions of social capital (cf. Nahapiet and Ghoshal 1998).

If sharing knowledge within an organization is not self-evident (Szulanski 1996), and sharing knowledge across division boundaries can be more difficult (Aalbers et al. 2015), then sharing knowledge across alliance partner boundaries may be problematic. In any

organization there are two routes for knowledge flowing: the formal and the informal route (Aalbers et al. 2014, McEvily et al. 2014), including in a semi-formal organization such as an alliance (Biancani et al. 2014). When organizational issues in relation to knowledge transfer and creation is discussed in the literature, "organization primarily means informal organization" (Foss et al. 2010). In an R&D alliance, where new knowledge is to be created, we focus on formal (workflow) connections and advice connections. While an alliance has no single governance structure, and employees from one partner cannot be directed by managers of the other partner, activities and exchange in an alliance are formally mandated. Failure to contribute to what the alliance is to accomplish can be sanctioned. Interactions in the advice network, composed of individuals who give relevant advice to others, on the other hand, are self-initiated and extra-role (Gulati and Puranam 2009, Smith-Doerr and Powell 2005). Failing to maintain such a tie will not be a matter of negative evaluation by a superior (Gibney et al. 2009). The effect of each of those ties on knowledge sharing in an alliance can be expected to differ. In this study we thus address the following research question: How do relations in the formal workflow and the informal advice networks in an R&D alliance impact individual performance?

Despite early and repeated calls for alliance-internal studies (cf. Zollo et al. 2002), our study is the first micro-level study seeking to understand the social interactions between individuals in an alliance. Social network analysis of knowledge transfer in a firm is performed before, however, with important findings from an academic and managerial perspective (e.g. Aalbers et al. 2014, Hansen 1999, McFadyen et al. 2009, Reagans and McEvily 2003). Contrary to what the literature suggests, however, adopting a multi-network approach as suggested in Aalbers et al. (2014), for social interactions in an R&D alliance we find that the formally mandated relations between individuals are much more conducive to individual performance than extra-role, self-initiated advice relations. When we include tie

strength for each of these ties the latter actually negatively impact individual performance in an alliance. How an alliance partner employee exchanges knowledge (through which channel or network, and how actively), thus matters crucially for the employee's performance and contribution to the alliance' success.

We first discuss relevant theories, suggesting hypotheses. Subsequently we discuss the research setting, the data collection procedure, the exact way in which we measure our variables, and the estimation procedure. After we present our results, we discuss what these mean for alliance, innovation and social network theory, whereupon we conclude.

2.2 Theoretical background

The fundamental idea behind the social network perspective is that the structure of social interactions enhances or constrains access to valued resources (Ibarra 1993, Sparrowe et al. 2001). A social network is defined as a set of nodes such as individuals connected by a set of (socially) meaningful relationships, such as friendship, co-working, or information exchange (Lea et al. 2006). A social network perspective allows for the study of how specific characteristics of individuals' interactions with others can be key predictors of knowledge sharing and knowledge creation in a firm (e.g. Burt 1992, Cross and Cummings 2004, Fleming et al. 2007, Hansen 1999, 2002, McFadyen et al. 2009, Mors 2010, Obstfeld 2005). In this study we focus on the social networks of individuals in an R&D alliance.

2.2.1 Formal network and advice network

Former research on social networks has indicated that if network positions in an organization are studied, a permanent one such as a firm or a temporary one such as an alliance, two types of networks need to be considered, the formal and the informal network (Allen 1977, Allen and Cohen 1969, Blau and Schoenherr 1971, Blau and Scott 1962, Ibarra 1993, Mehra et al.

2001, Gulati and Puraman 2009, Simon 1976). The formal network is the formally prescribed set of interdependencies between actors set forth in job descriptions and reporting relationships (Aalbers et al. 2014, Gulati and Puraman 2009, Mehra et al. 2001). The informal network refers to the interpersonal relationships between actors that are not formally mandated but rather self-initiated and extra-role (Mehra et al. 2001, Simon 1976: 148). In particular, we will concentrate on the advice network that is composed of relations through which actors share resources such as information, assistance, and guidance that are not mandated yet are related to the completion of their work (Ibarra 1993, Sparrowe et al. 2001). In an R&D alliance, the formal network is composed of the individuals coming from different partner organizations and the mandated workflow relations among them, while the advice network is self-formed and based on the individuals' reputation and relevant expertise, as well as the relations of advice seeking and providing among them.

In the formal network it is prescribed with which alters a particular actor should share knowledge. It is part of his or her responsibility in the job. The knowledge to be shared typically includes routine, or simple knowledge required in daily activities. However, in a more complex, knowledge-intensive work setting, tacit or compound knowledge is also exchanged in the formal network. If actors cannot attain enough useful knowledge from the formal network, they can use their contacts in the advice network. Knowledge from the advice network may not be very specific. What is exchanged in the advice network consist, for instance, of a new approach to solve a problem or a new perspective to understand a particular phenomenon. Individuals may not be able to directly utilize this knowledge, but they can be inspired to take a fresh look at their work.

2.2.2 Connectedness: Centrality in a network

If people are in a central position of a network they can make better use of the access to attain valued resources. There are, however, different ways in which an individual can be centrally positioned.

The number of direct interactions a focal actor has with other actors, which refers to as degree centrality (Borgatti 2005, Wasserman and Faust 1994), is important in the formal network in particular. The formal network consists of contacts that individuals are required to have with alters. Contacts not mandated cannot be maintained. As a consequence of such contacts in the formal network an actor can expect to receive information and knowledge. A position in the formal network is defined by someone's (hierarchical) position in the organization (e.g. the project leader) and the reporting relations that come along with it. Knowledge sharing in the formal workflow network is determined by management ascribing position to individuals and requiring they exchange knowledge of a particular kind – failure to do so can be sanctioned. For each contact it is determined what knowledge may be exchanged so that actors can function properly within the organization. It cannot be assumed, however, that what knowledge is transferred from actor A to actor B can also be shared with actor B's other contacts, actor C for instance. Information and knowledge in the formal network cannot be assumed to freely flow, which is why only the direct contacts that an actor has, his or her degree centrality, is an indicator of the knowledge he or she commands. An actor in a central position in the formal network receives increasingly more valuable information and knowledge than someone with a decentral position.

In the advice network individuals have discretion over whether they give and ask for advice (Sparrowe et al. 2001). In addition, individuals have discretion over what particular knowledge to share, and knowledge shared is not prescribed or constrained by what position

they hold and what knowledge they receive (Ensign and Hébert 2009). In the advice network the attractiveness of one's position is determined by the diversity of input one receives from others that one can pass along to others: getting access to new options and different perceptions of problems and phenomena, and being able to understand how one's own knowledge contributes to the larger picture of the organization's strategic innovation efforts. Betweenness centrality in the advice network –the frequency with which an actor falls on the shortest geodesic path between any pair of two actors in this network– describes the extent to which an actor can access the full extent of knowledge diversity in an organization (Borgatti 2005, Wasserman and Faust 1994). Thus betweenness centrality, which implies the advantageous network position via which one can access much but probably unspecific and complementary knowledge, is an informative indicator of individuals' knowledge acquirement in the advice network of an R&D alliance.

2.3 Hypothesis development

2.3.1 Formal network and individual work performance

One's position in the formal network of an R&D alliance is determined by top management, stipulating what information and knowledge is exchanged with whom. An actor with a central position in the formal network (high degree centrality) thus can expect to receive much information and knowledge. Below we will argue along two lines of reasoning that high degree centrality in the formal network is positively associated with the actor's individual alliance-related work performance. First, based on social power theory (Bruins 1999, Erchul and Raven 1997, Raven 1993), we claim that a central position in the formal network of the organization or alliance will lead to legitimate power and legitimate possibility to influence others on the basis of one's position (Erchul and Raven 1997). The more central the position

of the actor in the formal network, the more legitimate power he or she will have and the more likely it is that important information will be transferred to the actor. Being given the responsibility of maintaining a large number of mandated contacts in the formal network implies a high level of expertise, leading to expert power that stems from the possession of knowledge or expertise in a designated area (Erchul and Raven 1997). This means that the actor not only has access to important information, but also can interpret this information in a correct and beneficial way, which will increase his or her individual alliance-related work performance. This effect will be present independent of someone's hierarchical position or tenure. Second, according to the power-feeling-action theory (Galinsky et al. 2003, Keltner et al. 2003), any type of power is associated with positive feeling, attention to rewards, automatic information processing, and disinhibiting behavior. The more power someone has, the higher his or her motivation for achievement. In a knowledge sharing environment, the more power an actor obtains because of his or her central position in the formal network, the more information will be obtained by this actor. More work-related discussions will be started by or participated in by this actor, information obtained can be better analyzed, and, subsequently, more knowledge is developed by such an actor as well (Aalbers et al. 2014, Ibarra 1993, Wasko and Faraj 2005), which in turn will contribute to this actor's alliance-related work performance.

For these reasons, more centrally positioned individuals in the formal network will have increased individual work performance. We therefore hypothesize:

Hypothesis 1: Degree centrality in a formal network is positively associated with individual (alliance-related) work performance.

2.3.2 Moderator: Strength of ties in the formal network

A central position in the formal network, we argued, will lead to an increased individual work performance. However, the intensity of the interaction between the actor and his or her direct contacts in the formal network influences this relationship. Tie strength is the frequency of interactions, as well as the knowledge exchange embedded in those interaction relationships (McFadyen and Cannella 2004). Tie strength is a demonstration of a social relation's intensity, which can be determined by contact frequency, intimacy and depth of affection (Granovetter 1973).

In former research it has been suggested that it is not that easy to transfer knowledge among partners of a network, especially when there is a low contact frequency (Hansen 1999, Uzzi 1996, 1997). Knowledge or information transfer requires coding, transferring, receiving, recoding and assembling – the more complex the knowledge is transferred, the more difficult, time-consuming and costly these processes are. All these steps take time and in all of them interpretation problems may arise. The higher the interaction frequency among senders and receivers, the more feedback is possible and the fewer problems will arise (Leonard-Barton and Sinha 1993). Moreover, by frequent interaction relation-specific heuristics can be developed between senders and receivers, as well as a specialized language for conveying complex knowledge (Reagans and McEvily 2003, Uzzi 1997).

Problems with knowledge transfer will particularly occur in an R&D alliance, because of differences in culture among the participating firms, differences in knowledge transfer mode and possibly appropriability issues as well, while the knowledge that must be transferred in general is highly complex. We thus argue that the stronger the direct ties a focal actor has in the formal network, the more knowledge he or she will receive, the better the actor can interpret and contextualize incoming knowledge, and therefore the better alliance-related work performance the actor will have.

Hypothesis 2: Tie strength positively moderates the relation between degree centrality and
individual (alliance-related) work performance.

2.3.3 Advice network and individual work performance

Members of the alliance will seek advice in the advice network if the formal network does not provide satisfactory or enough information. Since members search for advice in an alliance consisting of at least two partner organizations, the process of searching may not be very smooth, but can be a matter of trial and error. Therefore, many people will be approached, mostly only giving a small piece of the required information, or being able to give a referral to someone else. In such a search process an actor with a 'bridging' position in the advice network will be an important mediator in connecting others in the network. Someone in a bridging position will, indirectly, be able to access a diversity of knowledge and information. Someone in a social network position with a high what is called betweenness centrality will be able to pick up increasingly more diverse information and knowledge that cannot be acquired in the formal network (Borgatti 2005, Freeman 1979, Wasserman and Faust 1994).

According to social power theory (Bruins 1999, Erchul and Raven 1997, Raven 1993), a high betweenness centrality in the advice network implies a high level of informational power, stemming from the provision of relevant information one can expect to receive from other network partners. The informational power immediately gives access to different kinds of knowledge in the advice network and the power to decide with whom to share it. Moreover, because of the discretionary nature of advice giving, the Matthew effect (Merton 1968) will lead to access to even more knowledge of different types. Those who have obtained a favorable position in which they command increasingly more diverse information and knowledge can expect to be approached by alters offering unsolicited advice or offering more knowledge in return for what knowledge someone offers. In such a favorable information

position, it is easy to use the acquired information in one's own alliance-related work, leading to an increased work performance.

Additionally, the power-feeling-action theory (Galinsky et al. 2003, Keltner et al. 2003) will also predict an increased work performance on the basis of a high level of informational power.

Hypothesis 3: Betweenness centrality in the advice network is positively associated with individual (alliance-related) work performance.

2.3.4 Moderation: Strength of ties in the advice network

Someone who maintains a favorable position in the advice network by having a high betweenness centrality can be expected to receive diverse information and knowledge. The literature about the moderating role of tie strength in the relationship between betweenness centrality in the advice network on the one hand, and individual work performance in the alliance on the other hand is inconclusive. Arguments point in both directions. Thus, in the following, we will develop and formulate two competing hypotheses, one claiming a positive moderation effect and the other claiming a negative effect.

Knowledge to be shared in the alliance mostly will be tacit and/or compound. That is, the transfer process is a complex process. In the advice network, the knowledge transfer is not only between direct contacts of an actor. The information and knowledge one receives indirectly, through one's direct contacts, from third parties can be of great importance, as finding suitable and relevant information directly can be difficult. Someone will seek advice in order to receive different perspectives on an issue. At the same time, however, someone must be able to determine the relevance and trustworthiness of information and knowledge thus received – especially important, and not self-evident as the information and knowledge received is not from a contact one has oneself. The knowledge is more distant, and less

readily interpretable. When ties between the focal actor and his or her direct contacts through which the actor receives the distant knowledge are strong, determining the value and relevance of the received knowledge will become easier (Gargiulo et al. 2009, Hansen 1999, Reagans and McEvily 2003). If the knowledge comes through a contact with whom the focal actor has a strong tie, the focal actor can better interpret the knowledge received via such a direct contact from third parties. Therefore, we hypothesize:

Hypothesis 4a: Tie strength positively moderates the relation between betweenness centrality and individual (alliance-related) work performance.

On the other hand, by having strong ties among the actors in an advice network, opinions, ideas and knowledge increasingly become similar across the actors (Erickson 1988, Zhou et al. 2009). If the strength of the ties with one's direct alters is strong, the benefits from maintaining a position in the network of bridging connections between subgroups of clustered alters for receiving diverse information will be lost. Increasingly redundant information will be shared among the network partners who immediately connect in a strong manner. The advantages of a high betweenness centrality position in the advice network, because of access to diverse information, then is lost. A group of strongly connected individuals will have a tendency to exclude information and knowledge that does not fit a shared world view (Byrne 1971, Ibarra 1995, Lakin and Chartrand 2003, Mollica et al. 2003, Ruef et al. 2003). When ties in the direct environment of the central actor become stronger, the diverse information will be transformed into redundant information of which the interpretation is less time-consuming but does not benefit the central actor's performance. Redundant information in one's immediate environment reduces the chances of connecting to other social circles and getting access to new sources of information (Granovetter 1973). In contrast, weak direct ties will more likely provide the central actor with non-redundant knowledge (Hansen 1999), and

the opportunity to connect, indirectly, with other social circles, and increase the actor's informational power. Thus weak direct ties will increase the benefits of the betweenness centrality position for the individual work performance of the central actor. Therefore, we hypothesize:

Hypothesis 4b: Tie strength negatively moderates the relation between betweenness centrality and individual (alliance-related) work performance.

2.3.5 Conceptual model

The conceptual model of this study is presented in Figure 2.1. Drawing on insights from the social network, the social power, and the power-feeling-action literatures, we suggest that degree centrality in the formal network and betweenness centrality in the advice network are positively associated with individuals' alliance-related work performance. Moreover, we argued, tie strength positively moderates the relationship between degree centrality in the formal network and individual work performance, while tie strength either positively or negatively moderates the relationship between betweenness centrality in the advice network and individual work performance. Control variables include: membership, job title, tenure, and rank, indicating which partner organization the alliance members come from, as well as their work-related knowledge and experience.
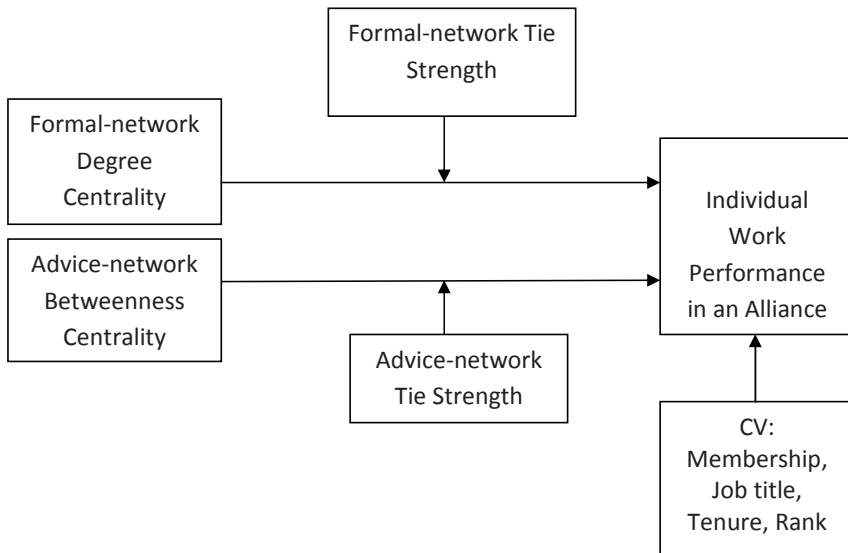
Figure 2.1 Conceptual model

2.4 Method

2.4.1 Organizational settings

In our study we collected data from an alliance composed of a company developing and producing fuel cells in China (the company) and a research institute focusing on chemical physics and in particular fuel cell research (the institute). We have collected data about the full social network of individuals involved in the knowledge transfer processes of the alliance.

The company, leading in the development and commercialization of fuel cells, is founded in 2001, while by now it employs 150 individuals. The company has a unit structure with intensive cooperation among the units. In order to obtain in-depth research-based knowledge to develop more advanced products, the company allied with the institute in which basic research is conducted.

The institute, founded in1961, is famous in China for its research in chemical physics.

It is structured in divisions and one of the divisions is the fuel cell division, where 50 scientists are employed. In addition to basic research, this division also made innovative breakthroughs in fuel cells and holds about 25 highly influential patents.

The R&D alliance (the alliance) focuses on fuel cell technology development and application. The alliance consists of several projects coordinated by project leaders and directors from the company and the institute. Besides the collaboration on the projects, within the alliance there are personnel training, technology consulting, testing, and regular seminars about recent developments in the forefront of the technology.

2.4.2 Data collection

Data on the individual alliance-related work performance of the alliance members were collected from the two alliance directors of the company and the institute. Data on the social network variables were collected from the alliance members by means of an egocentric network survey. This study used snowball sampling to obtain data about the whole social network. Snowball sampling is especially useful if the population is not clear from the beginning (Aalbers et al. 2014, Marsden 1990, 2002, Wasserman and Faust 1994). This holds especially for the advice network in our study. The online survey included validated name generator questions to have the correct data about the networks (Aalbers et al. 2014, Sparrowe et al. 2001). To reduce ambiguity with respect to the interpretation of the questions by the respondents, the questions were formulated in their native language. The invitation to participate in the survey was distributed by the two alliance directors via an email to each of the alliance members, accompanied by an introduction of the survey and the hyperlink to the online survey.

In order to obtain the high response rate that a study using network data requires, the survey was sent in three rounds to obtain data from all alliance members for both of the networks (Wasserman and Faust 1994). The final response rate is 97% on the company side

and 100% on the institute side. The number of respondents is 66, which almost is the total number of the individuals involved in the R&D alliance's work. While this may appear a small number of observations, earlier studies also analyzed networks of such size (e.g. Aalbers et al. 2013, 2014, Albrecht and Hall 1991, Dholakia et al. 2004, Tichy et al. 1979) providing robust outcomes (Aalbers et al. 2013, Costenbader and Valente 2003). The formal network has 312 knowledge transfer ties, and the advice network has 273.

2.4.3 Measurements

The formal network was identified by asking individual respondents with whom they are supposed to discuss ideas or solutions at work; the advice network was identified by asking individual respondents whom they ask for advice, or whom they give advice when they meet a problem at work that they do not possess the correct knowledge to address (Aalbers et al. 2014, Borgatti and Cross 2003, Cross and Prusak 2002, Rodan 2010, Sparrowe et al. 2001). We provided a guideline of naming seven employees for each network to make sure that only the most important contacts per employee were mentioned. Further contacts could be added, however. Based on the network data gained via the survey, the independent variables were calculated by using Ucinet 6.0 (Borgatti et al. 2002, Freeman 1979).

Dependent variable. Individual alliance-related work performance was measured by means of a 1-7 point Likert type scale in ascending order: the higher the rating, the better the performance. The individual work performance included five dimensions: individual work quality, efficiency, innovativeness, knowledge, and interpersonal capability (Barrick et al. 1993, Cross and Cummings 2004, Stewart et al. 2012, Welbourne et al. 1998).

Independent variables. Degree centrality was calculated by counting how many direct contacts an actor has (Balkundi and Harrison 2006, Bono and Anderson 2005, Brass 1984, Cross and Cummings 2004, Freeman 1979, Mehra et al. 1998). *Betweenness centrality* was

calculated by how many contacts an actor has when he or she plays the mediator role (Borgatti 2005, Freeman 1979, Wasserman and Faust 1994), referring to the actor's structural position as a bridge in the complete network.

Moderating variable. Tie strength was calculated by means of 1-7 point scale about interaction frequency in ascending order (Hansen 1999, Levin and Cross 2004). Since in an alliance the members are from different partner organizations, and the connections among them hardly involve intimacy or depth of affection, tie strength in this study was focused on how frequent actors interact with each other within a time phase**.**

Control variables. Since the individuals' alliance-related work performance was respectively scored by the two directors from both partners of the alliance, we control for their potential scoring difference by *membership*. Membership was measured by a nominal variable indicating that the alliance member was based in the company (1) or the institute (2)*.* In addition, we control for work-related knowledge and experience of alliance members: *Job title* has been measured by a dummy variable, indicating whether the job is indirectly (0) or directly (1) relevant for the R&D work. *Tenure* was measured by the number of month an alliance member works in a specific field. *Ran*k has been measured on a 1-5 point scale in ascending order, which indicated the level of an individual's work-related knowledge and experience accumulated in his or her own organization.

2.4.4 Analysis

Figures 2.2 and 2.3 provide visual representations of the formal and the advice networks, respectively. Descriptive statistics and correlations between the study variables of the two networks are presented in Table 2.1. Table 2.2 reports the standardized factor loadings of the dependent variable as well as its Cronbach's alpha.
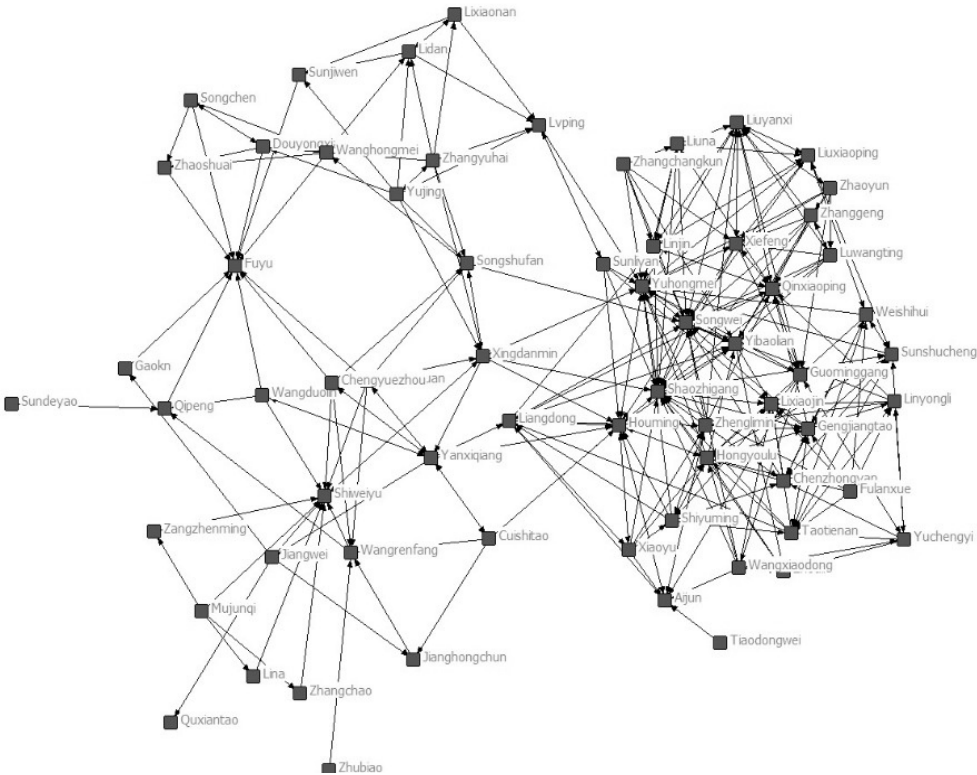
Figure 2.2 The formal network
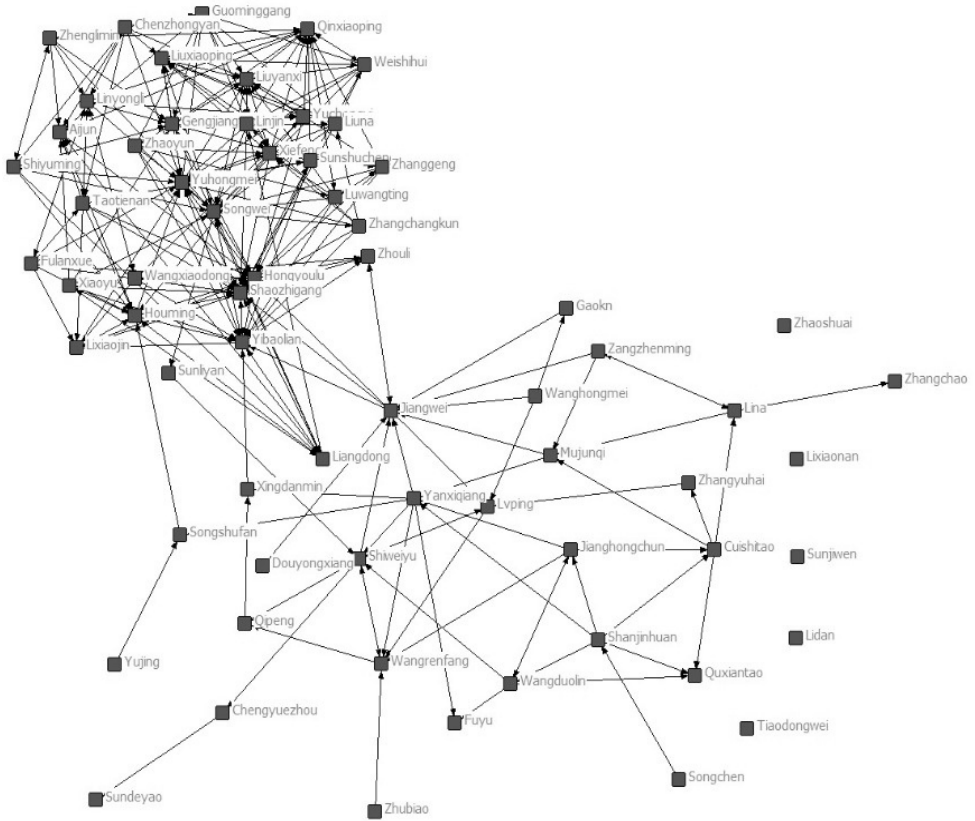
Figure 2.3 The advice network

Table 2.1 Descriptive statistics and correlations

	Variable	Mean	Std.dev.	1	2	3	4	5	6	7	8
1	Membership	1.500	0.504								
2	Job title	0.920	0.267	-0.057							
3	Rank	1.980	1.259	-0.182	0.088						
4	Tenure	62.940	56.997	-0.084	0.043	0.570**					
5	Degree centrality	11.748	6.926	0.597**	0.105	0.260*	0.140				
6	Betweenness centrality	2.061	3.150	0.214	-0.089	0.355**	0.185	0.516**			
7	Formal-network tie strength	5.394	1.060	0.391**	-0.052	-0.099	-0.144	0.059	0.004		
8	Advice-network tie strength	4.437	1.895	0.462**	0.144	-0.175	-0.219	0.215	0.109	0.321**	
9	Work performance	5.936	0.692	0.490**	-0.010	0.465**	0.376**	0.062**	0.417**	0.111	0.071

N=66. * / ** Significance at 5% and 1% respectively.

Table 2.2 Standardized factor loadings and Cronbach's alpha of the dependent variable

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

This study utilizes the ordinary least squares multiple regression to test the hypotheses (see Table 2.3). We involve 66 observations of the formal network, and 66 observations of the advice network. Since the network data are mutually dependent we use the bootstrapping option in SPSS (version 22), with 1000 samples and confidence interval at 95% (Efron and Tibshirani 1993, Preacher and Hayes 2004). We first examine the control variables' effects on individual alliance-related work performance in model A0. Then we add the main factor of degree centrality in the formal network and betweenness centrality in the advice network, in models A1 and B1, respectively. Afterwards, tie strength in the two networks is involved 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 considered simultaneously, in models C1 and C2. Introducing independent and moderating variables significantly increase model-fit indicators in model C2 (F-test for $\Delta R^2 = 2.245$, p<.05). As suggested by Kenny and Judd (1984) as well as Aiken and West (1991), all the variables are mean-centered before the regressions to avoid multicollinearity—all VIF values remain below 4.0.

Table 2.3 Standardized regression coefficient estimates with the dependent variable individual alliance-related work performance

D.V.	A 0	A 1	A 2	B 1	B 2	C 1	C 2
CVs							
Membership	0.590**	0.447**	0.435**	0.544**	0.640**	0.456**	0.436**
Job title	-0.026	-0.049	-0.051	-0.008	0.011	-0.032	-0.051
Rank	0.491**	0.409**	0.414**	0.425**	0.460**	0.388**	0.415**
Tenure	0.146	0.153	0.152	0.135	0.108	0.144	0.134
IVs							
Degree centrality (FN)		0.213*	0.223			0.156	0.356*
Betweenness centrality (AN)				0.158	0.104	0.100	-0.072
MVs							
Tie strength (FN)			0.016				0.059
Tie strength (AN)					-0.199*		-0.224*
Degree centrality X Tie strength (FN)			0.066				0.091
Betweenness centrality X Tie strength (AN)					-0.176*		-0.291**
N	66	66	66	66	66	66	66
F-value	20.435***	17.618***	12.344***	17.357***	13.695***	14.795***	10.557***
R^2	0.573	0.595	0.598	0.591	0.623	0.601	0.657
Adjusted R^2	0.545	0.561	0.550	0.557	0.578	0.560	0.595
F-test for $\triangle R^2$		3.259	1.202	2.641	2.564	2.070	2.245*

* p<.05; ** p<.01; *** p<.001.

2.5 Results

The multiple regression analyses in Table 2.3 display the findings with regard to hypotheses 1, 2, 3 and 4. As hypothesis 1 suggests, an individual's degree centrality in the formal network significantly enhances the individual's alliance-related work performance: hypothesis 1 is supported in models A1 and C2 (β-values of 0.213, $p < 0.05$; and 0.356, $p < 0.05$, respectively). Hypothesis 2 suggests that tie strength enhances the degree centrality's effect on individual alliance-related work performance: hypothesis 2 is not supported (the β-values in models A2 and C2 are insignificant). In addition, favorable positioning in the advice network, i.e. having what should be a favorable betweenness centrality, also does not play a significant role in individual alliance-related work performance: hypothesis 3 cannot be supported. The β-values in model B1, B2, C1 and C2 are insignificant. However, contrary to what we expected in hypothesis 4a, hypothesis 4b is supported in models B2 and C2: the moderating effect of tie strength in the advice network is significant (β-values of -0.176, $p < 0.05$; and -0.291, $p < 0.01$, respectively).

With respect to the control variables our findings show a significantly positive relationship between membership and individual alliance-related work performance, as well as a significantly positive relationship between rank and individual alliance-related work performance in all the models.

2.6 Discussion

 Despite the vast and burgeoning field of alliance research, we still have no understanding of alliance-internal dynamics on an individual level. This understanding is of crucial importance since alliance activity in many firms grows, while we also know that about 50% of the alliances fail (Ernst et al. 2011). Given their strategic importance, and the long term before outcomes can be expected, R&D alliances are more likely to fail than other alliances. For alliances, and for R&D alliances in particular, collaboration between employees from the allying partners is crucial. This study thus sought to explain the variation of alliance-based work performance of individuals by focusing on collaboration in the formal or workflow network on the one hand, and the informal advice network on the other hand. We found that formally mandated relations between individuals were much more conducive to individuals' performance in the alliance than self-initiated advising relations.

2.6.1 Theoretical implications

This study has several implications for alliance research. First, to our best knowledge we are the first to study alliance-internal dynamics on an individual level. Our findings show that about 60% of the variation in the alliance-based work performance of individuals can be explained by social network variables. The social interactions between individuals from the alliance partners overwhelmingly impact their alliance-related performance. Moreover, what kind of social interaction matters as well: we find different impacts of formal and advice networks. A favorable position in the formal network is much more important for individuals' alliance-related performance than it is in the advice network. In an R&D alliance, where knowledge transfer and knowledge creation are crucial, the formally mandated relations between individuals matter much more than informal and discretionary advice relations, which is remarkable. Another indication is that formal relations and structures are in need of

reconsideration (McEvily et al. 2014). There is need, too, however, not to do so in isolation of other ways in which individuals can interact (Aalbers et al. 2014). Finally, given the impact of the formal network compared to the advice network, it is likely that inter-firm alliance specific routines necessary for alliance success are primarily shaped in this formal network. Inter-firm routines play an important role in alliance performance (Zollo et al. 2002), and using social network analysis, longitudinally, allows for a detailed study of such routines' emergence.

In the context of an R&D alliance, sufficient interaction and exchange of knowledge and information about particular topics might not occur without the obligation to do so in the formal network. If left to individuals' discretion, knowledge exchange especially crossing firm boundaries to the alliance partner might not occur. When interaction is discretionary, as in the advice network, knowledge appropriability considerations, at the level of an individual or a department, can prevent interaction and ultimately inhibit alliance success, as alliance partners' interests do not fully align. Future research should not just clearly specify the type of (network) structure studied, but also, as argued by Aalbers et al. (2014), adopt a multi-network research design.

New, innovative knowledge in the context of an alliance hence is predicated to a large extent on the existence of proper social structures. Social network analysis, focusing as it does on the structure of the social interactions for any type of relation, can then help explain how, cognitively, knowledge spreads and therefore develops. Social network analysis thus provides a way to the work on when and how social capital, in line with the literature of Nahapiet and Ghoshal (1998), positively impacts firm and individual performance (cf. Tsai and Ghoshal 1998, Wasko and Faraj 2005). In an alliance setting the impact of structural capital differs by types of network – social network analysis provides greater precision to the study of the social capital's effects, and it also suggests how effects one would expect can differ by context. The

formal network structure does, but the informal advice network structure does not determine individual performance in the context of an R&D alliance. Future research could study more in depth how the nature of the cognitive content of what is exchanged, relative to the absorptive and cognitive capacity of people involved in the exchange (Cohen and Levinthal 1990), impacts the findings. Our findings for *Rank* as a variable indicate that a closer analysis of the actual content of what is exchanged and to what extent the exchanged knowledge is processed should provide useful theoretical insights. Previous studies found different outcomes from ours, again indicating that the context studied – an R&D alliance – makes a difference.

2.6.2 Managerial implications

This study also has important implications for R&D alliance managers. Such managers should in particular put effort in the development of a formal network in the alliance. In addition, they should select members to participate in the alliance on the basis of their ranks in the respective partner organizations of the alliance. Members of the alliance should, for their own sake, obtain a central position in the formal network, rather than in the self-initiated, informal advice network.

2.6.3 Limitations and future research

We highlight four limitations of our research, and suggest future research directions to address them. First, this study explored the influence of social network variables on the alliance-based work performance of individuals. In depth, qualitative research is required to further clarify the relationships between alliance-internal dynamics on the individual level on the one hand, and firm-level dynamics on the other hand. Second, our study is cross-sectional. Studying the dynamics of social interactions over a longer period of time would generate significant insights. This can both be done quantitatively as well as qualitatively – a multi-method research design is conceivable. Third, individuals have direct and indirect contacts.

More research is needed to understand how direct and indirect contacts contribute to individual performance – we have only done so partly in this paper. Fourth, by necessity, our findings are based on the data from one R&D alliance, in the field of chemical physics, in China. The external validity for the findings in our study can be provided by future research replicating our study in other industries, countries, as well as other types of alliances.

Chapter 3

Individual performance in an R&D alliance: The roles of job experience, social network position and motivation

3.1 Introduction

To meet competitive challenges firms nowadays have to generate a continuous stream of innovations (Rubera and Kirca, 2012). They need access to different knowledge sources to generate a continuous flow of new ideas and concepts. One way to get access to these knowledge sources is to ally. In most firms alliance activity grows (Ernst, Lichtenthaler, and Vogt, 2011). While alliances have been associated with the joined development of new knowledge, the realization of economies of scale in R&D and the avoidance of "wasteful" duplication (d'Aspremont and Jacquemin 1988; Katz 1986; Motta 1992; Spence 1984; Suzumura 1992; Ziss 1994), in practice alliances often fail (Bleeke and Ernst, 1993; Ernst et al., 2011).

Despite the vast and burgeoning field of alliance research from different perspectives (Anand and Khanna, 2000; Berends, van Berg, and van Raaij, 2011; Das, 2012; Davis and Eisenhardt 2011; Dickson, Weaver, and Hoy, 2006; Draulans, DeMan, and Volberda, 2003; Ernst et al., 2011; Heimeriks and Duysters, 2007; Hoang and Rothaermel, 2005; Ireland, Hitt and Vaidyanath, 2002; Lai and Chang, 2010; Michelfelder and Kratzer, 2013; Oxley and Sampson, 2004; Sampson, 2007; Saxton, 1997; Schreiner, Kale, and Corsten, 2009; Spekman et. al., 1998; Walter, Lechner, and Kellermanns, 2007), explaining alliance success or failure has remained elusive. This may be partly due to the firm-, or group-level analyses these studies have been carried out. Yet the alliance-internal dynamics could not be comprehensively revealed without an aggregate understanding on an individual level.

40

Following the call of Zollo, Reuer and Singh (2002), we will conduct a micro-level study explaining the individual alliance-related work performance of the alliance members. In our study we will take the capacity-opportunity-willingness theory (Blumberg and Pringle, 1982; Reinholt, Pedersen, and Foss, 2011) as a leading perspective. In particular, we will examine the influence of capacity on individual alliance-related work performance. Though individuals in an R&D alliance are confronted with new settings and work challenges, the primary basis of their performance will be their capacity. This capacity can be called forth most effectively if the setting of the alliance and the new directions to be explored by the alliance are as clear as possible. To clarify the setting alliance members have to engage in knowledge sharing with their alliance colleagues. A central position in the alliance network creates such an opportunity to engage in knowledge sharing. An R&D alliance is a temporary organization composed of partners who might even compete with each other. In such a setting knowledge sharing is not that self-evident. Therefore, we examine whether the moderating role of a central position of the alliance member in the social network of the alliance is contingent upon his or her intrinsic or extrinsic motivation to share knowledge.

This study will contribute to the existing literature in several ways. First, it will contribute to an individual-level understanding of alliance activities and performance. Such a micro-level explanation of the inner working of an R&D alliance is likely to be stable and generalizable (Coleman, 1990). Second, the study will give an empirical validation of the capacity-opportunity-willingness theory in an alliance. It will show the particular interactions between the key elements capacity, opportunity, and willingness that significantly influence the individual alliance-related work performance. Finally, contrary to former findings and suggestions within one firm (Bock and Kim, 2002; Bock et al., 2005; Lin, 2007; Osterloh and Frey, 2000), we show that extrinsic motivation is more important for fully exploiting the moderating role of the central position in the alliance network than intrinsic motivation.

We first discuss relevant theory, suggesting hypotheses. Subsequently we discuss the research setting, the data collection procedure, the exact way in which we measure our variables, and the estimation procedure. After we present our results, we discuss what these mean for motivation theory, capacity-opportunity-willingness theory, and social network theory.

3.2 Theoretical background

The success or failure of an R&D alliance eventually depends on its members. They have to realize the alliance goals. Therefore, it is crucial to be able to explain the individual alliance-related work performance of the alliance members. In the past huge efforts have been made to identify the most important antecedents of individual work performance. In 1982 Blumberg and Pringle grouped all known antecedents into three dimensions: capacity, opportunity, and willingness. The idea behind their theory is that in order for an individual to perform, all three elements must be present in some degree. Thus, they suggested explaining work performance by the interaction of the three elements (Blumberg and Pringle, 1982).

Capacity refers to the psychological and cognitive abilities enabling an individual to perform a task. Traditionally, personnel psychologists have assumed that performance, in large part, is a function of selection, placement, and training (Blumberg and Pringle, 1982). In this study we will concentrate on job experience, knowledge and capabilities an individual gained from work in an organization, in a specific function. Opportunity concerns the forces surrounding a person and his or her task which enable or constrain that person's task performance and are beyond the person's direct control (Blumberg and Pringle, 1982). Although the opportunity dimension includes a lot of situational variables, in this study we will focus on the individual's central position in the social network of the alliance members. A key role of alliances is sharing and creating new knowledge. In an R&D alliance sharing

knowledge across alliance partners' boundaries is difficult, it cannot easily be required by

managers (Burt, 1992; Connelly and Kelloway, 2003; Granovetter, 1973; Hansen, 1999;

Reagans and McEvily, 2003). To bring this out clearly, we focus on the social network of the

alliance members offering the opportunity to share knowledge. Finally, willingness includes

psychological and emotional characteristics that influence the extent to which an individual is

inclined to perform a task (Blumberg and Pringle, 1982). In this study we emphasize the

motivational aspects of performance.

Building on the capacity-opportunity-willingness theory, in our hypotheses below, we

will develop the following conceptual model (Figure 3.1).
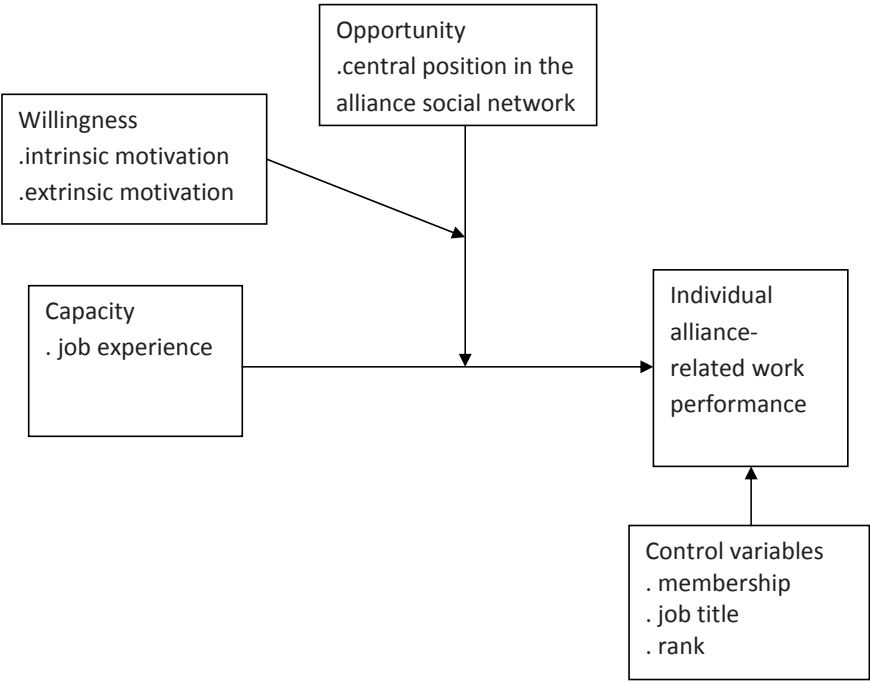
Figure 3.1 Conceptual model

We will explain that the direct relationship between capacity (job experience) and individual alliance-related work performance will be moderated by the opportunity to share knowledge (the individual's central position in the alliance network), while this moderating effect is on its turn moderated by the individual's willingness to share knowledge (intrinsic and extrinsic motivation). We control for membership of each alliance's partner, as well as individuals' job title and rank at the dependent variable.

3.3 Hypothesis development

3.3.1 Relationship between job experience and individual alliance-related work performance

Job experience is defined here by the time an individual already works in the current field in the current organization, reflecting the individual's prior-accumulated knowledge. In the eighties and nineties of the former century the relationship between job experience and job performance has already been investigated in a firm setting. In general, studies found that job experience, due to the acquisition of skills, techniques, methods, and psychological habits, has a positive impact on job performance (e.g. Gordon and Fitzgibbons, 1982; Ree, Carretta and Teachout, 1995; Schmidt, Hunter, and Outerbridge, 1986).

However, the alliance setting is more complex. In an R&D alliance professionals and other relevant people from the partners are combined in order to solve challenging problems that cannot be solved within the boundaries of the firm. This implies that members of the alliance will be faced with new settings. The alliance setting most likely has similarities with an "open learning" setting in which people have to acquire new knowledge and skills, but may choose how and when to acquire (Warr and Bunce, 1995). In an open learning setting job experience is expected to be beneficial for the learning outcomes. First, as people with much

job experience have a baseline understanding of key concepts and procedures which might be applicable in the new situation. Second, since people with much job experience may be less anxious in the new situation, they would more likely draw upon their previously-acquired knowledge and skills (Warr and Bunce, 1995).

Therefore, we hypothesize:

Hypothesis 1: Job experience is positively associated with individual alliance-related work performance.

3.3.2 The moderating effect of a central network position

In this study we concentrate on the formal network among members of the alliance. A formal network is the formally prescribed set of interdependencies between actors set forth in job descriptions and reporting relationships (Gulati and Puraman, 2009; Mehra, Kilduff, and Brass, 2001). We focus on the formal network instead of informal networks, because the knowledge sharing in an R&D alliance is not self-evident. Often alliance partners also compete with each other in other projects. Therefore, knowledge appropriability issues most likely play a role. In the formal network people are obliged to share knowledge and information about particular topics. The knowledge to be shared often includes routine or simple knowledge. However, in a more complex, knowledge-intensive work environment it may also include tacit or compound knowledge.

In the formal network, individuals with different network positions have different levels of knowledge access. A more central position in the network gives the individual increased access to different channels of information and knowledge (Sparrowe et al., 2001). In a task environment that is characterized by high levels of complexity, uncertainty and ambiguity it is important to be faced with others' interpretations about the alliance goals, interests, time horizons and core values (Mom, van den Bosch, and Volberda, 2009). A

central position in the formal alliance network offers the opportunity to access other's interpretations, but also to discuss them and come to more shared representations, interpretations and systems of meaning among parties (Nahapiet and Ghoshal, 1998). Moreover, a central position offers the opportunity to acquire more fine-grained collective knowledge, e.g. about organizational and technical opportunities and constraints with respect to the current projects in the alliance (Hoegl, Weinkauf, and Gemuenden, 2004; Nahapiet and Ghoshal, 1998).

To sum up, a central position in the formal network in the alliance gives the opportunity to see the "big picture" (Schönrok, 2010), which will be less clear if one has a more marginal position in the network, leading to more context uncertainty and role ambiguity. Understanding the alliance setting and the possibilities and constraints in the task gives an individual the opportunity to deploy his or her experience in a more efficient and effective way. Hence, it enhances the effect of job experience on one's alliance-related work performance. We hypothesize:

Hypothesis 2: The relation between job experience and individual alliance-related work performance is positively moderated by the individual's central position in the formal alliance network.

3.3.3 The contingent role of motivation in the effectiveness of the network position

In this study the willingness dimension in the model of Blumberg and Pringle (1982) is embodied by intrinsic and extrinsic motivation. Intrinsic motivation indicates the pleasure and inherent satisfaction derived from an activity (i.e. sharing knowledge), while extrinsic motivation focuses on the goal-driven reasons, e.g. rewards or benefits earned from performing an activity (i.e. sharing knowledge) (Lin, 2007). Intrinsic motivation is valued for

its own sake and appears to be self-sustained, while the idea of extrinsic motivation is strict reward-for-performance (Osterloh and Frey, 2000).

In the new, complex, and knowledge-intensive setting of an R&D alliance the knowledge to be shared is more tacit or compound. Despite the fact that knowledge sharing is mandated in the formal alliance network, alliance members hardly can be identified and sanctioned if they hold back their tacit knowledge (Osterloh and Frey, 2000). Moreover, due to potential problems with respect to knowledge appropriability, knowledge sharing in an alliance is far from obvious. Therefore, it would be beneficial for the process of sharing tacit or compound knowledge if an individual enjoys knowledge sharing for its own sake. This can be due to personal identification (e.g. with being an expert in technological knowledge), an increased self-esteem, or feelings of commitment. It may also have to do with alliance citizenship, showing the alliance how much the person is needed and how useful he or she can be to others in the alliance (Constant, Sproull, and Kiesler, 1996). Individuals can also act out of a sense of fairness, public duty, or concern for the alliance, or they can behave altruistically, enjoying helping others (Lin, 2007; Wasko and Faraj, 2000).

Anyway, driven by any of these mechanisms, individuals may be intrinsically motivated to share knowledge, thereby cancelling out the thresholds to share tacit or compound knowledge in the R&D alliance and being able to fully exploit the benefits of the central position in the formal network.

Therefore, we hypothesize:

Hypothesis 3a: Intrinsic motivation positively moderates the moderating effect of the central position of the individual in the formal alliance network on the relation between job experience and individual alliance-related work performance.

Many of the aforementioned motivators to share knowledge are based on the perspective that the decision to share knowledge is primarily non-economic and motivated by community interest and moral obligation (Wasko and Faraj, 2000). However, the decision to share knowledge can also be viewed as primarily economic. In that case knowledge is likely to be considered as a private good instead of a public good, owned by the individual instead of the company or community (Wasko and Faraj, 2000). Then people are more motivated by tangible returns such as promotions, raises, or bonuses. An R&D alliance is different from a single firm: it is temporary, composed of at least two partners with different strategic goals and firm cultures, while the partners may compete in other projects outside the alliance. Therefore, alliance members may be less committed to the alliance. For some alliance members this includes that they must be extrinsically motivated to share knowledge by tangible returns. The more tangible returns are offered, the more extrinsically motivated they will be and the better the thresholds to share tacit or compound knowledge can be neutralized, leading to the ability to fully exploit the central position in the formal alliance network.

Thus, we hypothesize:

Hypothesis 3b: Extrinsic motivation positively moderates the moderating effect of the central position of the individual in the formal alliance network on the relation between job experience and individual alliance-related work performance.

3.4 Method

3.4.1 Organizational settings

In our study we collected data from an alliance composed of a company developing and producing fuel cells in China (the company) and a research institute focusing on chemical physics and in particular fuel cell research (the institute). We have collected data about the full social network of individuals involved in the knowledge transfer processes of the alliance.

The company, leading in the development and commercialization of fuel cells is founded in 2001, while by now it consists of 150 employees. The company has a unit structure with intensive cooperation among the units. In order to obtain in-depth research-based knowledge to develop more advanced products, the company allied with the institute in which basic research is conducted.

The institute, founded in 1961, is famous in China for its research in chemical physics. It is structured in divisions and the fuel cell division is one of them, consisting of 50 employees. This division accomplished some breakthrough inventions in fuel cells and produced about 25 highly influential patents. It mainly generates income from licensing and by transforming its basic research into technology ready for commercial application.

The R&D alliance (the alliance) focuses on fuel cell technology development and application. It consists of several projects coordinated by project leaders and directors from the company and the institute. Besides the collaboration on the projects, within the alliance there are personnel training, technology consulting, testing, and regular seminars about recent developments in the forefront of the technology.

3.4.2 Data collection

Data on the individual alliance-related work performance of the alliance members were collected from the two alliance directors from the company and the institute. Data on the formal network, and intrinsic and extrinsic motivation were collected from the alliance members by means of an egocentric network survey. This study used snowball sampling to get in touch with the full social network. Snowball sampling is especially useful if the population is not clear from the beginning (Marsden, 1990; 2002; Wasserman and Faust, 1994). The online survey included validated name generator questions to have the correct data about the network (Aalbers et al. 2014; Sparrowe et al. 2001). To reduce ambiguity with respect to the interpretation of the questions by the respondents, the questions were formulated in their native language. The invitation to participate in the survey was distributed by the two alliance directors with an email to each of the alliance members, accompanied by an introduction of the survey and the hyperlink to the online survey.

The survey was sent in three rounds to reach the full social network of the alliance members. The final response rate on the company side is 97% and on the institute side is 100%. The total respondents within the alliance in the formal network are 66, which almost is the total number of the individuals involved in the alliance's work. Former studies also analyzed such small networks (e.g. Aalbers, Dolfsma, and Koppius, 2013; Albrecht and Hall, 1991; Dholakia, Bagozzi, and Pearo, 2004; Tichy, Tushman, and Fombrun, 1979) and have proven to present robust outcomes (Aalbers et al., 2013; Costenbader and Valente, 2003). The formal network has 312 knowledge transfer ties.

3.4.3 Measurements

The formal network was identified by asking individual respondents to whom they are supposed to discuss ideas, solutions at work (Borgatti and Cross, 2003; Cross and Prusak, 2002; Rodan, 2010). We provided a guideline naming seven employees for each network to

make sure that only the most important contacts per employee were mentioned. Further contacts could be added, however. Based on the network data gained via the survey, the variable concerning the central position in the formal network was calculated by using Ucinet 6.0 (Borgatti, Everett, and Freeman, 2002; Freeman, 1979).

Dependent variable. Individual alliance-related work performance was measured by means of a 1-7 point Likert type scale in ascending order, which means the higher the rating, the better the performance. The individual work performance includes five dimensions: individual work quality, efficiency, innovativeness, knowledge, and interpersonal capability (Barrick, Mount, and Strauss, 1993; Cross and Cummings, 2004; Stewart, Courtright, and Barrick, 2012; Welbourne, Johnson, and Erez, 1998). The five dimensions are significant for indicating one's work performance in general, but also particularly in the R&D alliance. In such a knowledge-intensive setting members cannot develop breakthrough technologies without knowledge, quality and innovativeness. Moreover, for the alliance time-to market is very important to be able to compete with rivals, thus work efficiency is an important dimension. Finally, especially in an alliance knowledge must actually be shared which asks for interpersonal capability of the alliance members.

Independent variable. Job experience has been measured by the number of month of the alliance member working in a specific field in his or her company or institute.

Moderating variables. To measure the central position of an alliance member in the formal network we used degree centrality as a centrality index. It is defined as the number of links incident upon a node (Borgatti, 2005; Freeman, 1979) and it is the most commonly used index to describe an individual's direct contact-based network position and the direct communication among individuals. Note that in the formal network with its mandated contacts, individuals mostly communicate with their direct contacts. *Degree centrality* was calculated by counting how many direct contacts an actor has (Balkundi and Harrison, 2006;

Bono and Anderson, 2005; Brass, 1984; Cross and Cummings, 2004; Freeman, 1979, Mehra,

Kilduff, and Brass, 1998). *Intrinsic motivation and extrinsic motivation* were measured by

means of a 1-7 point scale in ascending order. The four items of intrinsic motivation and the

six items of extrinsic motivation were based on Amabile et al. (1994), Lin (2007), and

Tremblay et al. (2009). See Table 2b for the wording of the items. Cronbach alphas were 0.84

and 0.90 respectively.

  Control variables. We control for membership of each partner, job title, and rank.

Membership was measured by a nominal variable indicating that the alliance member was

based in the company (1) or in the institute (2). *Job title* was measured by a dummy variable,

indicating whether the job is indirectly (0) or directly (1) relevant for the R&D work. *Ran*k

was measured on a 1-5 point scale in ascending order.

3.4.4 Analysis

  The general connection status of the formal network is presented in Figure 3.2.
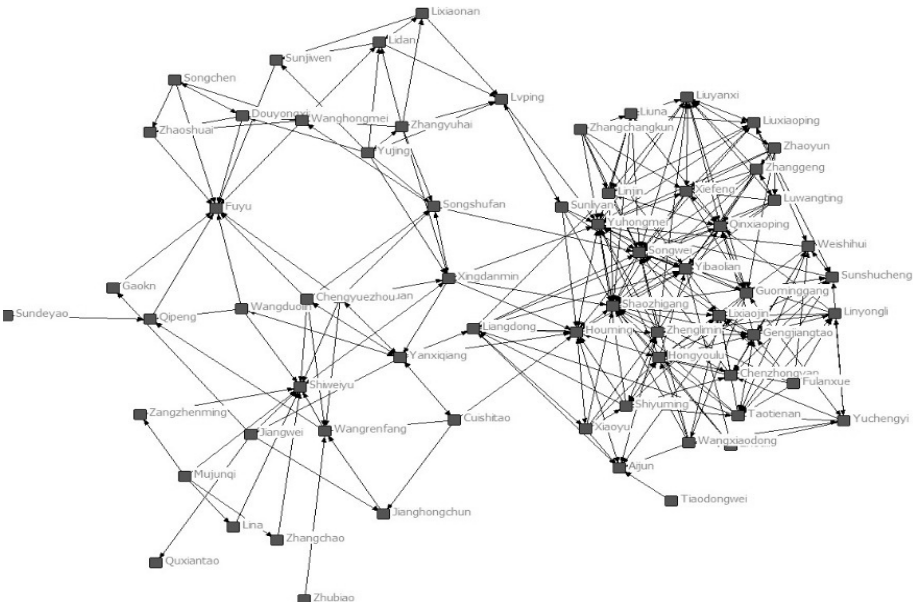
Figure 3.2 The formal network

Descriptive statistics and correlations between the study variables are presented in Table 3.1.

Table 3.1 Descriptive statistics and correlations

	Variable	Mean	Std.dev.	1	2	3	4	5	6	7
1	Membership	1.500	0.504							
2	Job title	0.920	0.267	-0.057						
3	Rank	1.980	1.259	-0.182	0.088					
4	Job experience	62.940	56.997	-0.084	0.043	0.570**				
5	Degree centrality	11.748	6.926	0.597**	0.105	0.260*	0.140			
6	Intrinsic motivation	6.284	0.588	0.214	0.066	-0.342**	-0.381**	0.066		
7	Extrinsic motivation	5.854	0.966	0.305*	-0.044	-0.303*	-0.293*	0.141	0.762**	
8	Work performance	5.936	0.692	0.490**	-0.010	0.465**	0.376**	0.602**	-0.095	-0.053

N=66. * / ** Significance at 5% and 1% respectively.

Table 3.2a and Table 3.2b report the standardized factor loadings and Cronbach's alpha of the dependent variable and intrinsic and extrinsic motivation respectively.

Table 3.2a Standardized factor loadings and Cronbach's alpha of the dependent variable

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

Table 3.2b Standardized factor loadings and Cronbach's alpha of extrinsic and intrinsic motivation

Construct item	Item wording	Factor loadings and Cronbach's α	
Intrinsic motivation		$\alpha = 0.838$	
		F1	F2
1	I enjoy knowledge sharing with colleagues	-0.069	**0.842**
2	Knowledge sharing with other colleagues is (1= very worthless… 7= very valuable)	0.079	**0.732**
3	I intend to have knowledge sharing more frequently with colleagues in the future	0.038	**0.874**
4	I will always make an effort to have knowledge sharing with my colleagues	0.061	**0.796**
Extrinsic motivation		$\alpha = 0.901$	
		F1	F2
1	I will receive increased job security from knowledge sharing	**0.704**	0.107
2	I will receive increased promotion opportunities from knowledge sharing	**0.850**	0.046
3	I will attain certain important objectives from knowledge sharing	**0.946**	-0.119
4	I strengthen relations between existing members of the alliance and myself	**0.764**	0.124
5	I expand the scope of my association with other firms' members	**0.665**	0.137
6	I believe that my future requests for knowledge will be answered	**0.913**	-0.071

This study utilizes the ordinary least squares multiple regression to test the hypotheses (Table 3.3). We take a hierarchical approach involving 66 observations of the formal network. Moreover, we use ridge regression, since despite the mean-centering of the variables in the moderator analysis (Aiken and West, 1991; Kenny and Judd, 1984) we still faced multicollinearity in our three way interaction models. To avoid that we had to use ridge regression and we used it in all models to make them comparable. We first examine the control variables' effects on individual alliance-related work performance in model I. Then we add the main factor of job experience to the analysis in model II. Afterwards, in model III the moderating effect of degree centrality in the formal network is examined. In models IV, V, and VI the three-way interactions regarding job experience, degree centrality and intrinsic or extrinsic motivation are considered. To see whether there exists an crowding-out effect of extrinsic motivation, in model IV or V only intrinsic motivation or extrinsic motivation is treated, while in model VI both intrinsic and extrinsic motivation are examined.

Table 3.3 Standardized regression coefficient estimates with the dependent variable individual alliance-related work performance

D.V.	I	II[1]	III	IV	V	VI
CVs						
Membership	0.265***	0.286***	0.203***	0.189***	0.193***	0.184***
Job title	0.021	0.032	0.032	0.036	0.041	0.041
Rank	0.368***	0.356***	0.264***	0.242***	0.242***	0.242***
IVs						
Job experience		0.153**	0.134**	0.135***	0.128***	0.133***
MVs						
Degree centrality			0.188***	0.172***	0.172***	0.165***
Job experience X degree centrality			0.091	0.085*	0.091*	0.085*
Intrinsic motivation				-0.080		0.033
Extrinsic motivation					-0.097	-0.097
Degree centrality X intrinsic motivation				0.007		-0.004
Degree centrality X extrinsic motivation					0.036	0.026
Job experience X intrinsic motivation				0.113**		0.076*
Job experience X extrinsic motivation					0.096*	0.074*
Job experience X degree centrality X intrinsic motivation				0.084*		0.040
Job experience X degree centrality X extrinsic motivation					0.108**	0.092**
N	66	66	66	66	66	66
F-value	13.058***	11.830***	11.249***	7.385***	6.943***	5.384***
R^2	0.716	0.722	0.746	0.782	0.808	0.808
Adjusted R^2	0.687	0.683	0.705	0.717	0.740	0.717
F-test for $\triangle R^2$		1.317	2.323	2.379*	3.765**	2.222*

* p<.05; ** p<.01; *** p<.001.

1) Note that this model is similar to model A0 of chapter 2, but results are slightly different due to the ridge regression technique used in chapter 3

3.5 Results

The multiple regression analyses in Table 3.3 display the findings with regard to hypotheses 1, 2, 3a and 3b. As hypothesis 1 suggests, an individual's job experience significantly enhances his or her individual alliance-related work performance: hypothesis 1 is supported in models II-VI (we found β-values between 0.128, p<0.001 and 0.153, p<0.01). Hypothesis 2 suggests that a central position in the formal network enhances the job experience's effect on individual alliance-related work performance: hypothesis 2 is supported in models IV-VI with β-values between 0.085 (p<0.05) and 0.091(p<0.05) respectively. However, intrinsic motivation does not always play a contingent role in fully exploiting the central position in the formal network: hypothesis 3a cannot be unilaterally supported. In model IV (without the additional influence of extrinsic motivation) we find a significant positive three-way interaction effect of 0.084 (p<0.05), but the β-value of 0.040 in model VI is insignificant. We do find a contingent role of extrinsic motivation in fully exploiting the central formal network position, thus hypothesis 3b is confirmed. In models V and VI the β-value concerning the three-way interaction with extrinsic motivation is 0.108 and 0.092 respectively (p<0.01).

With respect to the control variables our findings show a significantly positive association of membership and rank with individual alliance-related work performance in all models.

3.6 Discussion

This study aimed for contributing to explain the internal dynamics of R&D alliances on an individual level. Due to competitive pressure to innovate, many firms nowadays invest in alliance activity. However, still 50% of the alliances fail (Ernst et al., 2011). We conducted a micro-level study of the individual work performance in an R&D alliance.

Following the capacity-opportunity-willingness theory of Blumberg and Pringle (1982), we examined the direct relationship between job experience (capacity element) and individual work performance, as well as the moderating effect of a central position in the social network of the alliance on this relationship (opportunity element). Finally, we examined the moderating effect of intrinsic and extrinsic motivation to fully exploit the central network position in the aforementioned moderating role (willingness elements).

We found a significant positive relationship between job experience and individual alliance –related work performance and a positive moderating effect of degree centrality in the formal alliance network, which was on its turn contingent upon extrinsic motivation, but not upon intrinsic motivation. The moderating effect of extrinsic motivation was significantly positive.

Below we will give some theoretical and managerial implications of this study, as well as limitations and directions for future research.

3.6.1 Theoretical implications

The roles of intrinsic and extrinsic motivation

The willingness dimension of the work performance theory of Blumberg and Pringle (1982) was embodied by intrinsic and extrinsic motivation. Contrary to former findings, we found the role of extrinsic motivation being more important to fully exploit the degree centrality in the formal network than intrinsic motivation. In former research it was generally found that extrinsic motivation plays a negative or insignificant role in the knowledge sharing process (Bock et al., 2005; Lin, 2007; Wasko and Faraj, 2000), while intrinsic motivation strengthens the knowledge sharing process. We found opposite results. This might be due to the co-opetitive environment of an R&D alliance. It is composed of partners who elsewhere might compete with each other, raising appropriability issues. Moreover, it does not have a shared long-term goal and a culture as strong as a firm culture. Thus, individual knowledge sharing might be risky. Although it may contribute to the alliance performance, the process of knowledge sharing might disclose the knowledge that one partner does not want the other partner(s) to know. Apparently, in such a context reward-for-performance is required to overcome the potential thresholds in the knowledge sharing process.

In the within-firm setting extrinsic motivation has been suggested to crowd out intrinsic motivation. If intrinsic motivation already is available and extrinsic motivation comes in, there is a trade-off between the two often leading to a spill-over effect to reward-for-performance. In Table 3 (models IV, V, and VI) we also see such a crowding-out effect. It would be interesting to study such crowding-out effect in more details in an R&D alliance context. Future research may reveal whether such effect is similar in the R&D alliance compared to the within-firm situation.

Central position in the formal network

Previous studies found that formal contacts do not significantly contribute to knowledge exchange (e.g. Allen, James and Gamlen, 2007; Cross and Parker, 2004; Gulati and Puranam, 2009; Hansen, 1999; Mehra, Kilduff, and Brass, 2001). Sharing knowledge appears to be a kind of extra role; it requires much time and effort, as well as mutual trust (e.g. Burt, 1992; Connelly and Kelloway, 2003; Granovetter, 1973; Reagans and McEvily, 2003). Such circumstances do less coincide with the characteristics of a formal network with its mandated contacts. However, contrary to these former studies, we found a significant positive role of the formal alliance network in knowledge sharing in particular for people with a central position in this network. This result is probably again due to the specific co-opetitive setting of the R&D alliance. It apparently is less risky to let tacit or compound knowledge flow along the formal alliance network with mandated contacts. Moreover, the knowledge flowing along this formal network is helpful for the effective and efficient exploitation of one's experience in the field.

Interactions in the co-appetitive R&D setting

In their work on individual performance Blumberg and Pringle (1982) consider three dimensions of work performance: capacity, opportunity, and willingness. They suggested each of these dimensions to be important for the individual performance of the firm. Besides the within-firm study of Reinholt et al. (2011) there is no much empirical evidence whether these dimensions really interact and if so, how they interact. In our study we found particular interactions in the setting of an R&D alliance. Job experience has direct positive impact on individual (alliance-related) work performance. Despite the fact that job experience has been built in one partner organization, it is beneficial for the individual performance in the alliance. Thus, the experience within the partner organization also provides a basic understanding of key concepts and procedures in the alliance setting. The positive relationship between job

experience and individual alliance –related work performance will be strengthened by a central position (degree centrality) of the alliance member in the formal network. Thus, the safety of mandated contacts offers the opportunity to share, besides the routine knowledge, tacit or compound knowledge about the alliance setting, which enables fully exploiting the alliance member's experience. Finally, the advantages of the central position in the formal network are contingent upon the member's extrinsic motivation. Rewarding the sharing of knowledge will enhance the involvement of the alliance member in knowledge sharing, which will provide more information about the alliance setting and, in the end, will strengthen the relationship between job experience and individual alliance-related work performance.

3.6.2 Managerial implications

This study also has important implications for people involved in, or managing an R&D alliance. The main messages for managers are: first, select the employees from the alliance partners based on their specific job experience that is related to the alliance work; it is not a problem that this experience probably has been developed in one of the partner firms or organizations; second, put effort in the development of a formal network, which is helpful for interactions between members in the alliance, as well as try to stimulate frequent contact between the members of the formal network; third, establish appropriate forms, routines and rewarding systems to promote members exchanging knowledge.

For members of the alliance the main message is that for their own sake they should try to get a central position in the formal network, which gives the opportunity to get access to alliance-based context knowledge.

3.6.3 Limitations and future research

Our research is not without limitations. The following four important limitations suggest several future research directions. First, this study explored the influence of capacity, opportunity, and willingness on the alliance-based work performance of individuals. More in-depth qualitative research is required to further clarify the relationships between alliance-internal dynamics on the individual level and the more macro-level dynamics.

Second, our study is a cross-sectional one. Besides more in-depth qualitative information about alliance-internal dynamics on different levels of aggregation, it would be beneficial to study these dynamics and their influences along a period of time. Thus future research should include more longitudinal studies on alliance-internal dynamics.

Third, a more in-depth study on the variables reflecting capacity, opportunity, and willingness would be fruitful. In our study the variables job experience, central formal network position, and intrinsic and extrinsic motivation embodied capacity, opportunity, and willingness respectively. Future research should reveal the outcomes and interrelations among other variables within the dimensions capability, opportunity and willingness, such as level of knowledge and skills, state of health, task complexity, alliance structure, personality characteristics, and commitment.

Fourth, clearly our findings are only based on the data of one R&D alliance in the field of chemical physics in China. Thus, future research should include other industries as well as other countries to provide the external validity.

Chapter 4

Knowledge relevance in an R&D alliance: The roles of job experience, social network position and motivation

4.1 Introduction

Business literature has fully agreed upon the importance of innovation to organizational survival and prosperity (Rubera and Kirca 2012, Schumpeter 1942). This not only requires efficiently processing information and knowledge in the firm, but it also asks for the creation of new knowledge (Nonaka 1994). To obtain new inspiration and to speed up these knowledge-creating processes, many firms ally (Ernst et al. 2011). Indeed, a key role of an alliance is sharing and creating new knowledge (e.g. Sampson 2007, Spekman et al. 1998).

However, experience shows that transferring knowledge is far from easy. Impediments are due to motivational factors, such as the not-invented-here syndrome, and knowledge-related factors, such as recipient's lack of absorptive capacity (Katz and Allen 1982, Schulz 2003, Szulanski 1996, 2000). Studying these impediments is part of the research stream on the stickiness of knowledge. Stickiness of knowledge has been extensively examined within a firm (e.g. Szulanski 1996, 2000). In this article we claim that the stickiness of knowledge is even more expedient in an R&D alliance setting. In an R&D alliance people are faced with a new context, partly new tasks, and new challenges, while they have to work with different cultures, regulations, and modes to share knowledge. Partners in an R&D alliance may even be potential competitors. The stickiness of knowledge may be one of the most important reasons that many alliances fail (Bleeke and Ernst 1993, Ernst et al 2011).

Most current studies on knowledge stickiness are on unit- or firm-level (e.g. Katz and Allen 1982, Pérez-Nordtvedt et al. 2008, Szulanski 1996, 2000, Von Hippel 1994). The individual level has not been researched yet. Moreover, an important key variable is missing in the current studies, the perceived relevance of the transferred knowledge by the recipient (Schulz 2003). Indeed, the recipient's recognition that a particular piece of knowledge is relevant appears to be an important driver of knowledge flows between intra-firm units (Schulz 2003).

In this article we present a micro-level study into the antecedents of the individual recipient's perception of knowledge relevance in an R&D alliance setting. Relevance here concerns the alliance performance. Building on stickiness theory (Szulanski 1996, 2000) and relevance theory (Schulz 2003) we examine the influence of job experience as prior-accumulated knowledge on the recipient's perceived knowledge relevance. Moreover, we study the moderating effect of knowledge access to other alliance members' knowledge on this relationship, as well as the moderating effect of intrinsic and extrinsic motivation to share knowledge. The idea is that prior-accumulated knowledge builds up the absorptive capacity to be able to recognize the potential relevance of other's knowledge. Moreover, the better the access to the knowledge of other alliance members, the higher the likelihood that pieces of other's knowledge will coincide with pieces of one's own knowledge, thus becoming more meaningful for the recipient. Additionally, if recipients are reluctant to accept knowledge from others they will not be willing to use their full reservoir of prior knowledge to judge the potential relevance of other's knowledge. Thus, being motivated to give and take knowledge from others strengthens the relationship between a recipient's prior knowledge and the recognition of relevant knowledge from others.

This study will contribute to the existing literature in the following way. First, it will contribute to an individual-level understanding of knowledge transfer in R&D alliances. Such

a micro-level explanation of knowledge transfer processes is likely to be stable and generalizable (Coleman 1990). Second, by combining stickiness and relevance theory this study will contribute to both theories. Stickiness theory will be further developed on the individual-level, taking perceived knowledge relevance into additional consideration. Knowledge relevance theory is also further developed on the individual level, thereby including motivational factors to recognize the relevance of knowledge.

4.2 Theoretical background

Stickiness theory is grounded on the notion that the mere possession of potentially valuable knowledge somewhere in an organization or alliance does not necessarily mean that other parts of the organization or alliance benefit from that knowledge. This is due to the fact that transfers of knowledge, rather than fluid, often are difficult to achieve ("sticky") (Szulanski 1996, 2000, Von Hippel 1994).

In the knowledge management literature this stickiness has not received so much attention. In general, the idea is that knowledge transfer is costless and instantaneous, while it appears to be laborious, time consuming, and difficult (Szulanski 2000). In stickiness theory the incidence of knowledge transfer problems is predicted by characteristics of the basic elements of transfer: the source, the recipient, the knowledge transferred and the context in which the transfer takes place.

In Szulanski's study into within-firm stickiness knowledge-related barriers, such as the recipient's lack of absorptive capacity, causal ambiguity of the knowledge, and the arduousness of the relationship between the source and the recipient, were found to be more important than motivational factors (Szulanski 1996, 2000). To the best of our knowledge there are no studies about stickiness in an R&D alliance context. Moreover, although a lot of

knowledge-related characteristics have been taken into account, an important characteristic is missing: the perceived relevance of the transferred knowledge.

However, in relevance theory (Schulz 2003) the concept of knowledge relevance is crucial. In this theory relevance is defined as having a bearing on or connection with the matter at hand. Knowledge relevance is defined as the degree to which external knowledge (knowledge from other alliance members) has the potential to connect to local knowledge (the knowledge of the individual recipient). From this definition it is clear that relevance affects the value of knowledge. Schulz (2003) uses the lock-and-key metaphor, indicating that external knowledge, like a key, can connect to the recipient's knowledge in a way that fits, thereby unlocking it and switching it into a different state.

One of the main ideas in (linguistic) relevance theory is that comprehension is brought about because hearers select relevant implications of speakers' utterance and disregard less relevant ones. Implications are relevant to hearers if they lead to new, nontrivial implications in conjunction with the information and knowledge already available at the hearer and if it takes not much effort to derive these new implications (Sperber and Wilson, 1982). In business applications of this theory until now mostly knowledge-related and relational antecedents of knowledge relevance have been studied on unit level (Schulz 2003). To the best of our knowledge there are no studies on the individual level. Moreover, until now motivational factors have not been studied.

In our study we combine and utilize ideas of both stickiness theory and relevance theory (Schulz 2003, Szulanski 1996, 2000, Von Hippel 1994). Our conceptual model is presented in Figure 4.1 below.
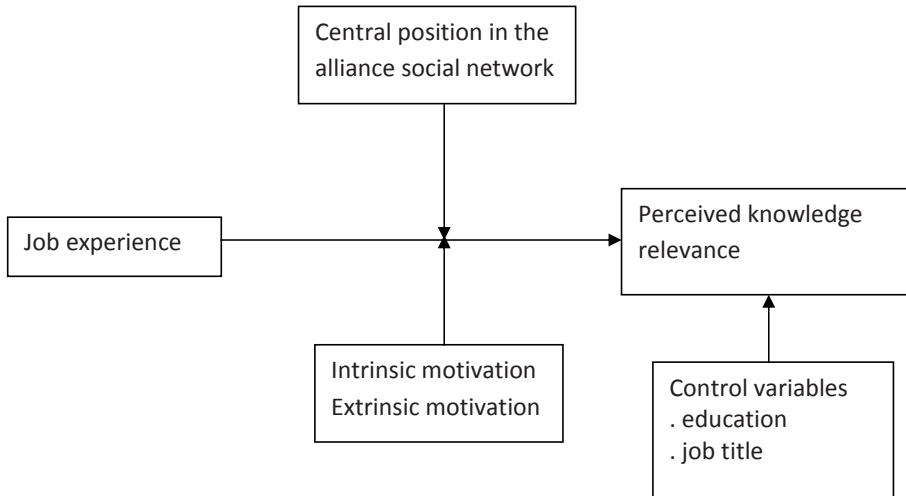
Figure 4.1 Conceptual model

Our micro-level study focuses on the perspective of the individual recipient of knowledge from other alliance members. Based on both stickiness and relevance theories we emphasize the role of the recipient's absorptive capacity in enabling to recognize the relevance of others' knowledge. The absorptive capacity is reflected by the recipient's job experience. The arduous relationship mentioned in the stickiness theory, as well as the informal relations between source and recipient mentioned in the relevance theory are reflected by the central position of the recipient in the alliance social network. We assume that the relationship between job experience and perceived knowledge relevance is positively moderated by the central position in the alliance network, since the more access the recipient has to external knowledge the higher the likelihood that pieces of this knowledge will fit with pieces of the recipient's prior knowledge. Finally, the motivational factors of the stickiness theory that are missing in the relevance theory are modelled by intrinsic and extrinsic motivation to share knowledge. We also assume intrinsic and extrinsic motivation to be

positive moderators of the relationship between job experience and perceived knowledge relevance, since only highly motivated people will exploit their full reservoir of prior knowledge to make a judgment of the relevance of others' knowledge.

In our study we control for more general knowledge of the recipient (education) and his or her position in one of the partner organizations (job title). Note that we do not take into account the concept of causal ambiguity mentioned in the stickiness theory. We assume that all knowledge in the R&D alliance setting is causally ambiguous. Thus, we do not expect this concept to have explanatory power.

4.3 Hypothesis development

4.3.1 The role of job experience

Job experience is defined here as the time an individual already works in the current field in the current organization. In this study job experience reflects the prior-accumulated knowledge of the recipient. Relevance theory (Schulz 2003) and absorptive capacity theory (Cohen and Levinthal 1990) predict that job experience will be positively associated with the recipient's perceived knowledge relevance.

Relevance theory suggests that if the knowledge volume of either the source or the recipient expands, the likelihood that pieces of knowledge of source and recipient fit together increases. Usually these coincidences of pieces of knowledge lead to elaborations, contradictions, or strengthening of the recipient's knowledge base and they will at least increase the recipient's recognition of the knowledge relevance of the other alliance member(s).

Absorptive capacity theory suggests that prior related knowledge is required to assimilate and use new knowledge. Research on memory development puts forward that

accumulated prior knowledge increases both the ability to put new knowledge into memory, and the ability to recall and use it. The more objects, patterns and concepts are stored in memory, the more readily new information about these constructs is recognized and stored.

Therefore, we hypothesize:

Hypothesis 1: Job experience of the recipient is positively associated with the recipient's perception of the relevance of knowledge from others in the R&D alliance.

4.3.2 The moderating effect of a central network position

In this study we concentrate on the formal network among members of the alliance. A formal network is the formally prescribed set of interdependencies between actors set forth in job descriptions and reporting relationships (Gulati and Puraman, 2009; Mehra, Kilduff, and Brass, 2001). We focus on the formal network instead of informal networks, because the knowledge sharing in an R&D alliance is not self-evident. Often alliance partners also compete with each other in other projects. Therefore, knowledge appropriability issues most likely play a role. In the formal network people are obliged to share knowledge and information about particular topics. The knowledge to be shared often includes routine or simple knowledge. However, in a more complex, knowledge-intensive work environment it may also include tacit or compound knowledge.

In the formal network, individuals with different network positions have different levels of knowledge access. A more central position in the network gives the individual increased access to different channels of information and knowledge (Sparrowe et al., 2001). At a central position in the formal alliance network there is a high inflow of pieces of external knowledge to the recipient. Applying relevance theory in a similar way as at the hypothesis 1 development, we may argue that an increase in job experience, thus, an increase in prior knowledge of the recipient will lead to more coincidences with pieces of external knowledge,

compared to a situation in which there is a low inflow of external knowledge. This will lead to a higher recognition of the knowledge relevance of others in the alliance, compared to the situation with a low external knowledge inflow.

Moreover, the central position in the formal alliance network offers the opportunity of an easier communication with network members, if we compare it with a less central network position. An easier communication helps network members to learn about each other's operations, it promotes the development of transactional memory (Wegner 1995) and it leads to a greater familiarity with the operations performed elsewhere in the alliance. Such familiarity may raise the awareness of the recipient about the potential availability of relevant knowledge at other members of the formal alliance network (Schulz 2003).

Thus, if the recipient has a central position in the formal alliance network, an increase in his or her prior knowledge will provide more insight in the potential availability of network members' relevant knowledge compared to the situation with a less central network position, leading to a higher likelihood that the knowledge of the alliance members will be considered relevant.

We hypothesize:

Hypothesis 2: A central position in the formal R&D alliance network positively moderates the relationship between the recipient's job experience and the recipient's perception of the relevance of knowledge from others in the R&D alliance.

4.3.3 The moderating effect of intrinsic and extrinsic motivation

In this study motivational factors are embodied by intrinsic and extrinsic motivation. Intrinsic motivation indicates the pleasure and inherent satisfaction derived from an activity (i.e. sharing knowledge), while extrinsic motivation focuses on the goal-driven reasons, e.g.

rewards or benefits earned when performing an activity (i.e. sharing knowledge) (Lin, 2007). Intrinsic motivation is valued for its own sake and appears to be self-sustained, while the idea of extrinsic motivation is strict reward-for-performance (Osterloh and Frey, 2000).

Knowledge sharing is a give-and-take activity. A source must be willing to give the knowledge to a recipient, and the recipient must be willing to accept the knowledge from the source. In this study we focus on the latter part of knowledge sharing, the willingness of a recipient to accept knowledge from the outside. Thus, intrinsic and extrinsic motivations concern the recipient's willingness to accept external knowledge. In the co-opetitive environment of an R&D alliance, acceptance of knowledge from the outside is not self-evident. It is composed of partners who elsewhere might compete with each other, raising appropriability issues. Moreover, it does not have a shared long-term goal and a culture as strong as a firm culture. Therefore, the not-invented-here syndrome (Katz and Allen 1982) might play an important role. This can result in foot dragging, passivity, or hidden sabotage (Szulanski 1996) of alliance members that can hardly be identified and sanctioned.

It would be very helpful if alliance members would enjoy learning what other members do and thus accept knowledge from others to learn. Members may also accept knowledge from others out of feelings of commitment, alliance citizenship, public duty, or concern for the alliance (Constant et al. 1996, Lin 2007, Wasko and Faraj 2000). When people are driven by any of these mechanisms, they are intrinsically motivated to accept external knowledge. If recipients are highly intrinsically motivated to accept knowledge from other alliance members, they are likely willing to exploit their full reservoir of prior knowledge to look for a fit with other's knowledge and thus recognize its importance. If recipients are not highly motivated, an increase in their reservoir of prior knowledge will not lead to a higher likelihood that they will recognize the knowledge relevance of other alliance members than in

the case they are highly intrinsically motivated, as they probably do not use their full reservoir of knowledge then.

Therefore, we hypothesize:

Hypothesis 3a: Intrinsic motivation positively moderates the relationship between the recipient's job experience and the recipient's perception of the relevance of knowledge from others in the R&D alliance.

Many of the aforementioned motivators are based on community interest or moral obligation (Wasko and Faraj 2000). Possibly these motivators are not very strong in a temporary R&D alliance setting. In that case people possibly can be motivated by tangible returns, such as promotions, raises, or bonuses (Wasko and Faraj 2000). The more tangible returns are offered the more extrinsically motivated the alliance members will be and the more they will be willing to fully exploit their resources of prior knowledge to try to coincide with other alliance member's knowledge. We hypothesize:

Hypothesis 3b: Extrinsic motivation positively moderates the relationship between the recipient's job experience and the recipient's perception of the relevance of knowledge from others in the R&D alliance.

4.4 Method

4.4.1 Organizational settings

In our study we collected data from an alliance composed of a company developing and producing fuel cells in China (the company) and a research institute focusing on chemical physics and in particular fuel cell research (the institute). We have collected data about the full social network of individuals involved in the knowledge transfer processes of the alliance.

The company, leading in the development and commercialization of fuel cells is founded in 2001, while by now it consists of 150 employees. The company has a unit structure with intensive cooperation among the units. In order to obtain in-depth research-

based knowledge to develop more advanced products, the company allied with the institute in which basic research is conducted.

The institute, founded in 1961, is famous in China for its research in chemical physics. It is structured in divisions and the fuel cell division is one of them, where 50 scientists are employed. In addition to basic research findings, this division also made innovative breakthroughs in fuel cells and holds about 25 highly influential patents.

The R&D alliance (the alliance) focuses on fuel cell technology development and application. It consists of several projects coordinated by project leaders and directors from the company and the institute. Besides the collaboration on the projects, within the alliance there are personnel training, technology consulting, testing, and regular seminars about recent developments in the forefront of the technology.

4.4.2 Data collection

Data on the formal network, intrinsic and extrinsic motivation and the perception of relevance of knowledge from other alliance members were collected at the alliance members by means of an egocentric network survey. This study used snowball sampling to get in touch with the full social network. Snowball sampling is especially useful if the population is not clear from the beginning (Marsden 1990, 2002, Wasserman and Faust 1994). The online survey included validated name generator questions to have the correct data about the network (Aalbers et al. 2014, Sparrowe et al. 2001). To reduce ambiguity with respect to the interpretation of the questions by the respondents, the questions were formulated in their native language. The invitation to participate in the survey was distributed by the two alliance directors with an email to each of the alliance members, accompanied by an introduction of the survey and the hyperlink to the online survey.

The survey was sent in three rounds to reach the full social network of the alliance members. The total respondents within the alliance in the formal network are 66. While this

may appear a small number of observations, earlier studies also analyzed networks of such size (e.g. Aalbers et al. 2013, 2014, Albrecht and Hall 1991, Dholakia et al. 2004, Tichy et al. 1979) providing robust outcomes (Aalbers et al. 2013, Costenbader and Valente 2003). The final response rate on the company side is 97% and on the institute side is 100%. The formal network has 312 knowledge transfer ties.

4.4.3 Measurements

The formal network was identified by asking individual respondents to whom they are supposed to discuss ideas, solutions at work (Borgatti and Cross 2003, Cross and Prusak 2002, Rodan 2010). We provided a guideline naming seven employees for each network to make sure that only the most important contacts per employee were mentioned. Further contacts could be added, however. Based on the network data gained via the survey, the variable concerning the central position in the formal network was calculated by using Ucinet 6.0 (Borgatti et al. 2002, Freeman 1979).

Dependent variable. Perceived Knowledge Relevance is measured by means of a 1-7 point Likert type scale in ascending order, which means the higher the rating, the higher the perception of knowledge relevance. The measurement scale includes six dimensions: usefulness for the alliance's overall performance, productivity, and effectiveness, as well as employees' job easiness, fastness and performance (Adams et al. 1992, Davis 1989, Levin and Cross 2004). The six dimensions are significant for indicating knowledge relevance: Knowledge in the end should be relevant for the whole alliance, reflected by the first three dimensions. In between it would be very helpful if knowledge is relevant for the recipient's own job execution, reflected by the latter three dimensions.

Independent variable. Job experience has been measured by the number of months of the alliance member working in a specific field in his or her company or institute.

Moderating variables. To measure the central position of an alliance member in the formal network we used *closeness centrality* as the centrality index. It is defined and measured as the inverse of the sum of all distances of one node to the other nodes in the network (Borgatti 2005, Freeman 1979). Thus, the more central a node is the lower its total distance to other nodes. The higher the closeness centrality of a network member, the easier other members can reach him or her in the R&D alliance, especially in the formal network in which contacts are mandated. *Intrinsic and extrinsic motivations* were measured by means of a 1-7 point Likert type scale in ascending order. The four items of intrinsic motivation and the six items of extrinsic motivation were based on Amabile et al. (1994), Lin (2007), and Tremblay et al. (2009). See Table 4.2b for the wording of the items. Cronbach alphas were 0.84 and 0.90 respectively.

Control variables. We control for general knowledge of the alliance members (education) and their job title. *Education* was measured on a 1-5 point scale in ascending order based on the diploma of the alliance member. *Job title* was measured by a nominal variable where 0 represents jobs that are indirectly important for R&D and 1 indicates direct relevance.

4.4.4 Analysis

The general connection status of the formal network is presented in Figure 4.2.
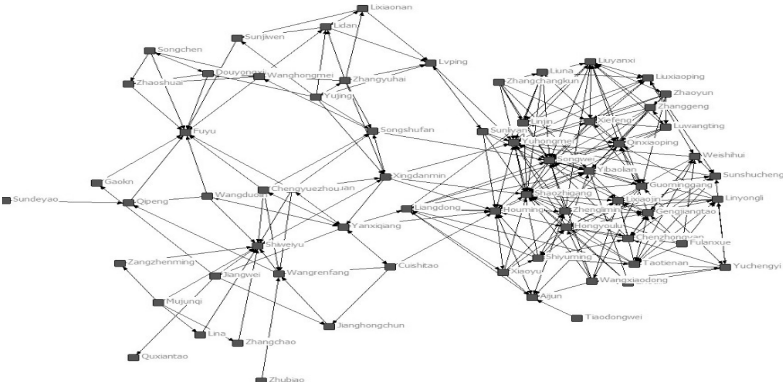
Figure 4.2 The formal network

Descriptive statistics and correlations between the study variables are presented in Table 4.1.

Table 4.1 Descriptive statistics and correlations

	Variable	Mean	Std.dev.	1	2	3	4	5	6
1	Education	3.580	1.110						
2	Job title	0.920	0.267	0.098					
3	Job experience	62.940	56.997	-0.036	0.043				
4	Closeness centrality	22.365	15.780	0.208	0.074	0.080			
5	Intrinsic motivation	6.284	0.588	-0.019	0.066	-0.381**	0.116		
6	Extrinsic motivation	5.854	0.966	-0.076	-0.044	-0.293*	0.212	0.762**	
7	Perceived knowledge relevance	6.077	0.792	-0.034	0.040	-0.174	0.316**	0.712**	0.785**

N=66. * / ** Significance at 5% and 1% respectively

Table 4.2a and Table 4.2b report the standardized factor loadings and Cronbach's alpha of the dependent variable as well as the intrinsic and extrinsic motivation respectively.

Table 4.2a Standardized factor loadings and Cronbach's alpha of the dependent variable

Construct item	Item wording	Factor loadings and Cronbach's α
Perceived knowledge relevance		$\alpha = 0.968$
1	The knowledge I received from others is useful for improving the alliance' performance	0.922
2	The knowledge I received from others helps improving the alliance' productivity	0.918
3	The knowledge I received from others helps improving the alliance' effectiveness	0.936
4	The knowledge I received from others helps making our jobs easier in the alliance	0.928
5	The knowledge I received from others helps making our jobs faster in the alliance	0.933
6	The knowledge I received from others helps improve our job performance in the alliance	0.945

Table 4.2b Standardized factor loadings and Cronbach's alpha of extrinsic and intrinsic motivation

Construct item	Item wording	Factor loadings and Cronbach's α	
		F1	F2
Intrinsic motivation		α =0.838	
1	I enjoy knowledge sharing with colleagues	-0.069	**0.842**
2	Knowledge sharing with other colleagues is (1= very worthless… 7= very valuable)	0.079	**0.732**
3	I intend to have knowledge sharing more frequently with colleagues in the future	0.038	**0.874**
4	I will always make an effort to have knowledge sharing with my colleagues	0.061	**0.796**
Extrinsic motivation		α = 0.901	
		F1	F2
1	I will receive increased job security from knowledge sharing	**0.704**	0.107
2	I will receive increased promotion opportunities from knowledge sharing	**0.850**	0.046
3	I will attain certain important objectives from knowledge sharing	**0.946**	-0.119
4	I strengthen relations between existing members of the alliance and myself	**0.764**	0.124
5	I expand the scope of my association with other firms' members	**0.665**	0.137
6	I believe that my future requests for knowledge will be answered	**0.913**	-0.071

This study utilizes the ordinary least squares multiple regression to test the hypotheses (Table 4.3). We take a hierarchical approach involving 66 observations of the formal network. Moreover, we use ridge regression, since despite the mean-centering of the variables in the moderator analysis (Aiken and West 1991, Kenny and Judd 1984) we still faced multicollinearity in the model where intrinsic and extrinsic motivation were analyzed together. To avoid that we had to use ridge regression and we used it in all models to make the models comparable. We first examine the control variables' effects on the perception of knowledge relevance in model I. Then we add the main factor of job experience to the analysis in model II. Afterwards, in model III the moderating effect of closeness centrality in the formal network is examined. Then the moderating effects of intrinsic and extrinsic motivation are examined in models IV and V respectively. In model VI all variables are considered together in one model.

Table 4.3 Standardized regression coefficient estimates with the dependent variable perceived knowledge relevance

D.V	I	II	III	IV	V	VI
Cvs						
Education	-0.111	-0.109	-0.104	0.033	0.080	-0.052
Job title	0.013	0.014	0.003	0.003	0.025	0.003
IVs						
Job experience		-0.111*	-0.111*	-0.068	-0.056	-0.046
MVs						
Closeness centrality			0.181**			0.135***
Job experience X Closeness centrality			0.097			0.080*
Intrinsic motivation				0.360***		0.238***
Extrinsic motivation					0.476***	0.272***
Job experience X intrinsic motivation				-0.055		-0.024
Job experience X extrinsic motivation					-0.120*	-0.090*
N	66	66	66	66	66	66
F-value	1.225	1.659	2.361*	7.327***	16.835***	10.955***
R^2	0.050	0.098	0.262	0.553	0.682	0.752
Adjusted R^2	0.020	0.054	0.187	0.508	0.656	0.707
F-test for $\triangle R^2$		3.299	5.745**	22.506***	39.748***	22.645***

* p<.05; ** p<.01; *** p<.001.

4.5 Results

The multiple regression analyses in Table 4.3 display the findings with regard to hypotheses 1, 2, 3a and 3b. As hypothesis 1 suggests, a recipient's job experience significantly enhances his or her recognition of relevant knowledge from other alliance members: hypothesis 1 could not be supported as in models II and III we found significant negative β-values of -0.111 ($p<0.05$) and in models IV-VI we found insignificant results. Hypothesis 2 suggests that a central position in the formal network positively moderates the effect of job experience on perceived knowledge relevance: hypothesis 2 is supported in model VI with β-value of 0.080 ($p<0.05$). In models IV and VI we found that intrinsic motivation does not play a moderating role in the relationship between job experience and perceived knowledge relevance. Therefore hypothesis 3a could not be confirmed. In models V and VI we found a significant negative moderating effect of extrinsic motivation on the relationship between job experience and perceived knowledge relevance (β-values of -0.120 ($p<0.05$) and -0.090 ($p<0.05$) respectively). Thus hypothesis 3b could not be supported either.

Although not hypothesized, we found significant positive direct effects of closeness centrality, intrinsic motivation and extrinsic motivation. None of the control variables had a significant association with the perceived knowledge relevance by the recipient.

4.6 Discussion

In this study we used stickiness and relevance theory (Schulz 2003, Szulanski 1996, 2000) to obtain more advanced explanations of micro-level knowledge sharing in an R&D alliance. We examined a crucial variable in the knowledge sharing process, the perceived relevance of knowledge from other alliance members by a recipient. Indeed, if the recipient does not recognize the importance of knowledge that flows in, nothing will be done with that knowledge, thus it is a wasteful transfer. Based on the stickiness and relevance theory we examined the direct relationship between the recipient's job experience and his or her perception of the relevance of knowledge of other alliance members. Moreover, we studied the moderating effects of a recipient's central position in the formal alliance network, as well as intrinsic and extrinsic motivation on the relationship between the recipient's job experience and his or her perception of knowledge relevance. Our findings show a partly negative, partly insignificant role of job experience in the perception of knowledge relevance. Additionally, we found a positive direct and moderating effect of closeness centrality of the recipient, a positive direct and insignificant moderating effect of intrinsic motivation, and a positive direct and negative moderating effect of extrinsic motivation.

4.6.1 Theoretical implications

Job experience

In this study job experience reflects prior-accumulated knowledge by the recipient. We found a partly negative and partly insignificant role of job experience in the recognition of knowledge relevance. This finding contradicts predictions from relevance theory and absorptive capacity theory, while it is also inconsistent with the key role of absorptive capacity in the stickiness theory (Cohen and Levinthal 1990, Schulz 2003, Szulanski 1996,

2000). However, this finding is consistent with the empirical findings of Schulz (2003), examining inflows and outflows of knowledge on unit-level within a firm. Possibly, our surprising finding has to do with the level of expertise required in an R&D alliance. The more experience a recipient obtains, the more he or she can be considered as an expert. March et al. (2000) indicated the diminished returns of expert knowledge: the intensity of learning is proportional to what remains to be learned. Experts consistently learn less new knowledge than novices (Schulz 2003). Thus, a larger volume of prior knowledge enhances absorptive capacity, but exhausts the space of knowledge not yet learned (Schulz 2003). However, more research is required to validate this reasoning.

Central position in the formal network

In stickiness theory one of the most important factors of stickiness of knowledge is an arduous relationship between source and recipient. In relevance theory informal relationships with peers appear to be crucial for the recognition of knowledge relevance. In our micro-level study of an R&D alliance both theories are confirmed. We found that a central position in the formal alliance network indeed has a direct positive impact on the recognition of knowledge relevance and it also has a positive moderating effect on the relationship between job experience and perceived knowledge relevance. In an R&D alliance setting formal relationships may be more important than informal relationships. Note that alliance partners often compete with each other outside the alliance. Therefore, appropriability issues most likely play a role. It probably is less risky to let expert knowledge flow along the formal alliance network with mandated contacts, compared to the informal networks.

Thus, the more central the position of the recipient in the formal alliance network, the higher the volume of knowledge inflows of the recipient, and the more likely pieces of this knowledge will fit pieces of the recipient's knowledge, leading to a recognition of relevance.

Motivational factors

In this study we used intrinsic and extrinsic motivation to embody the motivational factors from the stickiness theory. We only focused on the motivation of a recipient to accept knowledge from other members of the alliance. Our findings show a strong positive direct impact of intrinsic and extrinsic motivation on the recognition of relevant knowledge, while the moderating effect of intrinsic motivation is insignificant and the moderating effect of extrinsic motivation is (weakly) negative. Thus, for relevance theory on an individual level direct effects of intrinsic and extrinsic motivation need to be taken into account. Moreover, contrary to stickiness theory, on the micro-level of an R&D alliance motivational factors are more important than knowledge-related factors to predict the perceived knowledge relevance. This probably again has to do with the co-opetitive setting of an R&D alliance in which the acceptance of knowledge from others is far from evident. Especially in such a setting without shared long-term goals and a strong culture, the not-invented-here syndrome is likely to occur (Katz and Allen 1982). The somewhat stronger results of extrinsic motivation compared to intrinsic motivation are probably due to a belief of alliance members in safer, formal mechanisms. The surprising negative moderating effect of extrinsic motivation might speculatively be explained by the fact that a strong emphasis on other's knowledge renders the role of the recipient's own prior knowledge in the recognition of the knowledge relevance superfluous. Of course, this speculation must be validated in future research.

4.6.2 Managerial implications

This study also has important implications for people involved in, or managing an R&D alliance. The main messages for managers is in order to have a fluid transfer of relevant knowledge in the alliance, they should put effort in the development of a formal network in the alliance and they should stimulate the alliance members by tangible returns (promotions,

raises, bonuses) to improve individual's knowledge accumulation in the new context by absorbing relevant knowledge from other alliance members.

For members of the alliance the main message is that for their own sake they should try to get a central position in the formal alliance network and to be open to knowledge from others.

4.6.3 Limitations and future research

Our research is not without limitations. The following four important limitations suggest several future research directions. First, this study explored the influence of factors affecting perceived knowledge relevance in individuals' knowledge transfer. More in-depth qualitative research is required to further clarify the relationships between alliance-internal dynamics on the micro level and the more macro-level dynamics.

Second, our study is a cross-sectional one. Besides more in-depth qualitative information about alliance-internal dynamics on different levels of aggregation, it would be beneficial to study these dynamics and their influences along a period of time. Thus future research should include more longitudinal studies on alliance-internal dynamics.

Third, this study only included the most important factors of stickiness and relevance theory. However, since a micro-level study of R&D alliances is different from former higher-level research within firms, it might be beneficial to study in future research other factors mentioned in the stickiness and relevance theory as well, such as causal ambiguity, retentive capacity of the recipient, the role of specialized knowledge, and the environmental pressures in an alliance context.

Fourth, clearly our findings are only based on the data of one R&D alliance in the field of chemical physics in China. Thus, future research should include other industries as well as other countries to provide the external validity.

Chapter 5

Conclusions

To better explain the success or failure of an R&D alliance, this dissertation looks into the alliance-internal dynamics on an individual level: it argues that the dynamics' basis is the knowledge sharing among alliance members; its frame is the social network within the alliance; and its outcome is the individual work performance. With in-depth research, this study comes to several significant findings, which particularly contribute to three theories.

5.1 Social network theory

Generally, it is believed that compared with informal relationship, formal relationship does not provide rather useful information or significantly contribute to knowledge exchange (e.g. Allen, James and Gamlen, 2007; Cross and Parker, 2004; Gulati and Puranam, 2009; Hansen, 1999; Mehra, Kilduff, and Brass, 2001). In some degree, knowledge sharing is a kind of extra role which requires much time, effort and mutual trust (e.g. Burt, 1992; Connelly and Kelloway, 2003; Granovetter, 1973; Reagans and McEvily, 2003), whereas the formally mandated relationship has its own limitations to reach those requirements. From another perspective, R&D alliance is a temporary, decentralized and cross-functional organization. Generally, in such an organization, informal networks are important (Cross and Prusak, 2002), which usually provide same and even better information for task completion than what formal networks do (Morrison, 1993). An advice network essentially is a specific form of informal network, implying in the context of an R&D alliance, it may provide better information than a formal network does. However, this study finds the contrary result: the formal network plays a more important role in knowledge exchange than the advice network does.

The finding implies that in this co-opetitive R&D context, knowledge mainly is shared in the formal network. This probably is related to the context itself: On the one hand, the alliance members come from different alliance partners with different cultures and cooperation modes, thus sharing knowledge with each other naturally would not be smooth. But establishing the mandated relationship and relevant work requirements as well as responsibilities, knowledge sharing would be less difficult; it would not only involve the routine knowledge, but also the tacit or compound knowledge. On the other hand, alliance partners probably are potential rivals outside the alliance, implying the existence of appropriability issues. Usually there are more procedures about knowledge sharing in the formal network, which allows them to transfer knowledge with lower risks. The reasons why knowledge mainly flows in the formal network also can explain the study's findings about the formal network's impact on the work performance and the perceived knowledge relevance.

Accordingly, this study concludes that in the co-opetitive R&D context, the formal network composed of formal relationships plays quite significant roles in knowledge exchange, recognition, and work performance. Moreover, based on this study, there still are some questions for further study: How direct and indirect contacts contribute to individual performance? Why does not tie strength significantly moderate individuals' favorable position in the formal network? In addition, future research should also, as argued by Aalbers et al. (2014), adopt a multi-network research design, and involve more in-depth qualitative research.

5.2 Motivation theory

In former research it was believed that intrinsic motivation stems from the pleasure and inherent satisfaction derived from an activity (i.e. sharing knowledge); it is valued for its own sake and appears to be self-sustained. Extrinsic motivation focuses on the goal-driven reasons, e.g. rewards or benefits earned from performing an activity (i.e. sharing knowledge); it is strict reward-for-performance (Lin, 2007; Osterloh and Frey, 2000). Thus it is suggested that intrinsic motivation is helpful for long-run outcome, while extrinsic motivation for the short-run; and it was found that extrinsic motivation plays a negative or insignificant role in the knowledge sharing process (Bock et al., 2005; Lin, 2007; Wasko and Faraj, 2000), while intrinsic motivation plays a positive role. However, this study finds the contrary results in the context of an R&D alliance: extrinsic motivation rather significantly helps the realization of individual knowledge sharing and the achievement of associated work performance. Additionally, this study also finds the extrinsic motivation has a crowding-out effect on intrinsic motivation.

These findings imply that individuals who share knowledge within the alliance are mostly extrinsically motivated; they care about rewards or benefits from knowledge sharing rather than enjoyment or pleasure. This probably is due to the alliance's context: as discussed previously, it is composed of partners who elsewhere might compete with each other, thus appropriability issues cannot be overlooked; in addition, the partners do not share a long-term goal and a culture as strong as a firm's. Thus, though knowledge sharing may contribute to the alliance performance, the process itself might disclose the knowledge that one partner does not want the other partner(s) to know. Hence, the enjoyment from knowledge sharing is weakened while the benefit concern is strengthened. This might be part of the reasons why intrinsic motivation is inhibited and is "crowded out" by extrinsic motivation.

Accordingly, this study concludes that in the co-opetitive R&D context, extrinsic motivation rather than intrinsic motivation plays a significant role in knowledge sharing and related work performance. Certainly, there still are several questions need to be answered, such as how the extrinsic motivation "crowds out" the intrinsic motivation in the context of an R&D alliance? Is it different from the mechanism in the context of a single firm? Moreover, in-depth qualitative research is required to comprehensively clarify the extrinsic motivation's impacts within an alliance, as well as the context's impact on extrinsic motivation's roles.

5.3 Stickiness theory and Relevance theory

Despite stickiness theory attaches importance to knowledge-related variables, an important variable is missed—the perceived relevance of knowledge, which concerns building a connection between an individual's own knowledge and the transferred knowledge from others. Both stickiness theory and relevance theory believe that within a firm, the more prior-accumulated knowledge, the easier for individuals to develop absorptive capacity, as well as connect their own knowledge to the knowledge being transferred from others, which in turn decreases the stickiness (Cohen and Levinthal 1990; Schulz, 2003; Szulanski 1996, 2000). However, this study comes to a different finding: job experience that reflects prior-accumulated knowledge has a partly negative and a partly insignificant role in the recognition of knowledge relevance. This implies that the more job experience which is accumulated previously, the harder for an individual to perceive the value of other's knowledge, and effectively finish the relevant knowledge transfer. Possibly, this surprising finding has to do with the level of expertise required in an R&D alliance. Usually individuals with much experience are considered as experts, and are badly needed for improving the alliance's performance. However, the intensity of learning is proportional to what remains to be learned

(March et al., 2000), and experts consistently learn less new knowledge than novices (Schulz, 2003). Thus, a larger volume of prior knowledge enhances absorptive capacity, but exhausts the space of knowledge not learned yet (Schulz, 2003).

In addition, stickiness theory found that knowledge-related barriers, such as the recipient's lack of absorptive capacity, causal ambiguity of the knowledge, are more important than motivational factors as the key stage to decrease stickiness, say, recognizing the value of others' knowledge mainly relies on individual's accumulated knowledge rather than the motivation of exchanging knowledge (Szulanski, 1996; 2000). However, this study's finding also challenges this prediction: it finds a strong positive direct impact of intrinsic and extrinsic motivation on the recognition of relevant knowledge, while the moderating effect of intrinsic motivation is insignificant and the moderating effect of extrinsic motivation is (weakly) negative. This implies that highly motivated people will be better at recognizing the value of others' knowledge than the highly job-experienced people. The interesting finding probably again has to do with the co-opetitive setting of an R&D alliance: in such a setting without shared long-term goals and strong culture, the not-invented-here syndrome is likely to occur (Katz and Allen, 1982), which can cause foot dragging, passivity, or hidden sabotage (Szulanski, 1996) of alliance members that can hardly be identified and sanctioned. Thus the acceptance of knowledge from others is far from evident in the co-opetitive R&D context, whereas motivation is rather significant to promote knowledge exchange, establish trust and culture, as well as abandon bias and accept the knowledge from others. For relevance theory on an individual level, the effects of motivational factors need to be taken into account.

Based on the findings, there are some questions for further study, such as how do the motivation-related factors affect the knowledge-related factors in the context of an R&D

alliance? In addition, as a micro-level study of R&D alliances is different from former research within single firms on higher levels, in future research it might be beneficial to study other factors mentioned in the stickiness and relevance theory as well, such as causal ambiguity, retentive capacity of the recipient, the role of specialized knowledge, and the environmental pressures in an alliance context.

All in all, this study tries to look into the internal dynamics of an R&D alliance on an individual level, answers the series of research questions, and with significant findings comes to the conclusions meaningful for the development of relevant theories and practice. In future research, more variables could be involved to complement the outcomes and interrelations, such as the level of individuals' knowledge and skills, state of health, task complexity, alliance structure, personality characteristics, and commitment. In addition, more in-depth qualitative research is needed to explore the internal dynamics with more details on the individual level, as well as its relationship with the dynamics on other levels. Moreover, longitudinal studies would help to conduct more findings and develop the relevant theories. It is also necessary to include other industries, countries as well as other types of alliances to provide the external validity.

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Samenvatting

Voor het aangaan van concurrentie-uitdagingen, zoals innovatief zijn, werken steeds meer bedrijven samen (Gulati, 1995; Osborn en Hagedoorn, 1997; Powell et al., 1996). Volgens de theorie en bestaande studies zijn dergelijke allianties een belangrijk middel voor het genereren van nieuwe kennis terwijl vaste lasten gedeeld worden, wat schaalvoordelen oplevert in Research & Development, verspillend dubbel werk vermijdt, en toegang kan verschaffen tot nieuwe markten (d'Aspremont en Jacquemin, 1988; Barringer en Harrison, 2000; Katz, 1986; Motta, 1992; Sakakibara, 2002; Spence, 1984; Suzumura, 1992; Ziss, 1994). Ondanks deze voordelen voldoen veel allianties niet aan de verwachtingen, of monden zelfs uit in mislukking (e.g. Bleeke en Ernst, 1993; Kogut, 1989; Ernst et al., 2011). Er is tot op heden weinig bekend over de alliantie-interne dynamiek op individueel niveau. Hoewel er een aantal studies gedaan zijn die een analyse geven vanuit verschillende perspectieven op bedrijfs- of groeps-niveau (Anand en Khanna, 2000; Berends et al., 2011; Davis en Eisenhardt, 2011; Dickson et al., 2006; Draulans et al., 2003; Ernst et al., 2011; Heimeriks en Duysters, 2007; Hoang en Rothaermel, 2005; Ireland et al., 2002; Lai en Chang, 2010; Michelfelder en Kratzer, 2013; Oxley en Sampson, 2004; Sampson, 2007; Saxton, 1997; Schreiner et al., 2009; Spekman et al., 1998; Walter et al., 2007), is het succes of falen van allianties tot dusverre grotendeels onverklaard gebleven.

Net zoals andere organisaties, bestaan allianties, en R&D-allianties in het bijzonder, uit individuen die de doelen van de alliantie verwezenlijken door nieuwe vormen van samenwerking aan te gaan met werknemers van de alliantiepartners. De mate waarin die samenwerking individuen helpt om beter te presteren en bij te dragen aan het succes van de alliantie is echter nog steeds onduidelijk (Zollo et al., 2002). Daarom is het voor het ontwikkelen van een gedetailleerde uitleg op het individuele niveau noodzakelijk om naar het micro-niveau van de alliantie te kijken. De sleutel tot deze uitleg ligt in de hoofdonderdelen van de interne dynamica van allianties en hoe deze onderdelen gerelateerd zijn. In overeenstemming hiermee kan de globale onderzoeksvraag van deze studie als volgt geformuleerd worden: Wat verklaart de prestaties in en de bijdragen van individuen aan R&D-allianties?

In een R&D-alliantie kan kennisvorming en succesvolle samenwerking niet plaatsvinden zonder uitwisseling van kennis tussen individuen (Schumpeter 1942; Dosi 1982; McFadyen en Cannella 2004): het delen van kennis vormt de basis voor de interne dynamiek van de alliantie, en maakt coöperatie en relevante prestaties mogelijk. De uitwisseling van kennis tussen individuen is alleen niet zo eenvoudig. Het delen van kennis is geen onderdeel van het takenpakket en doorgaans moeilijk door managers te vereisen (e.g. Burt, 1992; Connelly en Kelloway, 2003; Granovetter, 1973; Hansen, 1999; Reagans en McEvily, 2003). Bovendien is de R&D alliantie een tijdelijke en flexibele organisatie. Daardoor is het minder waarschijnlijk dat hiërarchische relaties een significante rol spelen in de R&D alliantie. Sociale netwerken die niet helemaal worden beperkt door het hiërarchische niveau en de grenzen van de organisatie, zijn echter wel belangrijk.

Deze studie richt zich op twee typen sociale netwerken in de R&D-context: het formele netwerk en het adviesnetwerk. Meestal wordt gedacht dat het formele netwerk niet zozeer bijdraagt tot de uitwisseling van kennis (e.g. Allen et al., 2007; Cross en Parker, 2004; Gulati en Puranam, 2009; Hansen, 1999; Mehra et al., 2001), maar dat het adviesnetwerk – een soort informeel netwerk tot effectieve kennisoverdracht kan leiden (Cross en Prusak, 2002; Morrison, 1993; Sparrowe et al., 2001). Toch is het in een R&D-alliantie voor een goede samenwerking belangrijk dat concrete verantwoordelijkheden worden toegewezen en dat de alliantieleden snel aan elkaar wennen, ondanks de potentiële competitie tussen de partners buiten de alliantie en het rijzen van 'appropriability'-problemen. In die zin kan het formele netwerk dus ook een onmisbare rol spelen. Het doel van hoofdstuk 2 is dan ook om het volgende te onderzoeken: welke rol spelen het formele netwerk en het adviesnetwerk in de uitwisseling van kennis in de context van een R&D alliantie? En verschilt dit in vergelijking met de rol die ze spelen in één enkel bedrijf?

Voortbouwend op de theorieën van kennisoverdracht, sociale netwerken en sociaal kapitaal, wordt in hoofdstuk 2 van deze studie geconcludeerd dat de degree-centraliteit van het formele netwerk een belangrijkere rol speelt dan de betweenness-centraliteit van het adviesnetwerk. Dit houdt in dat, in de R&D-context, kennis voornamelijk wordt gedeeld middels het formele netwerk en dat, indien zowel het formele netwerk als het adviesnetwerk bij dit proces betrokken zijn, het formele netwerk ook de functie van het adviesnetwerk zou kunnen overnemen.

Hoewel sociale netwerken kanalen bieden ten behoeve van individuele kennisuitwisseling in een alliantie, moet het daadwerkelijke gedrag van kennisoverdracht worden geïnspireerd door de motivatie van individuen. Onderzoek heeft aangetoond dat extrinsieke motivatie het gunstige effect van intrinsieke motivatie kan verdringen ('crowding out'), en zwakke of zelfs negatieve effecten op het delen van kennis kan hebben (Bock et al., 2005; Lin, 2007; Wasko en Faraj, 2000). In de context van een R&D-alliantie kan extrinsieke motivatie echter een andere rol spelen, zo vind ik, aangezien de alliantiepartners buiten de grenzen van de alliantie met elkaar kunnen concurreren, terwijl intrinsieke motivatie nog steeds belangrijk kan zijn, omdat de uitwisseling van kennis tussen individuen buiten het standaardtakenpakket valt. Hoofdstuk 3 van deze studie richt zich dan ook op de vraag: Welk type motivatie is van grotere invloed op de uitwisseling van kennis en het behalen van arbeidsprestaties? En wat is de relatie tussen motivatie, het sociale netwerk en werkervaring?

Voortbouwend op de theorieën over arbeidsprestatie en motivatie, wordt in hoofdstuk 3 geconcludeerd dat in R&D allianties extrinsieke motivatie op significante wijze bijdraagt aan de realisatie van individuele kennisuitwisseling en het behalen van daaraan verbonden individuele arbeidsprestaties. Bovendien blijkt dat extrinsieke motivatie een 'crowding-out' effect heeft op intrinsieke motivatie. Deze bevindingen impliceren dat individuen die binnen de alliantie kennis delen vooral extrinsiek gemotiveerd zijn: ze hechten meer belang aan de beloningen of voordelen van het uitwisselen van kennis dan aan het plezier of genot ervan.

Het formele netwerk is een bron van, en infrastructuur voor het delen van kennis. Extrinsieke motivatie drijft het gedrag van kennisuitwisseling, hoewel deze uitwisseling niet succesvol zal zijn als de betreffende kennis als irrelevant wordt ervaren. Volgens de 'stickiness'- en (kennis-) relevantie-theorieën (e.g. Schulz, 2003; Szulanski, 1996; 2000) zijn individuele werkervaring of absorptiecapaciteit zowel als de relaties met anderen belangrijke determinanten van de ervaren relevantie van kennis, en is motivatie minder van invloed (Szulanski, 1996; 2000). In de context van een R&D-alliantie zijn er echter nieuwe taken, uitdagingen en situaties, die het nut van eerder opgedane werkervaring beperken. Daarbij zou, zoals eerder genoemd, de rol van intrinsieke en extrinsieke motivatie in de nieuwe situatie wel eens kunnen veranderen, wat betekent dat het effect daarvan op het herkennen van relevante kennis ook verschilt.

De resultaten in hoofdstuk 4 van deze studie onderschrijven die proposities. Ten eerste heeft door werkervaring eerder opgedane kennis een negatieve en deels insignificante invloed op het herkennen van de relevantie van kennis. Eerder opgedane werkervaring maakt het moeilijker voor een individu om de waarde van andermans kennis in te schatten, wat de kennisoverdracht effectief belemmeren kan. Ten tweede hebben intrinsieke en extrinsieke motivatie een sterk positief, direct effect op het herkennen van relevante kennis, terwijl alleen het modererende effect van extrinsieke motivatie zwak negatief blijkt te zijn.