Strategic alliance networks and innovation:
a deterministic and voluntaristic view combined

Victor Gilsing & Charmianne Lemmens

Eindhoven Centre for Innovation Studies, The Netherlands

Working Paper 05.02

Department of Technology Management
Technische Universiteit Eindhoven, The Netherlands

January 2005
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TAG POSITIONING PAPER

Draft version (January 2005)

Victor A. Gilsing*
Charmianne E.A.V. Lemmens*

*Eindhoven Centre for Innovation Studies (ECIS), P.O. Box 513, 5600 MB Eindhoven, The Netherlands, v.a.gilsing@tm.tue.nl and c.e.a.v.lemmens@tm.tue.nl
1. INTRODUCTION
Over the past decades we have witnessed a tremendous growth in the number of strategic technology alliances in the high-tech sectors. Especially, the number of alliances aimed at technological learning and knowledge creation, has grown rapidly since the mid 80s (see figure 1). We define strategic technology alliances as ‘cooperative agreements for reciprocal technology sharing and joint undertaking of research between independent actors that keep their own corporate identity during the collaboration’ (see e.g. Hagedoorn and Schakenraad, 1994; Vanhaverbeke et al., 2002). They are strategic in the sense that they affect the long-term goals of the companies such as knowledge acquisition and technology development. To obtain these goals, strategic alliances and interfirm networks are an effective organisational form that enables to combine and integrate complementary knowledge and capabilities from a diversity of actors (Porter, 1990; Hamel and Prahalad, 1990; Grabher, 1993; Smith Ring and Van de Ven, 1994; Hagedoorn, 1993; Hagedoorn and Schakenraad, 1994; Spekman et al., 1995; Uzzi, 1997; Nooteboom, 1999, 2004; Ahuja, 2000; Rowley et al., 2000).

![Figure 1 Growth in the number of alliances](image)

The increasing costs of R&D in combination with a shortening of product and technology lifecycles and blurring industry boundaries in a dynamic technological environment have made it almost impossible to develop technology on a stand-alone basis. Firms use these technology alliances to reduce costs of R&D, to transfer technology in order to improve innovative performance, to reduce time-to-market or to search for new technological opportunities (for a more elaborate overview, see e.g. Hagedoorn, 1993). In addition, they are also considered to be efficient vehicles for external knowledge acquisition (see e.g. Duysters and Hagedoorn, 2000). Following this, research on alliances...
has focused for over a decade now on the question of *why and when* alliances are formed (Duysters et al., 2001; Kogut and Zander, 1993; Powell and Brantley, 1992). In other words, the focus has been on the so-called exogenous factors that cause alliance formation. Interdependence and complementarities have been addressed here as the most common explanation for firms forming inter-organizational ties (Richardson, 1972; Pfeffer and Nowak, 1976; Nohria and Garcia-Pont, 1991). These resource dependency perspectives (Pfeffer and Salancik, 1978; Wernerfelt, 1984) posit that external resource scarcity is the most important reason for engaging in collaborative agreements (Park et al., 2002). As a consequence, networks increasingly provide an alternative to a more self-contained form of organisation or to ‘standard’ market transactions (Koput and Smith-Doerr, 1996; Powell, 1996; Kogut, 1997; Ebers, 1997; Grandori, 1999). Particularly in high-tech sectors, alliances have become the dominant strategy and the empirical studies have produced evidence that they positively affect corporate performance in terms of growth (Powell et al., 1996), speed of innovation (Hagedoorn, 1993), organizational learning (Hamel, 1991) and reputation (Stuart, 1998; Stuart et al., 1999).

More recently, the strategic alliance literature has made progress in advancing our understanding of *how* inter-alliance dynamics – the so-called endogenous factors - affect the intent of creating, building and sustaining collaborative advantage through alliance formation (for example Gulati, 1995a, 1998; Walker et al., 1997; Gulati and Gargiulo, 1999; Chung et al., 2000). This endogenous dynamic refers to *with whom specifically* alliances are formed (Gulati, 1995a; Gulati and Gargiulo, 1999). It involves two perspectives on what drives the alliance formation process: the embeddedness perspective and the perspective of competitive tension among alliances.

The first perspective of embeddedness treats alliance networks as networks of social relations. This social network perspective on alliances explains the collaborative behaviour of actors in terms of their position and embeddedness in networks of relationships (for example Nohria, 1992; Gulati, 1998). Embeddedness refers to the structure of a network of social relations that can affect the firm’s economic action, outcomes and behaviour and that of its partners to whom it is directly or indirectly linked (for example Granovetter, 1992; Gulati, 1998). The fact that firms are embedded in a network of relations and have access to several qualified and resource-complementary partners influences their decision on whom to tie up with. This stream of research thus focused on the role of embeddedness as an important driving factor that is endogenous to the alliance formation process (for example Gulati, 1995a; Walker et al., 1997; Gulati and Gargiulo, 1999; Chung et al., 2000). In this context alliance formation is based on building preferential relationships characterized by trust, stability and rich exchange of information between partners (Dore, 1983; Powell, 1990; Gulati and Gargiulo, 1999). It asserts that network formation proceeds through the formation of new relationships, building on the experience with existing firm ties. By investing in these social relations through the replication of their existing ties, firms build up social capital (Burt, 1992). So, embeddedness and the social capital derived from that are thus by their very nature dependent on history (Chung et al., 2000). Social capital generates returns as it enables firms to access and capture the embedded resources in their
social relations (Lin, 1999). In this way the network becomes a growing repository of information on the availability, reputation, competencies and reliability of prospective partners (Walker et al., 1997; Gulati, 1995a; Powell et al., 1996).

The second viewpoint that drives alliance formation and the advantages derived from that, is formed by the internal competitive tension among alliances. Here the focus in the literature has largely been on bilateral (dyadic) alliances. In examining the relationship between competition and cooperation, research has largely focused upon the internal characteristics of the alliance, arguing that it is important to acknowledge the mixed-motive nature of ‘competition plus cooperation (co-opetition)’ of alliances and its implications for dependence, trust, and mutual benefit (Singh and Mitchell, 1996). In dealing with the internal competitive implications of alliances, research has either focused on the performance/financial benefits of alliance formation (Berg et al., 1982; Hagedoorn, 1993) or examined the implications of trust, opportunism, partner rivalry, and sustained cooperation as a means of achieving competitive benefits (Gulati, 1995; Hill, 1990). Although this approach has served to advance our understanding of the internal competitive implications considerably, it ignores the external competitive implications of alliance relationships. In other words, despite its insightful focus on the alliance itself, this line of research has been primarily introspective. It has not yet begun to incorporate the external competitive environment of alliances in its research domain. The rapid proliferation of strategic technology alliances has not only ushered in a new era of cooperation among companies big and small, but has also induced a new era of external technology competition among networks of multiple alliances. Cooperative technology agreements have become an integral part of competitive strategies. ‘Competition through cooperation’ has become the mainstay of a firm’s attempt to gain innovation and learning advantages. The virtual explosion of cooperative agreements on a worldwide basis has led to a new form of competition where networks of multiple alliances compete against each other in groups (Gomes-Casseres, 1994, 1996). It is now commonplace to observe technological competition between one group of firms linked via alliances against another alliance group. Research by Gomes-Casseres (1996) and by Doz and Hamel (1998) is among the first to have explored the increasing frequency of technology collaboration as a reflection of a fundamental shift from the traditional form of competition (firm vs. firm) to a new form (group vs. group). These scholars have provided a foundation for this largely unexplored and critical field of study. However, as global competition continues to intensify, a more thorough understanding of this new form of group-based technological rivalry is required (Gomes-Casseres, 1996; Das and Teng, 2002; Silverman and Baum, 2002; Lemmens, 2004). To further address this we propose to include a new research domain, namely the external competitive environment in which alliances compete, by empirically investigating the competitive effects of alliance network formation processes on partners and competitors at the group level. Understanding these issues is important as they have substantial implications for the competitive dynamics of technology-based industries.
In sum, a key message conveyed from the literature until now is that embeddedness and competition in alliance networks drive the formation of alliance networks and affects firms' innovative performance (Granovetter, 1992; Gulati 1998). The empirical evidence indicates that firms can indeed take advantage from their embeddedness in alliance networks and from occupying certain positions in these networks (e.g. Podolny and Stuart 1995, Stuart and Podolny 1996, Stuart 1998, Ahuja 2000, Rowley et al., 2000; Gulati et al., 2000; Gargiulo and Benassi, 2000). This strong focus on embeddedness and competition reflects a structuralist view of how a set of interrelationships between firms drives their behavior and innovation performance. This approach has brought the important insight to the fore that social relations matter for economic and innovative action. However, it has two important shortcomings. One is that it entails a rather deterministic stance as if firms are subject to an exogenous network structure that unilaterally directs their behavior and performance. Another shortcoming is that it reflects a static view and ignores change in alliances networks and the antecedents that cause this change. In this paper we aim to address these shortcomings.

To do so, we aim to explore the possibilities to develop a more voluntaristic view of how firms shape their networks with the aim to provide a more favorable social structural context for achieving their strategic aims. Whereas the deterministic view has focused on the question, in terms of Chandler (1962), how strategy follows structure, a more voluntaristic view aims to understand this causality the other way around, namely how structure follows strategy. This latter question is still unexplored territory in the literature (Stuart, 1998). Such a more voluntaristic view may enable us to understand how alliance networks change caused by specific firms’ actions. Understanding such dynamic processes in alliance network may require the use of different perspectives. One such perspective is that of the ‘micro-level of organizational action’ (Bae et al., 2003; Beerkens et al., 2004), that aims to understand how local actions of a focal firm and the local actions of its partners affect the network structure and its functioning. Relevant questions here are for example how firms can pursuing brokerage or closure advantages in terms of tying behavior, and how such strategies shape their networks and possibly affect the competitive bases of the industry. Another perspective could be evolutionary that may bring a more in-depth understanding how and why inter-organizational firm networks change over time, and in how far such change is attributable to more endogenous network dynamics, to more exogenous industry factors or to combinations of both (Madhavan et al., 1998; Meeus et al., 2002a, 2002b).

In this paper we consider both perspectives: -1- we build on the existing literature that considers how networks constrain and shape action (strategy follows structure) where network structure at the network level of aggregation influences the actors’ network positioning strategies at the firm level, and, -2- we examine how network positioning strategies at the firm level of aggregation constrain and shape network structures at the network level of aggregation (structure follows strategy). By considering both perspectives, we aim to shed new light on the debate between Burt (1992) and
Coleman (1988) on the effectiveness of network structure and the efficiency of network ties. Until now, the literature has focused on how both views differ, not so much on how they may also possibly complement each other. As we will argue throughout this paper, the question is not ‘who is right’, but ‘who is right under which conditions’. Based on the existing literature, we develop an attempt in this paper to explore where these views conflict as much as where they can be seen as complements, and how this is conditioned by the role of context. This understanding is important as the debate forms a leading thread for this paper in addressing the two main existing literature gaps as delineated above (figure 2): group-based competition and the dynamics of alliance networks.

The aim of this paper is to provide an overview of the most recent literature on interfirm networks and innovation and to stress the importance of further research into the two literature gaps we identified above. Given the vast body of literature dealing with networks, we limit ourselves to the academic literature that deals with strategic alliances, networks and interfirm relations in relation to learning and innovation. In order to structure our overview of recent literature on networks and innovation, we propose a conceptual model that enables to discern among four relevant and interrelated levels of aggregation: the firm level, the group level, the network level and the industry level. When reviewing the literature, we position the various themes along these aggregation levels, which can increase our understanding of how these levels interact (figure 3).

![Figure 3 Conceptual model for differentiating between various levels of analysis](image)

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1 Burt stresses that efficiency that can be reached through the benefits of brokerage advantages through non-redundant weak ties that give access to new information. Coleman focuses on the benefits of closure advantages in densely connected networks through strong and redundant ties. In his view closure induces possibilities for joint innovative efforts through trust-based governance and social control.
Competition

‘Co-opetition’ in bilateral alliances

Exogenous dynamics:
Why and when are alliances formed?

Endogenous dynamics:
With whom are alliances formed?

Driving forces:

Embeddedness

Dynamics of inter-organizational networks:
Strategy follows structure (embeddedness is independent variable)

LITERATURE GAPS

Dynamics of inter-organizational networks:
Structure follows strategy (embeddedness is dependent variable)

RECEIVED WISDOM

‘Co-opetition’ in bilateral alliances

‘Competition through cooperation’ among networks of multiple alliances

Figure 2 Identifying the literature gap
This paper is structured as follows. In section 2, we discuss group-based competition and cooperation. Increasingly, firms are engaged in dense groups of partners characterized by strong within-group cooperation and substantial between-group competition. This adds the group level as a new level to the analysis, in between the firm and the network level, and raises the question how it affects opportunities for learning and innovation. In section 3, we discuss the role of conditions. Following the literature, we differentiate between exploration and exploitation and how these different contexts condition the relation between networks and innovation. In this respect, section 2 and 3 reflect the more deterministic view that follows from the structuralist perspective that dominates the literature. Section 4 then takes the reverse perspective by considering the dynamics of networks, where we treat network structural properties now as the dependent variable. We discuss how exploration and exploitation build on each other and the consequences of this evolutionary process for network structural properties and their dynamics. Here we abstract from the role of firms, a perspective that we further elaborate in section 5. In this section 5 we examine how the dynamics of network structural properties are affected by acts and strategies of firms. This connects with a ‘local action’ perspective (Bae et al., 2003, Beerkens et al., 2004) of how networks are shaped and constrained by endogenous acts of firms. In this respect, we move beyond the network level to the firm level by discussing the need for relating the literature on alliance networks to literature on entrepreneurship, corporate venturing, external venturing and other types of knowledge acquisition methods. In this respect, section 4 and 5 reflect a more voluntaristic view that complements the structuralist perspective. Finally, in section 7, we conclude and define a number of research projects.

2. INTRODUCTION TO GROUP-BASED COMPETITION

As argued in the introduction of this paper, the strategic alliance literature has recently made progress in advancing our understanding of how inter-alliance dynamics affect the intent of creating, building and sustaining collaborative advantage through alliance formation (Gulati, 1995a, 1998; Walker et al., 1997; Gulati and Gargiulo, 1999; Chung et al., 2000). This entails the endogenous factors that condition with whom specifically alliances are formed (Gulati, 1995a; Gulati and Gargiulo, 1999). As we argued, it involves two perspectives on what drives the alliance formation process: the perspective of competitive tension among alliances and the embeddedness perspective. In this section we focus on the former, namely on the competitive effects of alliance network formation on partners and competitors at the group level. In doing so, we focus on the group level as the level of analysis and abstract from the other three levels (industry-, network and firm), as also indicated in figure 3.
This section is structured as follows. In section 2.1 we provide some general background to the topic and discuss some recent, converging insights from the literature. In section 2.2, we discuss a number of unsettled issues and derive a number of hypotheses. In section 2.3 we conclude.

2.1 General background and converging insights

The rapid increase of strategic technology alliances has set in a new era of external technology competition among networks of multiple alliances. It is now commonplace to observe technological competition between one group of firms linked via alliances against another alliance group. Research by Gomes-Casseres (1996) and by Doz and Hamel (1998) is among the first to have explored the increasing frequency of technology collaboration as a reflection of a fundamental shift from the traditional form of competition of dyadic alliances (firm vs. firm) to a new form of multiple alliances (group vs. group). These scholars have provided a basis for this largely unexplored and important field of study. However, as global competition continues to intensify, a more comprehensive understanding of this new form of group-based technological rivalry is necessary (Gomes-Casseres, 1996). Research so far has largely focused on the mixed motives of ‘competition plus cooperation (co-opetition)’ in alliances and its implications for dependence, trust, and mutual benefit (Singh & Mitchell, 1996) or examined the implications of trust, opportunism, partner rivalry, and sustained cooperation as a means of achieving competitive benefits (Gulati, 1995; Hill, 1990). Despite its insightful focus on the alliance as a vehicle for co-opetition, this line of research has not yet begun to incorporate the external competitive environment in which alliances compete. Then, ‘competition through cooperation’ has
become the foundation of a firm’s attempt to gain innovation and learning advantages through technology competition among networks of multiple alliances. This implies that research has to go beyond the firm level and has to focus on the competitive effect of an increase in the number of alliances with partners and rivals on the competitive pressure experienced by a focal firm (Silverman and Baum, 2002).

The strategic technology alliances, through which companies acquire R&D-related knowledge, are expected to help them differentiate their innovative performance from other companies (Hagedoorn and Duysters, 2002). Hagedoorn and Schakenraad (1994) found a positive relation between technology-based alliances and their innovation rates. Concerning the usefulness of engagement in technology alliances to improve innovative performance, Duysters and Hagedoorn (2000) found that strategic technology alliances should be used as a vehicle for developing core competences related to innovation to complement capabilities in the long run, as they can be used as monitoring devices to scan the most promising technologies. Then because of the globalization of markets, the increasing complexity of technologies and rapid technological change and the increasing costs of R&D, technology alliances enable firms to both explore several technological developments as well as exploit the most promising ones internally at the same time (Duysters and Hagedoorn, 2000).

Apart from engaging in these collaborative agreements to foster innovative renewal, firms increasingly adopt multiple collaborative arrangements for competitive gains (Guidice et al., 2003). Then, in the alliance network formation process, the technological positioning in the network depends very much on the competitive forces that shape the industry. Globalization of competition and the deepening industry convergence force firms to engage in global scale production and acknowledge the cross-linking of industries through new technologies (Gomes-Casseres, 1996). Especially in high-tech sectors where technology positioning is crucial to firms’ survival chances, “competition through cooperation” (Gomes-Casseres, 1994, 1996; Doz and Hamel, 1998) has become a cornerstone of the firm’s competitive strategy.

By establishing multiple collaborative agreements, firms tend to compete intensely with each other in several areas they are active in, resulting in ‘co-petition’ behaviour (Gnyawali and Madhavan, 2001). Thus, a firm’s alliances can be instruments to withstand competition –by making enemies partners– but can also impose stronger competition on others, as winning the alliance race entails access to better partners, resources or patents (Silverman and Baum, 2002). As these cooperative technology agreements among competitors proliferate (Gomes-Casseres, 1996; Gnyawali and Madhavan, 2001) technology competition becomes indispensable in the technology positioning strategy of the firms involved. This actual explosion of collaborative agreements has led to a new form

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2 The relevance of this topic, as for instance demonstrated by the growing importance of strategic technology alliances as a major element in the external linkages of companies, has been documented in many publications (Hagedoorn, Duysters, 2002). See Hagedoorn (1996) and Osborn and Hagedoorn (1997) for an overview of the literature.
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of competition: group versus group rather than company versus company (Gomes-Casseres, 1996; Guidice et al., 2003) (see figure 4). The driving forces behind the formation of these technology-driven constellations are typically related to technology competition. Technology competition takes the form of multiple partner firms linked with each other through strategic alliances in groups or constellations (Das and Teng, 2002) “competing against other such groups and against traditional independent firms” (Gomes-Casseres, 1996: 3). Through multiple R&D collaboration in alliance blocks, innovators can capture the full benefit of their innovative activity through spillovers and externalities, as they now are able to share the costs and revenues of R&D projects, which can serve as an incentive to conduct further R&D (Sakakibara, 2002). Other important driving forces that incur group formation involve establishing industry standards as a result of standard battles between firms and entail (re)positioning strategies of companies (Gomes-Casseres, 1996; Das and Teng, 2002). A common theme behind these motivations is taking advantage of economies of scale and scope (Gomes-Casseres, 1996).

However, as global competition continues to intensify, a more thorough understanding of this new form of group-based technological rivalry is required (Gomes-Casseres, 1996). This understanding has to go beyond the research at the firm-level addressing the competitive effect of an increase in the number of alliances with partners and rivals on the competitive pressure experienced by a focal firm (Silverman and Baum, 2002). Group-versus-group competition does not however decrease the importance of the competition that takes place at the firm-level. Then, a firm’s alliances can be considered instruments to defend against competition –by making enemies partners– but can also

Figure 4: Alliance blocks in the microelectronics industry (CGCP)
impose stronger competition on others, as winning the alliance race entails access to better partners, resources in the form of R&D capabilities (Gulati, 1995) or patents (Silverman and Baum, 2002). This implies that firms in groups have to move quickly, not only to pursue newly emerging opportunities but also to secure resource-complementary partners and hence foreclosing the competitors’ partnering opportunities (Gomes-Casseres, 1994; Silverman and Baum, 2002).

The relevance of the debate on social capital (e.g., Rowley et al., 2000; Gargiulo and Benassi, 2000) lies therein that the basic arguments of Coleman (1988) suggest that being part of a dense and redundant network is advantageous for innovative performance, since it involves trust and cooperation among its members in their joint innovative efforts. Relying on other players in the group gives better chances for innovative renewal as a result of spillover effects, which enables block members to tap into each other’s knowledge base. In this way block members exploit and deepen their existing capabilities by linking up with firms in their own technology cluster to improve their innovative performance. On the other hand, firms that follow an individual innovation strategy outside of alliance blocks cannot take advantage of network externalities and knowledge spillovers that the multiple strong ties provide for alliance group members. These non-block members lack this densely connected web of strong ties that constitutes a learning environment founded on trust-based governance, which is required for technological learning.

2.2 Unsettled issues

As argued, in section 2.1, allying for competitive gains becomes increasingly important (Guidice et al., 2003). As a consequence, we need to increase our understanding of this competitive effect of these alliance group formation patterns on rival groups in a global high-tech industry setting. This means we have to include a new research domain, namely the external competitive environment in which alliances compete, by empirically investigating the competitive effects of alliance network formation processes on partners and competitors at the group level. Group-based competition thus alters the nature of competition as it increases the significance of a firm’s alliances (Silverman and Baum, 2002) as tools to withstand competition or strengthen the competitive pressures on rival groups. Yet the implications of this phenomenon are crucial for understanding the competitive dynamics of technology-based industries, as well as for managers competing in such environments. Therefore, we would like to empirically and theoretically build further on previous work in this field concerning alliance-based competitive dynamics (Silverman and Baum, 2002), the group-based competition research of Gomes-Casseres (1996) and the work of Duysters and Lemmens (2003), who established that alliance group formation processes are dynamic and very much depend on the social capital and embeddedness of actors in alliance networks at the group level.

Concerning our theoretical considerations, we believe that in order to explain the group-based competition phenomenon in inter-organizational networks in relation to innovative performance, one has to go beyond the static resource-based view (Dyer and Singh, 1998) towards a more dynamic
perspective in order to explain competitive advantage and to incorporate the ability of responsiveness of firms. This is the point of departure in the behavioral and dynamic capabilities theories that take a dynamic perspective (Kogut, 1988; Teece and Pisano, 1994). Furthermore, in order to explain the group versus group dynamics in the formation of alliance groups, the resource-based view has to be addressed from a group-level perspective or even from a network level of aggregation instead of the firm-level (see figure 3). Ecological perspectives (Hannan and Freeman, 1977) on the technological environment’s carrying capacity would be helpful to legitimate alliance behavior as this behavior increases the availability of resources to the population as a whole, due to spillover effects. This helps all firms in the industry, even if the allying firms benefit more than their competitors (Baum and Oliver, 1992; Silverman and Baum, 2002). In order to increase our understanding of the competitive effect of alliance group formation patterns on rival groups in global high-tech industries, we have to address how alliance group formation induces a competitive effect on rival groups and what these effects mean.

To answer this question we would like to make a clear distinction between the kind of competitive moves and the competitive effects these moves induce.

Competitive moves and consequences for competitive intensity in the industry

The competitive effect of alliance group formation patterns on rival groups has to be linked to the various factors that cause this competitive pressure such as the number and kind of alliances rival groups have and the rivals’ network positions in the network. Initially, this question implies that we have to investigate when a firm’s alliances are likely to increase competitive intensity and when they are likely to decrease it. Research of Calabrese, Silverman and Baum (2002) and Silverman and Baum (2002) found that incumbents’ upstream, downstream and horizontal alliances yielded different effects on the likelihood of entry into subfields of the Canadian biotechnology. Then, these types of alliances differ in the degree to which they foreclose rivals’ alliance opportunities. Furthermore, they differ in the way they contribute to expanding the resource base available to industry participants. These types of alliances thus have different effects on the competitive dynamics in technology-based industries and on the carrying capacity of an industry (Silverman and Baum, 2002).

Downstream alliances link firms in technology-based industries to sources of complementary assets downwards in the vertical value chain, e.g. for commercialization of knowledge. These can be biotechnology firms’ downstream alliances with pharmaceutical or marketing companies to provide access to distribution channels or marketing expertise. These types of alliances typically do not pose a high foreclosure risk to its rivals. Then, large pharmaceutical firms often maintain alliances with lots of different biotech firms simultaneously. Then, these marketing and distribution activities are very scale- and scope intensive (Calabrese et al., 2002), which implies that for economic feasibility reasons these downstream firms have to work together with multiple players in the industry. Hence, due to
spillovers these alliances increase the resources available to partners and rivals in the industry. Thus if an alliance block extends its alliance portfolio with downstream alliances in order to commercialize technology or increase accessibility to distribution channels, this is likely to have little effect on the competitive intensity in the industry.

**Hypothesis 1:** If an alliance block extends its alliance portfolio with downstream alliances in order to commercialize technology or increase accessibility to distribution channels, this is likely to have little effect on the competitive intensity in the industry.

Upstream vertical alliances with universities or other research institutions link technology-based firms to sources of cutting-edge technological expertise. This results in an infusion of scientific input into the industry. However, due to lack of scale and scope economies in research projects, universities often do not collaborate with more than one biotech firm at a time. In this way, partners of the allying firms can benefit from the knowledge available; however is not likely that spillovers occur to the rivals of the allying firms. Biotech firms’ exclusive alliances with upstream partners (e.g. universities) foreclose rival biotech firms’ access to those partners, which increases the competitive dynamics in the industry (Silverman and Baum, 2002). Thus, if an alliance block extends its alliance portfolio with upstream alliances (research institutions) in order to get access to leading edge technology, this is likely to have a moderate effect on the competitive intensity in the industry.

**Hypothesis 2:** If an alliance block extends its alliance portfolio with upstream alliances (research institutions) in order to get access to leading-edge technology, this is likely to have a moderate effect on the competitive intensity in the industry.

Horizontal alliances link firms to other firms in the industry horizontally across value chains. In comparison to the vertical alliances mentioned above, these alliances do not tap resources outside of the focal industry. Horizontal alliances thus have no productive effect on the resource available to the industry (Silverman and Baum, 2002). As the number of horizontal alliances with the same partner type increases, this may lead to a situation of strategic gridlock (Gomes-Casseres, 1994, 2001; Garcia-Pont and Nohria, 2002) where the number of eligible partner diminishes as a result of overcrowding in this field (Gomes-Casseres, 2001). Rivals thus face a rapidly shrinking pool of eligible and desirable partners, which increases the competitive dynamics in the industry (Silverman and Baum, 2002). Therefore, if an alliance block extends its alliance portfolio with horizontal alliances (competitors), this is likely to have a major effect on the competitive intensity in the industry.
Hypothesis 3: If an alliance block extends its alliance portfolio with horizontal alliances (competitors), this is likely to have a major effect on the competitive intensity in the industry.

2.3 In conclusion

In this section, we have considered group-based cooperation and competition. We have focused on the embeddedness at the group level and its effect on rival groups and on firms’ innovation performance. In terms of figure 3, the focus here has to be on the group level as the level of analysis. More specifically, we have discussed the competitive tensions among alliance groups and its effects on group formation. As we argued, to understand this phenomenon we have to enrich the resource-based perspective in two ways: we have to take a more dynamic perspective to explain the external competitive environment in which alliance groups compete and we have to move to a group-level of aggregation to explain this. Understanding these issues is important as they carry substantial implications for the competitive dynamics of technology-based industries. There is a general lack of relevant literature and empirical work in this field and therefore there is a clear need to fill this gap by further theorizing and empirical testing. Furthermore, we are interested in analysing the factors that induce competitive effects (e.g. number and kinds of rivals’ alliances) and the consequences (e.g. increased intensity of competition which can result in increasing exit rates in the industry (Silverman and Baum, 2002) or dissolution of alliance groups).

3. ROLE OF CONTEXT: EXPLORATION AND EXPLOITATION

In this section we discuss the role of the industry context by differentiating between exploration and exploitation. More specifically we are interested how these conditions affect network structural properties. In terms of figure 3, the focus here is on the industry level and on how it affects the network level. In this respect we abstract from the group and firm level, as also indicated in figure 5.
This section is structured as follows. In section 3.1 we provide some general background to this topic and discuss some recent, converging insights from the literature. In section 3.2 we discuss a number of unsettled issues with regard to exploration and develop a new hypothesis. In section 3.3 we discuss some unsettled issues for exploitation and also propose two new hypotheses. In section 3.4 we conclude.

3.1 General background and converging insights

In the social capital literature there is an ongoing debate on the advantages and disadvantages of social embeddedness with regard to learning in networks. In this debate on social capital (e.g., Rowley et al., 2000; Gargiulo and Benassi, 2000) the basic arguments stem from Burt’s (1992) structural hole argument versus Coleman’s (1988) closure argument. Burt (1992) suggests that firms embedded in sparsely connected networks will enjoy brokerage advantages based on access to new and non-redundant information (Rowley et al., 2000). Hence, strategic opportunities are raised as firms form bridges between densely connected, i.e. redundant, parts of the network and other, non-redundant, parts of the network (Burt, 1992; Walker et al., 1997). Such strategies enable these firms to access knowledge or information that has a high yield.

From a managerial perspective, the firms occupying structural holes the so-called spanners have the advantage that they have to coordinate few alliances. The risks regarding their small amount of partnerships are rather limited, as these relations are characterized by low levels of integration as a result of the weak type of ties they hold. On the other hand, spanners envisage less commitment and trust in these relationships. As a result, sensitive information is not exchanged, as the alliances are not
founded on trust-based governance. Due to the constant search for new information and partners and the lack of reputation effects, the partner turnover can be high.

Coleman (1988) argues that being part of a dense and redundant network is advantageous for innovative performance, since it involves trust and cooperation among its members in their joint innovative efforts. Empirical evidence indicated that members in redundant and closed networks (for example alliance groups) innovatively outperform non-group members, as they are able to take advantage of the network externalities in their group, as these solid relationships are a means to transfer tacit knowledge in this learning environment based on trust-based governance (see e.g. Lemmens, 2003; Duysters et al., 2003). Within the closed networks, partners are reliable and trustworthy and members enjoy learning opportunities that are based on access to sensitive and tacit information. Shared norms and the fear of reputation effects prevent opportunism within these networks. Partners enjoy close collaboration among multiple partners, which enables them to reach economies of scale, scope and skill. However, operating in these closed networks also has some disadvantages, such as the high level of mutual dependence and the large number relations with partners with different interests that have to be managed and coordinated.

Burt’s argument for reducing redundancy through the creation of structural holes is based on the criterion to maximize efficiency in one’s network. In contrast, Coleman stresses the benefits of dense networks as such a structure facilitates the functioning of social norms and reputation effects. Apart from the question ‘who is right’, we can observe a rather universalistic tone in these normative implications, irrespective of any context. Some recent studies have tried to shed more light on this and have indicated that the optimality of the network structure is strongly dependent upon the environmental context (Rowley et al., 2000; Ahuja, 2000; Duysters and Hagedoorn 2002; Gilg 2003; Nooteboom, 2004). This echoes the argument as advanced in evolutionary economics that processes of learning and innovation are subject to selection forces by the institutional environment, and that selection is assumed to take place in relation to the distinctive structure of this institutional environment, reflecting the assumption of local optimality instead of universal optimality (Nelson, 1987; McKelvey 1997; Meeus and Oerlemans, 2000). So, the question on the debate between Burt and Coleman is not ‘who is right’, but ‘who is right under which conditions’? Hence, to understand the relation between networks and innovation or learning, we need to clearly examine the role of context. One perspective to deal with the role of context, and increasingly being used in the literature, is the distinction between exploration and exploitation (Holland, 1975; March, 1991). Exploitation entails improvements with respect to established practice, while exploration entails the development of new practices. This is related to the distinction between first and second order learning (Bateson, 1972), and between single and double loop learning (Argyris and Schön, 1978). An important issue now is to further elaborate on this distinction between exploration and exploitation by studying their differential effects on the optimality of network structural properties.
Increasingly, the literature provides indications on how the optimality of network structural properties differs between exploration and exploitation. Following Ahuja’s distinction (2000) between direct and indirect ties, the larger the number of indirect ties of a firm in its alliance network, the greater the effect on both exploitation and exploration, with the impact of the number of indirect ties on exploration being significantly larger (Ahuja, 2000; Vanhaverbeke et al., 2004). Moreover, there is increasingly evidence that the benefits of redundancy versus non-redundancy are also highly contingent on the context (Ahuja, 2000). For exploitation, replication of existing ties and redundancy is most effective as put forward by Coleman’s closure-argument. Whereas for exploration the use of non-redundant ties is most effective as put forward by Burt’s structural hole argument. Moreover, past involvement of a firm in strategic alliances has a stronger positive impact on exploration than on exploitation (Vanhaverbeke et al., 2004).

3.2 Exploration: unsettled issues

As indicated in section 3.1, Burt’s structural hole argument seems to have most relevance for exploration. However, we claim that this is only part of the story. In fact, in exploration companies are faced with a dual task. On the one hand, they need to get a first, quick understanding on which different alternatives are available and develop a general feel what these alternatives entail. This has been stressed in the literature thus far. On the other hand though, firms need to make sure that such novel knowledge, once accessed, is evaluated and when proven to be valuable, is transferred and absorbed in an adequate way. This requires a dense structure that enables firms to ‘triangulate’ among their multiple sources and thus better assess their value, and to better absorb knowledge from them (Duysters and Hagedoorn 2002). In our view, this combination of existing, redundant ties and new, non-redundant ties for exploration is overlooked in the literature thus far. Ahuja (2000) and Rowley et al. (2000) measure the extent in which non-redundant ties add value, but ignore in how far this is in combination with and in addition to (some of) the existing, redundant ties firms have. In other words, Ahuja (2000) and Rowley et al. (2000) measure the effect of non-redundant ties, however, without taking into account how the existing strong ties condition this effect. Rowley et al. (2000) do measure the effect of strong ties in exploration (but again without a joint consideration of the non-redundant ties) and hypothesize that “…in high levels of exploration, the number of strong ties a firm has with its strategic partners is negatively related to its performance” (p. 375). Interestingly enough, the authors do not find support for this hypothesis nor are they able to explain this satisfactorily. At the same time though, Rowley et al. (2000) find amongst others support for the weak tie argument, i.e. “In exploration the number of weak ties the firm has is positively related to its performance” (p. 375).

In our view, this implies that there is only an effect of non-redundant ties in exploration when a firm also disposes of ‘sufficient’ existing, redundant ties; indicating that in exploration it is the
combination of existing, redundant ties and new, non-redundant ties that pays off.\(^3\) Apparently, there is not only a Burt-rent in exploration, but there is also a Coleman-rent at work. Once external knowledge is accessed, density (closure) brings two benefits in a setting of exploration: it enables a rapid diffusion of knowledge so that it can then be readily evaluated and absorbed. Moreover, such a structure creates a potential for social control, based on informal mechanisms such as social norms, reputation and so on, to prevent opportunistic behavior. This brings the following hypothesis to the fore:

**Hypothesis 4:** If a company intends to broaden its technology base the use of non-redundant ties will be more effective in combination with redundant (direct and indirect) contacts.

Now, to tackle this hypothesis we should understand that there are different degrees of exploration, ranging from incremental adaptations to radical changes created through novel combinations (Nooteboom and Bogenrieder, 2004). Some exploration tasks may put more weight to accessing external knowledge whereas other tasks may emphasize the role of triangulation and evaluation. This differentiation in degrees of exploration and the implications for network structural properties is an unstudied issue thus far, and may well differ per sector as per time period. In other words, they may be a strong industry effect in how exploration and exploitation settle in different industries. For example, Ahuja (2000) found a positive relationship between redundancy and innovation performance in the chemical industry. In this industry, the dominant design is in the production process and exploration takes place through experimenting with incremental changes in this process, either focused on cost reduction or on the production of new chemicals (e.g. through the use of new raw materials or a new type of catalyst). So, we may associate this with a limited degree of exploration that seems to require triangulation and absorption, enabled by redundancy. Industries such as ICT and biotechnology may be characterised by more radical exploration and, intuitively, we then expect a larger role of non-redundancy vis-a-vis redundancy. In other words, it seems to be useful to study networks in exploration in different industries over time and to try to determine in how far the ‘optimal mix’ of redundancy and non-redundancy is conditioned by the industry and its associated level of exploration.

### 3.3 Exploitation: unsettled issues

Here we focus on exploitation. In exploitation, the focus is on the refinement and strengthening of its existing technology base and competencies. In general, in exploitation dominant designs have emerged and technological and market uncertainty have decreased (Abernathy and Utterback, 1978). This enables the codification of product knowledge that diffuses more widely across the industry (Malerba 2000).

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\(^3\) In a way, indirect empirical evidence for this position is found in the paper of Vanhaverbeke et al., (2004). Past involvement in alliances, indicative for strong ties in terms of durability is positively associated with exploration, whereas over the same period, also evidence is found for the weak tie argument for exploration.
and Breschi, 1997). This makes process innovation an important way to achieve competitive advantage, leading to a focus on more incremental, process-based innovations (...). For that firms need specific and more fine-grained information that will provide a deeper knowledge of the particular process technology. Such process innovations generally entail more tacit knowledge that is best exchanged within more durable relations and trust-based relations (Uzzi, 1997; Larson, 1992; Nooteboom, 2000). Such partners have to be trusted before they can touch the ‘heart’ of the company, especially in the case of core technology. Moreover, in exploitation there is generally a stronger focus on competition so that partners may also be potential competitors. So, this favors Coleman’s closure argument, stressing the benefits for redundancy as it provides a potential for trust-building and social control. Therefore we hypothesize:

**Hypothesis 5a:** If a company intends to strengthen its existing technology base (core technologies)

*the replication of existing ties in a redundant network is most effective as put forward by the network closure theory of social capital.*

Thus, Coleman’s closure argument seems to have most relevance for exploitation. Again however, this is only part of the story. In exploitation, considerations of efficiency are crucial, since competition has shifted to competition on price, with new entrants in the emerging market. As argued by Burt (1992), there are costs associated with maintaining contacts. Therefore, the drive for efficiency in exploitation requires the elimination of redundant relations. In other words, there is a need for a less dense structure. The increased codification of knowledge furthers diffusion without the need for relation-specific investments of mutual understanding. This enables a less dense structure, since now one can identify what competencies are and will remain relevant, who has those competencies, and who is likely to survive in the industry. Investments shift to large-scale production, distribution systems, and brand name, which are all long-term, and increase in size and economic life. In view of such large and often sunk investments, with a long economic life, and to maintain efficient division of labour, network structure is likely to be stable. Therefore, we hypothesize:

**Hypothesis 5b:** If a company intends to strengthen its existing technology base (core technologies)

*a non-redundant and stable network is most effective as put forward by the structural hole theory of social capital.*

So, hypothesis 5a and 5b are contradictory. Hypothesis 5a stresses the benefits of redundancy in view of tacit knowledge exchange and trust-building, conform Coleman. Hypothesis 5b stresses the benefits of non-redundancy in view of efficiency, which is in line with Burt’s efficiency considerations. Which of the two hypotheses holds better is difficult to tell upfront. In exploitation, evidence has been found both for the benefits of redundancy (Rowley, 2000; Vanhaverbeke, et al., 2004) as well as for non-
redundancy (Hansen et al., 2001; Roijakkers, 2003; Nooteboom and Gilsing, 2004). So, although the distinction between exploration and exploitation has proven to be useful to understand the differential role of social capital, it might be too general. There may also be an industry effect at work, in how exploration and exploitation ‘settle’ in specific industries. So, to verify these two hypotheses it may be useful to bring in such an industry perspective to study in which industries firms generally favor redundancy over non-redundancy, or put differently, favor social control over efficiency.

3.4 In conclusion

In this section we have stressed the importance to consider the role of context in understanding the relation between networks and innovation. In terms of figure 3, the focus here is on the relation between the industry level and the network level. More specifically, we have introduced the role of the industry context, based on the exploration-exploitation dichotomy, and studied how it affects the optimality of the network structure in terms of Burt versus Coleman. Although this distinction between exploration and exploitation has proven to be useful, it may still be too general. There may be a stronger sectoral effect in how exploration and exploitation settle in network structural properties and how this affects firms’ innovation performance than anticipated in the literature thus far. In view of this, subsequent studies need to build further on this contingency approach (Bae and Gargiulo, 2003) and investigate how possibly relevant environmental conditions in other industries such as ICT, biotechnology and agriculture condition the relation between networks and firms’ innovation performance. Such a contingency-approach is increasingly being used in the literature and has delivered promising results (see e.g. Podolny and Baron 1997; Rowley et al, 2000; Ahuja, 2000, 2001; Podolny, 2001; Hagedoorn and Duysters, 2002). Based on this, we can then study and understand how firms can combine exploitation with exploration most effectively.

So, we plea to study exploration and exploitation in combination with other relevant contingencies, which prevents us from embracing the same universalistic tone in the literature that we criticized, and that we want to get away from. Still, in doing so, we have abstracted from the process along which alliance networks move from a context of exploitation towards exploration and vice versa. This will be considered next in section 4.

4. THE DYNAMICS OF NETWORKS: MOVING BEYOND LOCAL SEARCH

In this section we examine how alliance networks move from a context of exploitation towards exploration and in doing so, may give rise to changes in the industry context. In terms of figure 3, the focus here is on the relation between the industry level and the network level but now in the reverse order in comparison with the previous section: how the network level affects changes at the industry level. In doing so, we abstract again from the other two levels (group and firm), as also indicated in figure 6.
This section is structured as follows. In section 4.1 we provide some general background to this topic and discuss some recent, converging insights from the literature. In section 4.2 we discuss an unsettled issue, namely the move from away from exploitation to new exploration and how this is conditioned by network structural properties. In section 4.3 we conclude.

4.1 General background and converging insights

In section 4 we have considered networks and their context as the independent variables that condition firms’ behavior and their innovation performance. Regarding the role of context, we make use of the common distinction between exploration and exploitation. However, until now the literature has treated exploration and exploitation in a rather dichotomous way and has abstracted from how both types of learning are related. In reality of course, a context will seldom be characterized by either full exploration or exploitation, but rather contain elements of both. Moreover, when taking more of an evolutionary perspective, we argue that networks will generally move from a context of more exploitation towards more exploration and vice versa. This then provides the fundamental challenge for firms how to combine them, echoing March’s original argument (1991).

Exploitation is generally seen to start when technological variety that emerges from exploration is reduced, in consolidation into a dominant design (Abernathy, 1978; Abernathy and Utterback, 1978; Abernathy and Clark, 1985). The establishment of such a dominant design lowers technological uncertainty substantially. It leads to the emergence of a new technological regime in which radical technological development is substituted by more focused, incremental and cumulative improvements along a specific technological trajectory (Dosi et al., 1988; Duysters, 1996), which is
competence enhancing (Tushman and Anderson, 1986). This ‘supports’ the way the industry is functioning and the bases of competition, increasingly reinforcing the existing status quo (Tushman and Anderson, 1986; Madhavan et al., 1998). Basically, this transition from exploration to exploitation can be considered as a ‘structure reinforcing process’ (Madhavan et al., 1998) with major consequences for the formation and functioning of alliance networks. Such a structure reinforcing process at the industry level increasingly provides pressures to conform to the status quo, in ‘organizational isomorphism’ (Dimaggio and Powell, 1983) with major consequences for the dynamics within these alliance networks.

In most alliances, firms select partners based on prior positive experience, where they rely on their embedded relations. Partnering is thus influenced by the network of prior ties (Gulati and Gargiulo, 1999) and depends on the embedded social relations the firm is already engaged in (Granovetter, 1985; Gulati, 1998). Members of closed networks develop strong, cohesive ties through frequent interaction. Strong ties (Granovetter, 1973) are solid, reciprocal and trustworthy relationships. They tend to create a large basis of trust and intimacy between the partners (Granovetter, 1973; Brass et al., 1998). Since trust is an important basis for knowledge sharing and joint learning, firms are expected to be more productive in joint innovative activities. As those firms invest a substantial amount of time and energy to establish these strong relationships, changing transaction partners in the short run is not likely, since it involves substantial switching costs and implies the risk that existing relationships will dissolve (Chung et al., 2000). Thus, when trustworthy partners are readily available, searching for or switching to new partners is difficult and costly (Chung et al., 2000). Firms rather replicate their existing ties within their technological community than search for new ones (Gulati, 1995a, 1998; Walker et al., 1997).

Furthermore, this repeated alliance formation in alliance groups based on strong ties through local search (Duysters and Lemmens, 2003), causes the densely connected firms to act similarly and to develop similar preferences (Knoke and Kuklinski, 1982). Similarity can encourage interaction and can be the cause of attraction. Scholars refer to this process as “interaction breeds similarity” and “similarity breeds attraction” (Brass et al., 1998). So, in this process social capital drives the network to self-organize, self-transform and self-reinforce. The network actually becomes a growing repository of information on the availability, reputation, competencies and reliability of prospective partners (Walker et al., 1997; Gulati, 1995a; Powell et al., 1996). The driving forces that cause the network to evolve thus relate to the fact that network structuring and technology development happen simultaneously in a co-evolutionary way: networks and technology development constantly shape each other along a trajectory or path, with a focus on exploitation (Kash and Rycoft, 2000). However, the enabling effect of embeddedness in alliance formation that is based on replication of preferential relations can turn into a paralyzing effect as those firms become locked-in these closed parts of the network. They only rely on partners in their own closed social system (Duysters and Lemmens, 2003) or technological community. Then, over time those firms may start to suffer from relational and
technological “over-embeddedness” (Uzzi, 1997), caused by relational inertia and the increasing similarity of firms’ knowledge bases within the closed parts of the network.

4.2 Unsettled issues: from exploitation to exploration

The interesting question now is how one gets away from such over-embeddedness as well as from the existing dominant designs in technology and prevailing dominant logics of organization and competition. In other words, how can firms make the transition from a sole focus on exploitation towards a (increasing) focus on exploration. This is an (almost) unstudied issue in the social network literature thus far. Innovation theory still tends to focus on the working out of novelty, towards a ‘dominant design’, and in doing also neglects this transition process from exploitation to exploration and vice versa. In other words, it focuses on the carrying of invention into innovation rather than how a new invention builds on existing knowledge and routines.4

Following March’s original argument (1991), the key challenge facing firms is to combine exploitative and explorative learning. However, until now the literature has treated the two types of learning as distinctive categories and analysed how the optimality of network properties differs between both contexts (Ahuja, 2000; Rowley et al., 2000; Rothaermel and Deeds, 2004; Nooteboom and Gilsing, 2004; Vanhaverbeke et al., 2004). By focusing on the opposed characteristics of these two contexts, these studies tend to dichotomise explorative and exploitative learning processes and ignore the transitional process of moving from exploitation to exploration, i.e. of moving beyond local search. It is here that the notion of ‘moving beyond local search’ may have appealing value as it bears more of the transitional process from exploitation to exploration in it. In various strands of literature there is still a strong focus on the role of ‘local’ search for organizational knowledge. Evolutionary theory strongly emphasises this path-dependent search for organizational knowledge that closely relates to past R&D outcomes and activity (e.g. Nelson and Winter, 1982; Stuart and Podolny, 1996).

In relation to this, Cohen and Levinthal’s (1990) notion of absorptive capacity points to the importance of past R&D in order to be able to absorb new technological knowledge. The resource-based view of the firm stresses the importance of these firm-specific competences as a key-source for competitive advantage (Penrose, 1949; Wernerfelt, 1984). In some recent studies however, it has been stressed that firms need to move beyond local search in order to stay competitive in the long run (Stuart and Podolny, 1996; Teece et al., 1997; Rosenkopf and Nerkar, 2001; Rosenkopf and Almeida, 2003; Ahuja and Katila, 2004). These studies address the importance of creating access to distant and

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4 In evolutionary terms, innovation theory focuses on selection and retention rather than on the creation of new variety. So, the notion that outcomes of such learning and innovation can also substantially affect the institutional environment and causing it to change from within as it were, is seriously neglected. In terms of the three evolutionary mechanisms, most of these studies strongly focus on how selection processes take place but do not investigate how this relates to variety, nor how variety affects selection again. We consider that to be a major limitation in the innovation literature thus far.
heterogeneous sources of knowledge but have ignored how such access can be created and in how far this is affected by a firm’s alliance network.

So, an urgent issue now is to develop an attempt to go inside the ‘black box’ of this transition process and to study how alliance networks move beyond local search, i.e. from a setting of exploitation towards a setting of exploration. We propose to develop an understanding of this process in terms of its main characteristics, the driving forces underlying it and the implications for the structural properties of alliance networks and their dynamics. As a general idea one can argue that firms in exploitation need to move away from these core rigidities in groups under disruptive technological changes, alliance group members should actually engage in ties that provide access to non-redundant and novel information (Walker et al., 1997; Rowley et al, 2000). Engaging in non-redundant ties outside the existing alliance group may be important to create access to the needed heterogeneous sources of knowledge (Rosenkopf and Nerkar, 2001; Ahuja and Katila, 2004). In this respect, alliance group members that line up with such outsiders may potentially generate higher rewards in terms of opportunities for learning and innovation than when they keep replicating ties within their own technological community. We therefore hypothesize:

**Hypothesis 6:** When moving beyond local search, firms that create ties that are non-redundant with their existing network will be more innovative than firms that replicate existing ties

A related question now is in how far the possibilities to create non-redundant ties are equally spread across firms in the alliance network. To study this we focus on the role of a specific network position. Following Burt’s argument (1992), one’s network position importantly conditions the possibility to profit from one’s social capital such as opportunities for information and control. Now, according to one view, a move beyond local search instigates a structure-loosening process in which a more peripheral position would be more beneficial (Madhavan et al, 1998). This idea that a peripheral position may be more beneficial when moving beyond local search can be argued as follows. A peripheral position may create more possibilities for all kinds of leeway to experiment with ties outside the group. The basic underlying idea here is an evolutionary one, namely that the selection forces exerted by the existing network such as the expectation of loyalty and shared norms of reciprocity in the alliance group are less stringent at the periphery than in the group core (Eldredge and Gould, 1972; Nooteboom, 2000). Peripheral firms may have less economic, psychological and social commitments to the existing technology and to the core of the group. More central firms may not always have this option, as social pressure and loyalty to the existing group may preempt this. Such firms need to make an explicit trade-off between moving beyond their existing network to access new technology that can enhance their innovative performance versus the disadvantage of negative reputation effects from leaving the network. This may be especially difficult for more centrally positioned firms given their commitments to existing partners, which may be generally less the case
for more peripheral firms. In this way, peripheral players may more easily create access to new information, which implies new opportunities for learning. As a consequence, we may expect that the peripheral players are more innovative than their core group counterparts, when moving beyond local search towards exploration. We therefore hypothesize:

**Hypothesis 7:** When moving beyond local search, there is a positive relation between a peripheral alliance group position and the formation of non-redundant ties

**Hypothesis 8:** When moving beyond local search, peripheral alliance group members will have a higher innovative performance than their core counterparts

### 4.3 In conclusion

In this section we have discussed the process along which alliance networks move from exploitation to exploration, or put differently, move beyond local search. In terms of figure 3, the focus here has been on the relation between the industry level and the network level but now in the reverse order in comparison with the previous section: how the network level affects changes at the industry level. In our discussion here we have already touched upon the role of firms in this process, a perspective that we further elaborate in the next section.

### 5. Firm-level perspective: the role of alliance networks in balancing exploration and exploitation

The transitional process from exploitation towards exploration, as discussed in section 4, can be considered as driven by new variety creation. According to this evolutionary view, such variety creation forms a response to the selective pressure of the existing selection environment in exploitation, and is brought about by actions of (individual) firms. This brings us to the role of firms and how their actions and strategies may potentially affect alliance networks. The focus here is on the firm level and we abstract from the other three levels (figure 7). In doing so, we further elaborate on the voluntaristic perspective as also discussed in section 4.

This section is structured as follows. In 5.1 we provide some general background to the topic and discuss some recent insights in the literature. In section 5.2 we introduce some unsettled issues by discussing the role of alliance networks in balancing exploration and exploitation. In section 5.3 we conclude.
5.1 General background and converging insights
As discussed in section 3 and 4, exploitation and exploration present two different approaches to organizational learning. This distinction was made by March’s and his original argument (1991) was two-fold: firstly, these two categories call upon profoundly different resources and capabilities held by firms, and secondly, both should be balanced somehow in order to survive on the short and long term. In the literature until now, the dominant focus has been on his first claim. As a consequence, the literature on alliance networks has followed his dichotomization and studied how much these categories differ (Rowley et al., 2000; Hagedoorn and Duysters 2002; Vanhaverbeke et al., 2004; Gilsing, 2005). His second claim has received much less attention as little research has focused on the interaction between the two and how they can best be balanced. In this respect, Tushman and O’Reilly (1996) advanced the ‘ambidexterity premise’: the idea of an ambidextrous firm that pursues a combination of explorative and exploitative learning, both of which are required to innovate successfully in turbulent technological environments: exploitation of existing capabilities is needed to explore new capabilities and exploration of new capabilities enhances the firm’s existing knowledge base. In this respect, exploration and exploitation, when jointly employed, form a dynamic path of absorptive capacity (Katila and Ahuja, 2002; He and Wong, 2004). The question now is in how far a firm’s social capital enables to balance both types of learning.

5.2 Unsettled issues: ‘networking ambidexterity’
Given the focus of this positioning paper on alliance networks we are especially interested in the role of a firm’s alliance network in creating an ‘ambidexterous’ organization. In this respect, we propose to
introduce the notion of ‘networking ambidexterity’, following Noorderhaven and …..(2004), as the capacity of a firm to balance exploration and exploitation through its alliance network. Two important issues need to be addressed here. How can firms make use of their network in such a way that it enables them to balance exploration and exploitation and what trade-offs are to then be made among the broad spectrum of knowledge acquisition mechanisms?

Due to the rapidly increasing speed of technological changes, technology-based new business development can no longer be achieved through internal growth based on exploitative learning only. A systematic scanning of the available technologies and ideas outside the company through exploration is crucial. These types of learning often take place simultaneously, which means that companies have to install mechanisms to support these dual business opportunities and competencies. These trends are forcing firms to develop knowledge internally and to acquire knowledge externally through licensing, technological alliances, acquisitions (Lambe and Spekman, 1997; Hagedoorn, ….; Duysters,…..) and the spinning-in of promising technology start-ups they have invested in earlier (corporate venturing). These governance modes can thus no longer be considered as separate sources of knowledge acquisition, but as complementary ones. This implies that in order to explain organizational learning in terms of exploration and exploitation, there is a need for combining the literature on alliance networks with the literature on corporate venturing and on alternative types of knowledge acquisition methods (e.g. licensing, acquisitions etc.). However, the literature streams on internal knowledge generation and external knowledge acquisition in terms of alliance networks and corporate venturing have been kept separate so far. Integrating these streams of literature is crucial to understand the organizational learning strategies of companies. Therefore future research should open up a possibility to frame this literature about alliances into the broader framework of knowledge acquisition strategies of technology-based companies. Next to these conceptual issues, further research should also provide empirical evidence on how companies make trade-offs between internal venturing, joint ventures and external ventures as alternative knowledge acquisition methods, and should address the effects on innovation performance.

5.3 In conclusion

In this section we have addressed the importance for firms to use their alliance network in combination with other types of knowledge acquisition modes in order to balance exploitative and explorative learning strategies and innovation. Then to increase innovative performance in turbulent environments firms are increasingly required to employ a portfolio of governance modes to acquire external knowledge. However, the academic literature is lacking to explain this phenomenon so far, as the literature streams on internal knowledge generation, alliance networks and corporate external venturing have been kept separate so far. There is a clear need to conceptually as well as empirically demonstrate how companies make trade-offs between internal ventures, joint ventures and external
ventures as alternative knowledge acquisition methods, and how this affects their innovation performance.

6. CONCLUSION

After well over a decade of study, consensus has grown in the literature that strategic alliances form an efficient mechanism to effectuate the potential for learning and innovation brought about by resource heterogeneity across firms (Porter, 1990; Hamel and Prahalad, 1990; Grabher, 1993; Smith et al., 1994; Hagedoorn, 1993; Hagedoorn and Schakenraad, 1994; Spekman et al., 1995; Uzzi, 1997; Nooteboom 1999, 2004; Ahuja, 2000; Rowley et al., 2000). In this respect, network embeddedness, as an important mean to access heterogeneous sources of knowledge, is considered as the key driving factor why and when alliances are formed (Duysters et al., 2001; Kogut and Zander, 1993; Powell and Brantley, 1992). In this respect, the dominant focus in the literature has been on the exogenous factors that cause alliance formation. This strong focus on exogenous embeddedness reflects a structuralist view of how a set of interrelationships among firms drives their economic behaviour and innovation performance. This approach has brought the important insight to the fore that social relations matter for economic and innovative action, and that they positively affect corporate performance in terms of growth (Powell e.a. 1996), speed of innovation (Hagedoorn, 1993), organizational learning (Hamel, 1991) and reputation (Stuart, 1998; Stuart et al., 1999). In section 2 and 3 of the paper, we have built on this structuralist view by considering two topics in more detail, namely group-based competition and the role of context.

Section 2 elaborates on the role of embeddedness at the group level and its effect on rival groups and on firms’ innovation performance in group-based collaboration and competition. In terms of figure 3, the focus here is on the group level as the appropriate level of aggregation. This implies that the inimitability of the combined resources in the alliance group, instead of on the resources of separate members have to be preserved. To further address this we need to empirically investigate the resources that contribute to the success of alliance groups and the competitive effects these groups induce. Understanding these issues is important as they carry substantial implications for the competitive dynamics of technology-based industries. There is a general lack of relevant literature and empirical work in this field and therefore there is a clear need to fill this gap by further theorizing and empirical testing.

In section 3 we discussed the role of context in how it affects the relation between network structural properties and innovation. In terms of figure 3, the focus here is on the relation between the industry level and the network level. We have discussed the role of industry context in terms of the exploration-exploitation dichotomy and argued how it may affect the optimality of the network structure in terms of Burt versus Coleman. Although this distinction between exploration and exploitation has proven to be useful, it may still be too general. There may be a stronger effect of other relevant contingencies that affect in how exploration and exploitation settle in network structural
properties, and how this affects firms’ innovation performance, than anticipated in the literature thus far. In view of this, a future research program needs to build further on this contingency approach (Bae and Gargiulo, 2003) and investigate how relevant environmental factors condition in how far firms may obtain a Burt-rent or a Coleman rent in exploration and exploitation. An interesting approach here may be to compare high-tech industries such as ICT and biotechnology with food and agriculture. Such a comparison prevents us from embracing the same universalistic tone in the literature that we criticized, and that we want to get away from. Moreover, this enables us to better understand the food- and agricultural industries by taking one or two high-tech sectors as the benchmark.

In section 4 and 5 we attempt to go beyond the structuralist view, with its deterministic stance, by developing a more voluntaristic perspective on the relation between innovation networks and innovation. Here we consider two topics, namely the move beyond local search and a firm’s perspective.

In section 4 of this paper we propose to develop a more voluntaristic perspective by considering how firms and alliance networks move from a context of exploitation towards exploration. In terms of figure 3, the focus here is on the relation between the industry level and the network level but now in the reverse order: how changes in the network structure induce changes at the industry level. In doing so, we abstract again from the other two levels (group and firm). The key question here is how one gets away from the risk of over-embeddedness in exploitation. In other words, how can firms make the transition from a sole focus on exploitation towards a (increasing) focus on exploration. This connects with the growing literature that study how firms can move beyond local search (Rosenkopf and Almeida, 2003; Rosenkopf and Nerkar, 2001; Ahuja and Katila, 2004). In view of this, a future research program needs to develop an attempt to go inside the ‘black box’ of this transition process and to study how alliance networks move beyond local search. An interesting approach here may be to study how network positions condition this process as well as how such favorable network positions may be created deliberately.

In section 5 we further elaborate on this voluntaristic view by taking a firm perspective. In terms of figure 3, the focus here is on the firm level of aggregation and we abstract from the other three levels. We introduce the notion of ‘networking ambidexterity’, following Noorderhaven and …..(2004), as the capacity of a firm to balance social networks to enable exploration and exploitation. We addressed how firms make use of their network to acquire knowledge that enables them to balance exploration and exploitation and we focused on the trade-offs they have to make among the broad spectrum of knowledge acquisition mechanisms, in view of balancing exploration and exploitation. Firms are increasingly required to employ a portfolio of governance modes to acquire external knowledge. However, the academic literature is lacking to explain this phenomenon so far, as the literature streams on internal knowledge generation, alliance networks and corporate external venturing have been kept separate so far. There is a clear need to conceptually as well as empirically demonstrate how companies make trade-offs between internal ventures, joint ventures and
external ventures as alternative knowledge acquisition methods, and how this affects their innovation performance.
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