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Governing Explorative R&D Alliances: Searching for Effective Strategies**

Although firms increasingly rely on interfirm collaboration to explore new technological opportunities, few studies have examined the ways in which this collaboration form is governed. In this paper, we attempt to increase our understanding of governing explorative R&D alliances. First, we argue that explorative R&D alliances are likely to face substantial risks of opportunistic behavior and high coordination costs. Second, applying insights from the alliance literature, we identify formal governance mechanisms as effective tools to mitigate the risk of opportunistic behavior as well as coordination costs. However, relying on insights from the new product development literature, we argue that such formal governance mechanisms may hamper exploring new technological opportunities. Third, we propose and develop alternative strategies, facilitating the governance of explorative R&D alliances: 1) relying on embedded relationships in which heterogeneity is maintained and 2) balancing formal and relational governance. To conclude, we emphasize the importance of longitudinal, multi-level research to study the characteristics and dynamics of different governance mechanisms within interfirm collaboration.

Key words: **Alliances, Exploration, Formal Governance, Relational Governance**

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** The authors gratefully acknowledge the financial support of the Fund for Scientific Research – Flanders (FWO G.0286.06) and the Flemish Government (Policy Research Center 'Entrepreneurship, Enterprises and Innovation') for conducting this research. Earlier versions of this paper have been presented at the 2nd workshop on trust within and between organizations, Amsterdam, October 23-24 2003 and at the Academy of Management 2004 Meeting, New Orleans, August 6-11. Useful comments and suggestions on this paper have been provided by two anonymous reviewers, Anoop Madhok, Luc Sels, and Koenraad Debackere.

Article received: September 29, 2005
Revised version accepted after double blind review: January 10, 2006.

Introduction

Firms not only have to exploit their existing technologies, but also need to explore new technologies for tomorrow's products (Christensen/Overdorf 2000; Katz/Allen 1985; Wheelwright/Clark 1992). Exploring new technologies internally is a time-consuming and an expensive process that is fraught with uncertainty (March 1991). Firms therefore tend to sign contractual agreements with external partners to explore new technological opportunities (Koza/Lewin 1998; Rothaermel/Deeds 2004). Such explorative R&D alliances allow spreading the costs of R&D activities over different partners and exchanging both tacit and explicit knowledge, facilitating cross-fertilization (Doz/Williamson 2002; Rothaermel/Deeds 2004).

While most studies point to the potential advantages of interfirm collaboration for explorative purposes, they do not address the question of how this particular form of interfirm collaboration can be governed (Gerwin 2004). This theoretical paper therefore aims to contribute to our understanding of the governance process of explorative R&D alliances. In this paper, we first define the concept of explorative R&D alliances and point to conditions that facilitate exploration. We then argue that explorative R&D alliances face substantial risks of opportunistic behavior and coordination costs. Next, we assess the effectiveness of formal governance mechanisms in the specific setting of explorative R&D alliances. Based on insights from the alliance literature, we identify formal governance mechanisms as effective tools to mitigate the risk of opportunistic behavior as well as coordination costs. At the same time, applying insights stemming from the new product development literature, we point to the limitations of formal governance mechanisms for the exploration of new technological opportunities. Finally, we propose two alternative governance strategies that seem to be capable of addressing the problems of opportunistic behavior and coordination costs without hampering the exploration of new technological opportunities. These two alternatives imply 1) relying on embedded relationships in which heterogeneity is maintained and 2) balancing formal and relational governance.

Explorative R&D alliances: Definition and conditions

As the focus of this paper is on explorative R&D alliances, we first define this concept in detail. Subsequently, we identify facilitating conditions to come to successful exploration, providing the framework in which effective governance strategies for explorative R&D alliances can be identified.

Defining explorative R&D alliances

Applying the exploration-exploitation dichotomy of March (1991), researchers within the alliance literature (e.g., Faems et al. 2005; Koza/Lewin 1998; Rothaermel 2001; Rothaermel/Deeds 2004) make a distinction between exploration alliances and exploitation alliances. According to March (1991: 71), exploration implies activities captured by terms such as 'search, variation, risk taking, experimentation, play, flexibility, discovery, innovation.' Exploitation relates to activities such as 'refinement, choice, production, efficiency, selection, implementation, execution.' Relying on this exploration-exploitation framework, Koza and Lewin (1998: 257) argue that 'the intent behind entering an exploration alliance involves a desire to discover new opportunities', while

'an exploitation alliance involves the joint maximization of complementary assets.' Following the logic of above definitions, we consider an explorative R&D alliance as an agreement between otherwise independent firms that pool their capabilities for the purpose of discovering new technological opportunities.

To clarify the boundaries of our study, we need to emphasize that we only look at explorative R&D alliances between contractually linked partners. When we talk about contractually linked partners, we refer to the existence of a non-equity relationship among otherwise independent firms, based on written agreements and verbal understandings (Gerwin 2004). Contractually linked partners need to be distinguished form institutionally linked partners or partners that have an equity based relationship (Das/Teng 1998). We focus on contractual alliances because recent studies (e.g. Hagedoorn 2002; Osborn et al. 1998; Rohtaermel/Deeds 2004) indicate that, in technology intensive settings, their numbers and share in the total of alliances has far exceeded that of institutional relationships.[1]

Necessary conditions for exploration

Both organizational learning scholars (e.g. Holmqvist 2003; March 1991) and innovation scholars (e.g. Ahuja/Lampert 2001; Burgelman 1983) have paid attention to conditions, influencing the execution of explorative activities. Reviewing these literatures, we distinguish three conditions that facilitate exploration: 1) heterogeneity; 2) task conflict; and 3) double-loop learning.

Heterogeneity. The first condition refers to the presence of heterogeneity in skills, knowledge and attitudes. Schön (1963) already argued that novel solutions and insights stem from problem-defining and problem-solving interaction sequences, whereby multiple opinions and viewpoints become integrated into a new synthesis or artifact. Similarly, Pelz and Andrews (1966) came to the conclusion that differences in approaches between a scientist and his/her colleagues may provide the intellectual jostling or 'dither' which is needed for really creative work. Therefore, conducting activities such as improvisation and experimentation implies generating and addressing differences in opinion and interpretation between the actors involved (Dutton/Duncan 1987).

Task conflict. In addition to heterogeneity among team members, task conflict is a second condition that facilitates exploration. Task conflict[2] exists when there are disagreements among group members about the content of the tasks being performed (Jehn 1995: 258). Such task conflict is different from relationship conflict, which

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1 For instance, Rothaermel and Deed (2004), examining a sample of 325 biotechnology firms that entered 2565 alliances over a 25-year period, reported that the ratio of a firm's equity alliances over its total alliances on average was 0.04. In other words, 96 % of a firm's alliances were characterized by a non-equity governance structure.

2 Conducting a factor analysis, Jehn (1995) identified 4 items that allow measuring the extent of task conflict in work units: 1) How often do people in your work unit disagree about opinions regarding the work being done? 2) How frequently are there conflicts about ideas in your work unit? 3) How much conflict about the work you do is there in your work unit? and 4) To what extent are there differences of opinion in your work unit?

emerges when there are interpersonal incompatibilities among group members (Jehn 1995). While relationship conflict typically creates tensions, animosity, and annoyance among members, having a detrimental effect, task conflict is found to be beneficial for non-routine tasks as it brings along critical evaluation, increasing thoughtful consideration of alternative solutions, and encourages people to develop new ideas and approaches (Baron 1991; Guetzkow/Gyr 1954; Janis 1982; Jehn 1995). Exploration, being an example of a non-routine task, consequently benefits from task conflict and the innovative ideas that this type of conflict creates.

Double-loop learning. A third and final condition of exploration is the willingness and capability for double-loop learning. Argyris and Schön (1978) have made a conceptual distinction between single-loop and double-loop learning. Single-loop learning occurs when errors are corrected without altering the underlying norms. For instance, a thermostat is programmed to turn on if the temperature in the room is cold, or turn off the heat if the room becomes too hot (Argyris 2002). Double-loop learning occurs when errors are corrected by changing the norms and then the actions. In such higher-order learning processes (Fiol/Lyles 1985) current assumptions are questioned and changed in line with new knowledge. A thermostat would be conducting double-loop learning when it would question whether the predefined temperature is the most comfortable one, and then adjusts the temperature (Argyris 2002). The importance of double-loop learning for the execution of explorative activities has been stressed. Individuals and teams, when conducting explorative activities, must be capable and willing of reconceiving their environment as well as their own identity (Brown/Duguid 1991; March 1991). In this way, new insights and heuristics can emerge, allowing for the definition and solution of complex problems related to new technological opportunities (Ahuja/Lampert 2001).

Opportunistic behavior and coordination costs in explorative R&D alliances

Explorative R&D alliances allow spreading R&D costs and pooling different but complementary knowledge (Doz/Williamson 2002; Rothaermel/Deeds 2004). Despite these advantages, explorative R&D alliances face some major governance challenges. The alliance literature, relying on insights from both transaction cost theory and contingency theory, suggests the likely emergence of two problems in explorative R&D alliances: the risk of opportunistic behavior and the difficulty of achieving coordinated action.

The risk of opportunistic behavior

In the alliance literature, transaction cost theory has been extensively applied to understand the forms, functions and effectiveness of interfirm collaboration (Zajac/Olsen 1993). According to transaction cost theory (e.g. Williamson 1985), the fundamental governance question is: How can exchange relationships be structured to economize on transaction costs? Adopting this perspective, numerous alliance scholars (e.g. Das/Teng 1998; Deeds/Hill 1998; Oxley 1997) point to the risk of opportunistic behavior or 'seeking self interest with guile' (Williamson 1985). In alliances, opportunistic behavior is exemplified by cheating, shirking, distorting information, misleading

partners, providing substandard product/services, and appropriating partners' critical resources (Das/Teng 1998). The risk of opportunistic behavior may limit the success of alliances because it retains the potential to severely harm participating organizations (Hamel 1991; Williamson 1991). They consequently will be hesitant to fully collaborate with the other partner(s), avoiding that these latter partner(s) abuse the collaboration for their own private benefit (Das/Teng 2001; Gerwin 2004).

However, not all types of alliances are confronted with the same extent of opportunistic behavior (Das/Teng 2001). Applying a transaction cost theory perspective, three conditions are identified that increase the risk of opportunistic behavior in alliances: 1) asset specificity, 2) measurement problems and 3) uncertainty (Poppo/Zenger 2002). Asset-specificity emerges as alliance partners make significant relationship-specific investments in physical and/or human assets (Dekker 2003). The more specialized investments become the lower its value in alternative uses. The contingent value of a specialized resource consequently exposes its owner to a greater risk of opportunistic behavior than the owner of a generalized resource (Klein et al. 1978). Difficulty in measuring the performance of exchange partners and uncertainty both result in monitoring problems (Poppo/Zenger 2002). In such circumstances, partners may have incentives to limit their efforts toward fulfilling the agreement, increasing the risk of opportunistic behavior (Blumberg 2001).

All three conditions are likely to be present within the context of explorative R&D alliances. First, explorative R&D alliances often require specific investments and activities of different partners which – while in development - can not be easily transferred to other contexts, increasing the asset specificity of the transactions [3] (Lambe/Spekman 1997). Second, within explorative projects, performance will often be difficult to measure especially because potential returns on this kind of investment are often unclear or intangible (March 1991; McGrath 2001). Third, conditions of uncertainty are the norm when it comes to exploring new technologies (Rothaermel/Deeds 2004). We therefore conclude that explorative R&D alliances face a substantial risk of opportunistic behavior.

Problems of achieving coordinated action

Other alliance scholars (e.g. Doz 1996; Gerwin 2004; Gulati/Singh 1998) argue that it is difficult to achieve coordinated action between different partners. For instance, Doz (1996) discusses how a strategic alliance between a small entrepreneurial and a large established pharmaceutical organization failed because both partners were using their own organizational routines at the interface between them, often with consequences such as conflicts, tensions, and people opting out of the relationship.

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[3] We need to remark that, according to transaction cost theory, there are limits to the acceptable level of asset-specificity in alliances. Williamson (1991) argued that alliances are valuable modes of governance as long as asset-specificity is of a moderate degree. As asset-specificity increases above some threshold, transaction costs become prohibitive and transactors move to unified governance/hierarchy. In other words, transaction cost theory suggests that, as the need for asset-specific investments becomes very high in explorative innovation settings, partners should consider a more hierarchical mode of governance to explore new technological opportunities.

Alliance scholars rely on insights from contingency theory (e.g. Lawrence/Lorsch 1967; Thompson 1967) to determine the coordination costs in alliances. Contingency theory emphasizes that organizational structures should fit environmental demands (Lawrence/Lorsch 1967). According to this theoretical perspective, the need for coordination among organizational subsystems is contingent on 'the complexity of their tasks and task environments' (Metcalfe 1980: 511). Applying these insights, several alliance scholars (Gerwin 2004; Gulati/Singh 1998) argue that coordination costs in alliances are dependent on the level of task interdependence and task uncertainty.

As already mentioned, task uncertainty is likely to be extended when the purpose is to explore new technological opportunities. In addition, Gerwin (2004) proposes that the execution of upstream activities such as experimentation and basic research asks for reciprocal information-processing between partners, increasing the level of task interdependence. In sum, both task uncertainty and task interdependence are likely to be extensive in explorative R&D alliances, triggering substantial coordination costs.

The viability of formal governance mechanisms within explorative R&D alliances

To address the potential problems of opportunistic behavior and coordination within interfirm collaboration, numerous alliance scholars emphasize the relevance of formal governance mechanisms. Consequently, we first present the reasons that are discussed within this literature. As it is however our attempt to identify effective governance mechanisms within the specific context of explorative R&D alliances, we next move to the new product development literature. Relying on insights from this literature, we point to the limitations of formal governance mechanisms in explorative innovation settings.

Advantages of formal governance mechanisms

Defining formal governance mechanisms, Dekker (2003) distinguishes between contractual obligations and formal organizational mechanisms. Contractual obligations represent promises or obligations to perform particular actions in the future (Macneil 1978). The more contractual obligations are codified within the formal contract, the greater is the specification of promises, and processes for dispute resolution (Poppo/Zenger 2002). Next to these contractual obligations, formal governance refers to formal organizational mechanisms. Following Gulati and Singh (1998), Dekker (2003) identifies five important organizational mechanisms frequently used in interfirm collaborations: 1) command structures and authority systems, 2) incentive systems, 3) standard operating procedures, 4) dispute resolution procedures, and 5) nonmarket pricing-systems.

Following the logic of transaction cost theory, alliance scholars (e.g. Parkhe 1993; Pisano 1990) argue that the implementation of formal governance mechanisms significantly reduces the risk of opportunistic behavior within interfirm relationships. Because formal governance mechanisms emphasize rules, procedures, and policies to monitor and reward desirable performance, it triggers formal control processes (Das/Teng 2001; Fryxell et al. 2002). Such formal control implies aligning incentives

of the different partners and provides monitoring of behavior and/or outcomes of the collaboration (Williamson 1985). It consequently helps to ensure that partners make efficient ex ante investments and avoid ex post bargaining and hold up threats, reducing the risk of opportunistic behavior (Deeds/Hill 1998).

Contingency theory argues that when coordination requirements increase beyond a certain point, managers handle them by adding an additional coordination method (Gerwin 2004). Standardization or coordination through the use of rules and procedures has been recognized as a viable coordination method in this respect (Galbraith 1977; Mintzberg 1979). Several alliance scholars (e.g. Dekker 2003; Gulati/Singh 1998) have stressed the advantages of formal governance mechanisms to achieve standardization in collaborative settings. Because formal governance mechanisms clearly stipulate the obligations and responsibilities of the different partners within the formal contract, the tasks of the partners, their relationships and decision making processes are extensively specified (Klein Woolthuis et al. 2005). In addition, formal organizational mechanisms such as standard operating procedures and command structures typically include planning, rules, procedures, and programs that serve the common purpose of minimizing communication, simplifying decision making, reducing uncertainty about future tasks, and preventing disputes (Dekker 2003). In other words, formal governance mechanisms make the division of labor and the interactions between partners more predictable and allow joint decisions to be made more by rules than by exception (Gulati/Singh 1998).

In sum, the alliance literature points to formal governance mechanisms as tools that reduce the risk of opportunistic behavior as well as the coordination problems among partners.

Limitations of formal governance mechanisms

During the past 20 years, numerous researchers (e.g. Ancona/Caldwell 1992; Brown/Eisenhardt 1997; Katz/Allen 1985) have studied the structures and processes by which new products are developed within firms. Following Gerwin and Ferris (2004), we refer to this literature as the new product development literature.[4] In this literature stream, indications are present that formalization might hamper exploration. For instance, McGrath (2001), studying 56 new business development projects within firms, found that innovation projects in which role and job definitions were extensively formalized were less effective in terms of exploration than innovation projects in which role and job definitions were less formalized.

The different explanations of this negative relationship between formal governance mechanisms and exploration all refer to the restricting impact of formalization on explorative activities. According to 'The Simplified Merton Model' of March and Simon (1958), reliance on formalized role behavior brings along rigidity of behavior. Stressing formal roles and job definitions discourages people to deviate from the expected behavior, making the occurrence of creativity very unlikely. Similarly, Kiesler and Sproull (1982) propose that explicit rules, procedures and programs narrow the

[4] For an extensive overview of the new product development literature, we refer to Brown and Eisenhardt (1995).

field of search, create a frame for the interpretation of new information and increase the likelihood that data disconfirming the decision premises upon which the objectives were based will be ignored. Katz and Allen (1985) argue that, when formal incentive systems are present, engineers and scientists become anxious to conduct exploration because returns from exploration are systematically less certain, more remote in time and organizationally more distant from the locus of action. More recently, Benner and Tushman (2003) stress that formalized process management practices such as ISO 9000 and Six Sigma push an organization for productivity, leaving little room or slack for pursuing novel ideas.

In sum, formal governance mechanisms tend to stress standardization instead of heterogeneity, task agreement instead of task conflict, and single loop learning instead of double loop learning (Makhija/Ganesh 1997). In other words, the reliance on formal governance mechanisms seems to suppress the conditions that have been identified as facilitators for explorative activities. We therefore argue that formal governance mechanisms are likely to limit the possibilities for exploration.

We therefore have to conclude that a problematic situation seems to arise with respect to the governance of explorative R&D alliances. While the alliance literature seems to recommend formal governance mechanisms to reduce the risk of opportunistic behavior and coordination costs in explorative R&D alliances, the new product development literature provides evidence that formal governance mechanisms hamper the possibility to explore new technological opportunities, which is the main objective of this kind of interfirm collaboration. In the following section, we identify alternative strategies that allow dealing with risks of opportunistic behavior and coordination costs without limiting the possibility for exploring new technological opportunities.

Governing explorative R&D alliances: Alternative strategies

A number of recent studies (Faems et al. 2005; Rothaermel/Deeds 2004; Schildt et al. 2005) provide empirical evidence of the potential effectiveness of explorative R&D alliances. These studies clearly indicate that collaboration with other firms may be a viable mechanism to explore new technological opportunities. However, they do not examine the way in which collaborative processes are governed in explorative R&D alliances (Gerwin 2004). As a consequence, these studies do not provide insights in how risks of opportunistic behavior and coordination costs can be addressed without hampering the execution of explorative activities. In this section, we suggest two alternative strategies that may facilitate the governance of explorative R&D alliances: 1) relying on embedded relationships in which heterogeneity is maintained and 2) balancing between formal and relational governance. For each alternative, we first discuss the reasons why they offer the potential to facilitate the governance of explorative R&D alliances. We then identify possible actions to implement these alternative governance strategies.

Relying on embedded relationships in which heterogeneity is maintained

The first alternative strategy that we propose is relying on embedded relationships while maintaining heterogeneity in partners' skills, knowledge, and attitudes. Below, we first define the concept of embedded relationships. We then argue that, in embed-

ded relationships, the presence of relational governances or 'the reliance on goodwill trust and interfirm routines to govern interfirm collaboration' (Joshi/Campbell 2003; Poppo/Zenger 2002) minimizes the risk of opportunistic behaviour and coordination costs, reducing the need for formalization. Subsequently, we discuss the impact of embedded relationships on the opportunity to explore technological opportunities. We argue that the presence of relational governance in embedded relationships stimulates exploration. However, we also point to the risk of diminishing heterogeneity in embedded relationships, imposing limitations on the exploration of new technological opportunities. In the final paragraph, we therefore suggest two strategies to maintain heterogeneity in embedded relationships.

Definition of embedded relationships. Until now, we implicitly assumed that partners did not have a history of prior interaction when the collaboration takes off. Some alliance scholars (e.g. Ahuja 2000; Eisenhardt/Schoonhoven 1996; Gulati 1995) stress though that firms, which have a history of successful prior interaction, are likely to collaborate again in the future as their past success has created goodwill trust and interfirm routines. Uzzi (1997), applying Granovetter's (1985) concept of embeddedness,[5] refers to this kind of relationships as embedded relationships.

Reduced need for formalization in embedded relationships. Gulati and Singh (1998) provide evidence that, when prior ties are present, the need for formal control mechanisms decreases. Similarly, Madhok (1995) argues that, when successful prior collaboration is present, the need for formalization is much lower. This reduced need for formalization is argued to be the consequence of trust as well as the presence of interfirm routines (Gulati/Singh 1998).

When partners have collaborated successfully in the past, the repeated cycles of exchange, risk taking, and successful fulfillment of expectations will have created a psychological identity characterized by shared norms, values and beliefs that emphasize faith in the moral integrity or goodwill of others (Gaertner et al. 1996; Homans 1962). This shared psychological state, stressing the confidence in another's goodwill, has also been called goodwill trust[6] (Das/Teng 2001; Ring/Van de Ven 1994). When goodwill trust is present, formal control can become less stringent as opportunistic behavior is much less likely to be observed (Das and Teng 2001). The presence of goodwill trust prevents opportunism, pushing formal control mechanisms to the background (Madhok 1995; Larson 1992). In sum, prior interactions that create a

5 Granovetter (1985: 482) has introduced the concept of embeddedness to make the argument that: 'the behaviour and institutions to be analyzed are so constrained by ongoing social relations that to construe them as independent is a grievous misunderstanding.' Emphasizing the importance of embeddedness, Granovetter (1985) criticizes transaction cost theory as an 'undersocialized conception of human action' that looks at transactions in an isolated way, neglecting the fact that these transactions are embedded in personal relations and networks between and within firms.

6 The repeated interactions are also expected to provide firsthand information about the extent to which the other partner is indeed trustworthy, leading to competence-based trust (Das /Teng, 2001; Rousseau et al. 1998).

trustful relationship considerably reduce the presence of opportunistic behavior and consequently the need for more formal arrangements.

Besides goodwill trust, the development of interfirm routines will decrease the need for formalization. Doz (1996) observed that, within successful alliances, partners do not only learn each others competences, but also learn how to interact successfully. In other words, firms jointly develop routines that enable interaction and adjustment (Gulati/Singh 1998, Ring/Van de Ven 1994). Examples of such interfirm routines are knowledge-sharing routines (Dyer/Singh 1998), and joint problem solving routines (Uzzi 1997). Uzzi (1997: 47) also found that, within embedded ties, 'problem-solving mechanisms were entailed that enable actors to coordinate functions and work out problems 'on the fly'.' Consequently, when such interfirm routines are present, issues of coordination can be addressed not by referring to formalized rules and procedures, but by attending to the process of real-time, informal communication. Under such circumstances, coordination by mutual adjustment starts to replace formalized coordination mechanisms (Mintzberg 1979).

In sum, the presence of goodwill trust and interfirm routines within embedded relationships reduces the need for formalization. Goodwill trust minimizes the risk of opportunistic behavior, while interfirm routines such as knowledge-sharing routines and joint problem solving arrangements reduce coordination costs through facilitating coordination by mutual adjustment. Both elements – goodwill trust and interfirm routines oriented towards joint knowledge sharing and problem solving – are seen as constituent parts of relational governance (Joshi/Campbell 2003; Poppo/Zenger 2002).

Relational governance facilitates exploration. Within the context of explorative R&D alliances, relational governance might facilitate explorative activities for two reasons. First, opposite to formal control emphasizing rules, procedures, and policies, goodwill trust implies the presence of shared norms, values, and beliefs (Das/Teng 2001). According to Ouchi (1980: 134), such 'clan control'[7] can reduce the risk of opportunistic behavior and allows carrying out tasks that are 'highly unique, completely integrated, or ambiguous for other reasons'. Second, interfirm routines that stress coordination by mutual adjustment are beneficial because this mode of coordination is characterized by excessive information sharing and informal communication, essential to come up with innovative solutions (Damanpour 1991; Aiken/Hage 1971; Weick/Roberts 1992, Nonaka/Takeuchi 1995). Relying on informal communication – against the background of a set of shared norms and values – offers the potential of handling task conflict without risking an escalation of relationship conflict. In this way, coordination by mutual adjustment might support explorative activities.

Risk of reduced heterogeneity in embedded relationships. The usefulness of embedded relationships has its limitations though. First, embedded relationships may restrict firms from new information and new opportunities (Gulati 1995). Organizations that collaborate repeatedly with each other tend to build up a large amount of domain similarity (Van de Ven/Walker 1984). Firms entering multiple collaborations over time with each other therefore face the risk of being confronted with diminish-

7 This mode of control has also been called informal or social control (Das/Teng, 2001).

ing marginal returns of information exchange (Gulati 1995). In other words, collaborating in the past may minimize the amount of heterogeneity present between the partners and consequently reduce its potential for successful exploration of new technological opportunities.

Second, within embedded relationships, feelings of obligation and friendship may become so great that social aspects of the collaboration supersede the economic imperatives (Simsek et al. 2003; Uzzi 1997). Consensus becomes so widely shared and articulated that it reduces the urge to communicate (Simsek et al. 2003) and the more shared norms, values and beliefs are stressed, the more difficult it is for individuals to deviate from them (Christensen/Overdorf 2000). In these circumstances, homogeneity instead of heterogeneity is emphasized, hampering the possibility for exploration.

To conclude, relying on embedded partners has major advantages in terms of governing explorative R&D alliances. Within embedded relationships, formal governance mechanism can be substituted by relational governance, facilitating explorative activities. However, these advantages can only be realized if a certain amount of heterogeneity in skills, knowledge and attitudes between the partners is maintained. Therefore, we propose:

Proposition 1: Relying on embedded relationships reduces the risk of opportunistic behavior and coordination costs without hampering exploration of new technological opportunities as long as heterogeneity in partners' skills, knowledge, and attitudes is maintained.

Strategies to maintain heterogeneity in embedded relationships. Several scholars (e.g. Bouwen/Fry 1991; Evans 1991; Janssens/Steyaert 1999) stress the importance of sequencing and layering strategies to handle dualities within organizations. Sequencing addresses dualities by shifting attention asymmetrically form one opposite pole to the other. Layering involves developing new capabilities while reinforcing past strengths (Janssens/Steyaert 1999). We here apply these two strategies to indicate how heterogeneity can be maintained in embedded relationships.

A first strategy is to sequence between periods of intensive collaboration and periods of non-collaboration. During intensive collaboration, partners together explore new technological opportunities. Over time, this will result in a reduction of heterogeneity. Subsequently, a period of non-collaboration is initiated, minimizing the frequency and intensity of interaction between the partners. During this period, by conducting other innovation projects internally or in collaboration with other partners, new, non-redundant information can be absorbed. Heterogeneity between the partners consequently increases, providing new possibilities to initiate explorative R&D alliances together in the next sequence. Evidence of such a sequencing strategy, reestablishing heterogeneity by introducing periods of non-collaboration, can be found in industry-university relationships (Bowie 1994; George et al. 2002). While technology intensive companies develop close relationships with universities, they do not initiate collaborative projects with them on an ongoing basis. Rather, these companies collaborate with universities sporadically, based on specific opportunities that come along. In this way, firms can maintain embedded relationships with such partners, without the risk of exhausting the potential added value of it.

Proposition 2: Sequencing between different explorative R&D alliances (i.e. switching between collaborative and non-collaborative periods with the same partner) allows maintaining heterogeneity in embedded relationships.

A second strategy is to initiate a layering strategy within the explorative R&D alliance itself by stressing discontinuity on the operational level of the relationship, while maintaining continuity on the managerial level of the relationship. On the operational level, discontinuity can be achieved through introducing new individuals to the collaboration. Katz and Allen (1985: 390) stressed that 'project newcomers represent a novelty-enhancing condition, challenging and improving the scope of existing methods and accumulated knowledge.' In other words, introducing new individuals means the questioning of existing interfirm norms, values and routines and consequently stimulating heterogeneity. However, too much discontinuity will threaten the goodwill trust and interfirm routines established between the partners (Ring/Van de Ven 1994). Therefore, also continuity is needed, maintaining the positive spirit that has been created in the past. We argue that this continuity can best be established on the managerial level. After all, managers are less directly involved in the explorative activities that require heterogeneity.

Proposition 3: Layering within explorative R&D alliances (i.e. introducing discontinuity on the operational level, while maintaining continuity on the managerial level) allows maintaining heterogeneity in embedded relationships.

Balancing formal and relational governance

The second alternative that we propose is to balance formal and relational governance. To develop the theoretical rationale behind this proposition, we point to recent studies in the alliance literature that suggest the existence of a complementary relationship between formal and relational governance. We also identify studies in the new product development literature that seem to support this argument. Subsequently, we provide two strategies to achieve a balance between formal and relational governance in explorative R&D alliances.

Formal and relational governance as complements rather than substitutes. Until now, we assumed that relational governance is effective to the extent that it reduces the need for formal governance. The assumption that formal and relational governance are substitutes is present in most of the alliance literature (e.g. Gulati 1995; Larson 1992; Macaulay 1963; Malhorta/Murnighan 2002). The main logic is that relational governance lowers transaction costs and facilitates adaptive responses, making formal governance obsolete. Larson (1992), for example, found that, when relational controls were present, formal controls were pushed to the background. Other scholars also argue that, when formal governance is emphasized, the formation of relational governance will be undermined. Conducting experiments, Malhorta and Murnighan (2002) provided evidence that, when formal contracts are present, individuals are not able to make personal attributions to the collaboration, limiting the development of interpersonal trust. Similarly, Macaulay (1963: 64) argued that the presence of carefully

planned contracts 'indicates a lack of trust and blunts the demands of friendship, turning a cooperative venture into an antagonistic horse trade.'

Recently however, researchers (e.g. Luo 2002; Poppo/Zenger 2002) have argued that formal and relational governance mechanisms are complements instead of substitutes. Poppo and Zenger (2002), for instance, found that contract complexity, indicating the presence of formal governance, increases relational governance, which in turn increases exchange performance; and that greater relational governance appears to positively affect contractual complexity, which in turn increases exchange performance. These findings support the argument of Macneil (1978) that relational governance becomes a necessary complement to the adaptive limits of formal contracts by fostering continuance and bilateralism when change and conflict arise.

The argument that formal and relational governance mechanisms are complementary seems to be supported within the new product development literature. Studying innovation within the computer industry, Brown and Eisenhardt (1997), for instance, concluded that organizations, which established a balance between mechanistic and organic organizational structures, were the most performant in terms of innovation. These organizations implemented semi-structures in which some features are prescribed such as responsibilities, project priorities, and time intervals between projects, but others not such as design process and communication. Similarly, Kamoche and Pina e Cunha (2001) argued that the implementation of a minimal structure leads to a balance between structure and flexibility. Such minimal structure consists of a technical structure (i.e. quality specifications and performance standards) as well as a social structure (i.e. shared behavioral norms and communication mechanisms).

In sum, formal and relational governance may be complements rather than substitutes and a balance between them might manage the risk of opportunistic behavior and coordination costs without limiting exploration. Therefore, we propose:

Proposition 4: Balancing between formal and relational governance reduces risks of opportunistic behavior and coordination costs without limiting the exploration of new technological opportunities.

Strategies to create a balance between formal and relational governance. We now propose two strategies that, in our opinion, allow creating a balance between formal and relational governance within explorative R&D alliances. In most alliance studies, the formal function of contractual obligations is emphasized. According to these studies, contractual obligations, through specifying which tasks individuals have to perform and which outcomes should be achieved, facilitate the formal monitoring of interfirm collaboration. However, some scholars (e.g. Klein Woolthuis et al. 2005; Poppo/Zenger 2002) argued that contracts, which focus on the *process* of collaboration instead of the *content* of collaboration, may also have a relational function to the extent that they stimulate processes leading to the emergence of relational governance. Studying a successful explorative R&D alliance, Chouchman and Fulop (2001), for instance, identified the presence of contractual obligations, which did not specify the content of the collaboration but rather stipulated that intellectual property was jointly owned by the partners and that information should be freely shared between the partners. According to the authors, these contractual clauses did stimulate extensive information shar-

ing between the partners. Dyer and Nobeoka (2000), who studied the knowledge-sharing network between Toyota and its suppliers, came to a similar finding. They noticed that the definition of 'reciprocal knowledge sharing rules' not only reduced the free rider problem but also facilitated the emergence of trustful relationships between the suppliers. Consequently, we argue that contractual obligations, that stress the importance of extensive information sharing within the collaboration, not only have a formal function (i.e. monitoring of the collaboration) but also have a relational function (i.e. building of goodwill trust between the partners).

Proposition 5: Contractual obligations that define a collaborative process, characterized by intensive information sharing between the partners, create a balance between formal and relational governance.

A second strategy we would like to bring forward is the complementary use of formal organizational mechanisms with relational governance mechanisms. In the same study of Couchman and Fulop (2001) two formal organizational mechanisms were identified to govern explorative R&D alliances: 1) a contract book, and 2) a steering committee. In the contract book, each partner expressed its commitment to the overall project goals.[8] The steering committee, with representatives from all partners, monitored whether all parties respected these commitments. Couchman and Fulop (2001) themselves talk about a 'disciplined approach' which guarantees a sound footing of the collaboration project.

These formal governance mechanisms were however complemented by participatory decision making and networking activities, previously identified as meaningful mechanisms within interfirm collaboration to facilitate relational governance[9] (Fryxell et al. 2002; Das /Teng 2001). The contract book, which defined in detail the project goals and the plan of action, was created through extensive involvement of the operational team members of the different partners. This participatory decision making made engineers together with management responsible for setting and achieving the objectives of the collaboration. The formalization of the overall objectives was consequently not top-down implemented, but emerged through a bottom-up process, facilitating goodwill trust and interfirm routines to emerge.

In a similar vein, the steering committee, which monitored the overall progress of the collaboration, was complemented with intensive networking activities. In specific,

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8 Couchman and Fulop (2001) also mention that the contract book did not define the specific scientific and technological development activities of the different teams. Teams were themselves responsible of how they would achieve the mutually agreed project goals. In this way, these mutually agreed upon project goals did not hamper the carrying out of explorative activities.

9 Some researchers (e.g. Dyer/Singh, 1998; Poppo/Zenger, 2002; Ring/Van de Ven, 1992) refer to trust as a relational governance mechanism. However, following researchers such as Das and Teng (1998) and Rousseau et al. (1998) we want to apply a clear distinction between trust (i.e. a psychological state comprising the intention to accept vulnerability based upon positive expectations of the intentions or behavior of another, Rousseau et al. 1998: 395) and governance mechanisms (structural arrangements deployed to determine and influence what organizational members do, Fryxell et al. 2002: 868).

interpersonal interaction between the different partners was stimulated by installing a secure computer network, holding weekly teleconference meetings among the different teams, and organizing 6-monthly face-to-face project review meetings. As Couchman and Fulop (2001) describe these network practices as an opportunity for socialization across disciplinary and organizational boundaries, they are expected to facilitate the emergence of goodwill trust and interfirm routines.

Proposition 6: The complementary use of formal organizational mechanisms with participatory decision making and networking activities creates a balance between formal and relational governance.

Discussion

Our discussion covers a summary of the major theoretical insights developed, suggestions for empirical validation of the proposed alternative strategies, and an overview of the limitations of this theoretical study.

Summary of theoretical insights

In this paper, we have examined the governance process of explorative R&D alliances through applying insights from both the alliance and new product development literature. In this way, we followed the advice of Gerwin and Ferris (2004: 35) who argued that 'it is indispensable to draw upon both strategic alliance and new product development research for further study of organizing joint new product development projects'. Based on existing alliance studies that apply transaction cost theory and contingency theory perspectives, we identified considerable risks of opportunistic behavior and coordination costs as two main problems pertaining to explorative R&D alliances. These studies further argue that formal mechanisms are effective ways to address these issues and facilitate the collaboration process. However, relying on insights from the new product development literature, we started questioning the viability of such a formal governance process when the collaboration is geared towards exploration. The standardization and rigidity of behavior that result from formal mechanisms are likely to prevent explorative activities.

To further address the question of how to govern the collaboration process without preventing exploration, we proposed two alternative governance strategies that may be able to balance these two, often contradictory, requirements. These strategies are relying on embedded relationships in which heterogeneity is maintained and balancing between formal and relational governance. The first strategy refers to the advantage of collaborating with embedded partners whom are trusted and with whom interfirm routines have been developed. Collaboration with such partners however can reduce partners' heterogeneity, discouraging exploration. Sequencing between explorative R&D alliances and layering within explorative R&D alliances may allow sustaining sufficient levels of heterogeneity in skills, knowledge, and attitudes. The second strategy considers formal and relational governance as complements rather than substitutes, pointing to the possibility of contractual obligations as mechanisms to facilitate extensive information sharing and to combine formal mechanisms with relational practices such as participatory decision making and networking activities.

Suggestions for empirical research

Although the theoretical arguments point out the plausible nature of the two strategies suggested for the governance of explorative R&D alliances, important questions remain. For instance, only a limited amount of studies have addressed the issue of how embedded ties evolve over longer periods (Hoang/Antonic 2003). Similarly, there are no records of how combinations of formal and relational governance mechanisms evolve longitudinally. Empirical research on the proposed governance strategies is hence needed and, we would argue, should consider the following aspects: 1) a focus on the process dynamics of interfirm collaboration and 2) the inclusion of both managerial and operational levels in the analysis.

Longitudinal case-study analysis. Most research on collaboration in general that considered governance mechanisms has focused on which governance mechanisms are used (e.g. Dekker 2003; Gulati/Singh 1998) and what the performance effects of the governance mechanisms are (e.g. Deeds/Hill 1998; Fryxell et al. 2002; Poppo/Zenger 2002). Conducting cross-sectional data analyses, they tend to approach governance mechanisms as a static phenomenon (Reuer et al. 2002). Because we are interested in the evolution of governance mechanisms, we suggest longitudinal case-study research to assess the dynamic evolution of collaborative relationships.

Longitudinal case-study research however remains absent within the literature on interfirm collaboration, with a few notable exceptions (e.g. Ariño/de la Torre 1998; Doz 1996; Larson 1992). Recent research considering tensions within interfirm collaboration (e.g. Das/Teng 2000; de Rond/Bouchikhi 2004) suggests a dialectical approach towards studying processes of interfirm collaboration. Such a dialectical approach stresses that dialectical forces[10] compete for scarce resources and managerial attention, undermine organizational features, and thus help account for conflict and the production of emerging organizational arrangements (Van de Ven/Poole 1995). This approach may be useful for our research questions as we have stressed in this theoretical paper the tension between formal governance, reducing risks of opportunistic behavior and coordination costs, and relational governance, facilitating exploration.

Managerial and operational levels. A second methodological issue is to include both managerial and operational levels in the analysis. Traditionally, scholars in the research domain of interfirm collaborations have mainly relied on the alliance managers as key informants (Currall/Inkpen 2000). In contrast, the team members, entrusted with the operational activities of the collaboration, have been much less involved in this kind of research (Oliver/Roos 2002). We assume that, especially within explorative R&D alliances, these operational team members (i.e. R&D personnel of the different partners) will determine to a large extent the effectiveness of the collaboration. After all, these people will have to conduct the explorative activities, necessary to bring along new technologies. Therefore, we argue that, when we want to understand the condi-

[10] Das and Teng (2000) identified three key pairs of competing forces within strategic alliances: cooperation versus competition, rigidity versus flexibility, and short-term versus long-term orientation.

tions for successful interfirm collaboration, which aims to explore new technologies, it is important to assess both management and operational levels.

Limitations

The theoretical insights are useful within its theoretical boundaries. While they are applicable to explorative R&D alliances, they may not be transferable to the context of exploitative R&D collaboration. Next to explorative R&D alliances, organizations are involved in exploitative R&D collaboration or collaboration used to leverage existing complementary assets (Koza/Lewin 1998). Exploitative R&D alliances, focusing on performance outcomes instead of learning objectives, are likely to differ form explorative R&D alliances in terms of governance. Because exploitative R&D collaboration is characterized by activities such as refinement, standardization and specialization (Koza/Lewin 1998; Rothaermel/Deeds 2004), one can expect that the use of formal control mechanisms is less problematic within such a setting. Similarly, Koza/Lewin (1998: 260) proposed that 'the greater the exploitation intent of an alliance, the greater the reliance on output control will be, while the greater the exploration intent of an alliance, the greater the reliance on behavior and process control will be'. Empirical testing of these differences between exploitative and explorative collaboration is however lacking, indicating a promising avenue for further research.

Conclusion

Organizations increasingly rely on explorative R&D alliances to develop new technological opportunities. As this collaboration form is a system that faces substantial complexity, it poses significant challenges on governing the interfirm relationship. Through relying on insights from both the alliance and new product development literature, we were able to improve our understanding of this governance process. It allowed us to question the effectiveness of formal governance mechanisms as well as to propose alternative strategies for the governance of explorative R&D alliances. The future research task to come is to empirically study the governance process of explorative R&D alliances. Longitudinal case-study research applying a dialectical approach may be especially relevant as it considers how different tensions, inherently present within explorative R&D alliances, influence how interfirm relationships are governed.

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