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The interplay of structural and relational governance in innovation alliances

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RESEARCH ARTICLE

Abstract

The present paper aims to extend the discussion in the governance literature about whether structural and relational governance mechanisms complement or substitute each other in innovation alliances. Where structural governance mechanisms refer to the division of tasks within the alliance and to upfront contractual and non-contractual input, output and risk-related agreements, relational governance mechanisms refer to trust, using informal norms and rules for coordination purposes. In innovation literature much attention has been paid to relational governance, which is expected to offer more of the flexibility needed for innovation than the regulations in structural governance that are perceived as rigid. However, the authors argue that the essential role of structural governance as a solid basis for creating trust, especially in alliances in which the partners do not know each other, is clearly underexposed in management literature. To fill this gap, a model conceptualizing the innovation alliance from inception to performance was tested using Partial Least Squares, employing a cross-sectional dataset of 94 innovation alliances in the Netherlands, Belgium, Germany and Austria. The results do indeed show the essential role of structural agreements in creating a platform for trust on which relational governance can strive, while a clear task division can help to reduce the complexity of the inter-organizational innovation process, by reducing the interdependency of the partners. Both structural mechanisms ease communication among the alliance partners, leading to a higher level of knowledge exchange, and ultimately leading to better alliance performance.

Keywords: strategic alliance, structural and relational governance

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1. Introduction

In order to remain competitive in a world of global competition a company must adapt to changing situations at an ever increasing speed. Product life cycles are shortening and require companies to innovate at ever shorter time intervals. 'The pressure to do more with less inexorably pushes […] companies to focus on their unique, hard to imitate and distinctive core competencies, continually nurturing and enhancing them, while abandoning those activities in which they do not possess distinctive competencies' (Hamel, 1996; see also Hamel and Heene, 1994; Omta and Van Rossum, 1999; Sanchez *et al*., 1996). At a single point in time, the innovation potential of a single company, based on its resources and core competencies, might be enough to face the competition. However, if the company's resources and capabilities need to be transformed to face the fast-changing business competition this process might take too long, and the new capabilities could be outdated by the time the change is completed. In such fast-changing circumstances a company might win the race by entering an innovation alliance, combining its own resources and capabilities with those of partner organizations. Therefore 'the capability of building and maintaining inter-organizational network relationships, such as joint ventures, license agreements, supplier customer partnerships and strategic alliances is increasingly viewed as key to sustained competitive advantage' (Omta and Van Rossum, 1999). In addition, several empirical studies suggest that 'open' innovation (Chesbrough *et al*., 2008), i.e. cooperating with other organizations in the innovation process, provides a greater innovation potential than closed (in-house) innovation (Batterink, 2009; Christensen *et al*., 2005; Dittrich and Duysters, 2007; Fetterhoff and Voelkel, 2006).

But there is also a downside to the new interconnectivity of firms. Companies are afraid of becoming more vulnerable,

due to greater dependency on external innovation sources (Jonash, 1996; Millson *et al.*, 1996), while connecting to one or a limited number of alliance partner(s) may exclude access to others. There are a range of critical issues that play a role in a strategic alliance: Which company contributes what; how high are the coordination costs; is the exchange of knowledge symmetrical enough (problem of outlearning the partner, Hamel, 1991); and which company benefits most from the results (Farr and Fischer, 1992). The conclusion may be that open innovation is not a self-evident choice. Instead the decision boils down to the managerial question: Is there a balance between the potential benefits of open innovation and the potential risks and the additional coordination costs? To achieve this balance, different governance mechanisms can be used. In contrast to the possibility of the occurrence of inter-organizational collaboration problems, not many studies are directed at the governance mechanisms to control for them. Moreover, there is far less research being conducted into the necessary interplay between the structural and relational governance mechanisms.

The present paper aims to extend the discussion in the governance literature about whether structural and relational governance mechanisms complement or substitute each other in innovation alliances. Structural governance mechanisms refer to formal agreements that are often written down in contracts (Zenger *et al.*, 2002), and are conceptualized in our paper as the division of tasks within the alliance, and to upfront contractual and non-contractual input, output and risk-related agreements. Relational governance mechanisms are based on trust, using informal norms and rules indicating how decision rights, ownership rights and rewards are distributed among the alliance partners. In innovation literature much attention has been paid to relational governance, which is expected to offer more of the flexibility needed for innovation than the regulations in structural governance that are perceived as rigid. Therefore, relational governance is seen to substitute rather than complement structural governance in innovation literature (Adler, 2001; Dyer and Singh, 1998; Gulati, 1995; Larson, 1992). However, following Poppo and Zenger (2002) and Tepic *et al.* (2011), we challenge this assumption and argue that structural and relational governance complement rather than substitute each other. We argue that the role of structural governance in providing a solid basis for creating trust, especially in alliances in which the partners do not know each other, is clearly underexposed. To fill this gap, a model conceptualizing the innovation alliance from inception to performance was tested using partial least squares (PLS), employing a cross-sectional dataset of 94 innovation alliances in the Netherlands, Belgium, Germany and Austria.

The remainder of this paper is organized as follows. Section 2 provides the conceptual model. In this model the different concepts are structured to the phase in the alliance process, the alliance potential, formalization, execution and performance phase. Section 3 discusses the research methods, the operationalization of the constructs and the methods of data collection and data analysis are presented. Section 4 presents the research results and starts with the baseline description of the participating companies and their alliances. The data are then analysed using partial least squares, comparing the theoretically expected model with the empirically revealed model. Finally, in Section 5 the conclusions are discussed, suggestions for further research are presented and recommendations for practitioners are made.

2. Conceptual model

Since the 1980s strategic alliances are increasingly being used by organizations to innovate (De Man and Duysters, 2005). In the 'open' innovation literature in particular (Chesbrough *et al.*, 2008), strategic alliances are advocated as important vehicles to gain access to external resources and knowledge in order to innovate in a more cost- and time-efficient way. Gulati (1998) defines a strategic alliance, as voluntary arrangements between firms involving exchange, sharing, or co-development of products, technologies or services. De Man and Duysters (2005) define it as 'cooperative agreements in which two or more separate organizations team up in order to share reciprocal inputs while maintaining their own corporate identities'. And Hamel (1991: 100) emphasizes that in an alliance 'access to people, facilities, documents, and other forms of knowledge is traded between partners in an on-going process of collaborative exchange'. Taking from these three definitions, we define an innovation alliance as a cooperative agreement between two or more parties with the aim of innovating, based on an ongoing collaborative exchange, in order to develop new knowledge, products and processes, while maintaining their corporate identity.

Based on the structural and relational perspective several factors that are expected to play a role in an innovation alliance and their assumed relationships are presented in the conceptual model in Figure 1. In this model, the Resource Based View (RBV), which regards the formation of an innovation alliance as an attempt to build a unique set of resources that provide competitive advantage to the partners (Dyer and Singh, 1998), is used to conceptualize

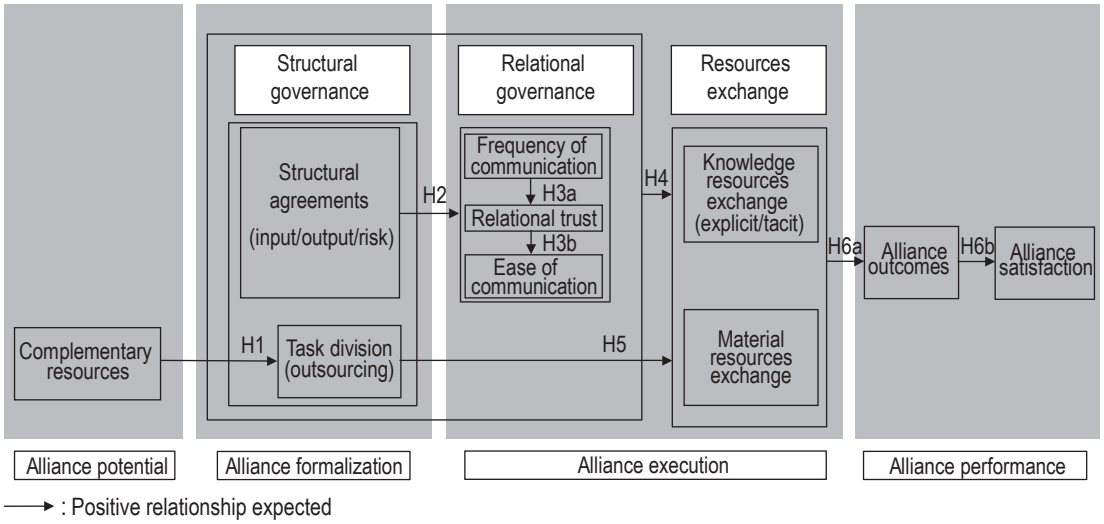

Figure 1. The conceptual model.

the alliance potential, while the Knowledge Based View (KBV) as an extension of the RBV will be used to assess the knowledge exchange aspect. The interdependency theory is used to discuss the possible consequences of a high degree of interdependency in strategic alliances (Lazzarini *et al.*, 2001). Building on these theories, the conceptual model shows the different constructs, according to their impact on the different phases in the alliance collaboration process, the alliance potential, formalization, execution and performance phase.

Alliance potential phase

In the 'alliance potential' phase preceding the actual start of an alliance, potential partners have to be identified. We define alliance potential as the innovation possibilities originating from the total set of resources available to the partners engaging in an alliance. Each potential partner not only has its own distinct set of material and immaterial resources, but may also have different expectations as to what it might gain from the alliance. The decisions made in the selection process set the stage for the alliance, and together determine the alliance potential. Based on the relevant literature (see below) we identified the complementarity of the resources as an important factor determining the potential of an alliance.

Resource complementarity

Each potential partner has its own distinct set of material and immaterial resources. The decision has to be made whether to search for partners with similar (De Man and Duysters, 2005) or complementary resources. By combining similar resources, the achievement of economies of scale and scope can be expected (Ansoff, 1965), whereas in an alliance with a partner that has complementary resources, synergy effects might be obtained (Harrison *et al.*, 2001). According to RBV, alliances can be considered as tools to create new unique sets of resources that enable the partnering firms to (partly) overcome the immobility problem of certain resources. It is therefore assumed that the potential of an alliance will be positively influenced by the level of complementarity of the resources that are brought to the alliance by the partnering organizations. Complementary resources provide learning opportunities and allow the creation of new capabilities (Harrison, 2001). Harrison *et al.* (2001) proved that, besides their importance in acquisitions, complementary resources play a major positive role in strategic alliances (see also Sarkar *et al.*, 2001). Chesbrough (2006) also stresses the importance of complementary resources in open innovation projects.

However, to be complementary, resources have to be different. This means that partners work in different research areas, use different technologies and possess different expertise. In turn this requires the ability to understand each other's knowledge contribution. Cohen and Levinthal (1990) point to the importance of absorptive capacity, defined as: a company's capability to recognize the value of new information; its ability to assimilate it; and its capacity to use it for commercial ends. Absorptive capacity in an alliance is dependent on pre-alliance knowledge overlap (Dyer and Singh, 1998; Mowery *et al.*, 1996) and further assumed to be influenced by interaction routines between

the partners (Dyer and Singh, 1998). Taking into account the value of newness and the absorptive capacity needed to capture it, there is then an optimal level of complementarity to be expected (Nooteboom *et al*., 2007; Schoenmakers and Duysters, 2006). So a higher level of complementarity is a necessary but not a sufficient condition for achieving a higher alliance performance.

Alliance formalization phase

After the alliance partner has been selected, the conditions of the partnership have to be negotiated in order to execute the alliance collaboration and to exchange knowledge (Easterby-Smith *et al*., 2008). The alliance formalization stage is about determining how to execute the alliance, either as a formal or informal partnership and deciding upon the interdependence level of the partnership.

Task division

Thompson (1967) distinguishes three types of interdependence: pooled, sequential and reciprocal. He indicates that pooled interdependence constitutes the lowest level of interdependence; then comes sequential interdependence; while reciprocal interdependence is placed at the highest level of interdependence between partners. Lazzarini *et al*. (2001) refer to strategic alliances as an example of reciprocal interdependence, so in the present paper innovation alliances are considered to have a high interdependency level. In interdependence literature a distinction is also made between task, goal and reward interdependence (Van Vijfeijken *et al*., 2002; Wageman and Baker, 1997). While Sambasivan *et al*. (2011) found a positive relationship in an alliance between level of interdependence and trust, commitment and communication, at least for task interdependence negative effects have also been reported due to the increased contingencies that have to be managed (Victor and Blackburn, 1987). Higher task uncertainty in an innovation alliance means that impersonal coordination mechanisms frequently fail (Van de Ven *et al*., 1976), while the coordination costs might also increase with higher task interdependence, due to the need for a higher number of interaction moments. A lower level of task division in an innovation alliance might therefore imply that too much of a company's resources (specifically the staff working hours) have to be spent on coordinating the activities between partners. Consequently, an optimal level of task interdependency can be expected to develop a new product or process at a reasonable speed and efficiency. In cases of (too) high task interdependence an attempt should be made to reduce the level of interdependence by dividing more tasks. Since innovation alliances can be assumed to show a high level of complementarity to make optimal use of a company's core competences and to save its scarce resources (Batterink, 2009), it can be expected that companies that are able to divide tasks in such a way as to lower the level of task interdependence will have increased the alliance potential. Therefore, it can be hypothesized:

Hypothesis 1: In a successful innovation alliance a larger complementarity of material and immaterial resources will be positively related to a higher level of task division.

Structural agreements

There are two dimensions that determine the power of structural agreements. Firstly, to what extent and in what detail were the structural aspects of the alliance discussed among the partners and agreed upon (non-contractual agreements). Secondly, to what extent are they included in a formal alliance contract (contractual agreements) that could be used in a court case (Grandori and Furlotti, 2010) to decide who owes what to whom, or in case of results who is the owner of the results. This corresponds to what Tepic *et al*. (2011) define as the formalization level of an alliance, which they conclude is necessary to stabilize a heterogeneous innovation network. Also non-contractual (or extra-contractual) agreements can be used to clarify the interest based incentives, bringing rational commitment and structure to the collaboration (Tepic, 2012; Tepic *et al*., 2011). At the same time they allow for flexible adjustments (Tepic *et al*., 2011).

Gulati (2007) provides a categorization of structural agreements that is reduced to input, output and risk-related agreements in the present paper. When entering an alliance it has to be clarified what to invest in the alliance, what to expect in terms of outcomes and which risks should be covered. Input agreements may structure working hours' contributions, who is supposed to tackle which tasks, but also who pays for what. Output agreements may include the deliverables and future intellectual property that is expected as a result of the alliance (see e.g. Chiesa and Manzini, 1998; Omta and Van Rossum, 1999). Last but not least, there is also the chance of alliance collaboration problems for unforeseen reasons. This could include conflicts among the cooperating partners, but also conflicts based on external factors, such as the bankruptcy of a partner that could cause the termination of the alliance. These eventualities can be covered by risk-related agreements.

Alliance execution phase

During the alliance execution phase, material and (explicit and tacit) knowledge resources have to be exchanged among the partners to develop new products and processes. In the present paper the following relational governance elements were identified as essential for facilitating the resource exchange: relational trust and communication (frequency and ease).

Relational trust and communication

Relational governance is based on repeated interaction (Dekker, 2004; Granovetter, 1985; Poppo and Zenger, 2002). A key concept in the relational view of governance is trust (Tepic *et al*., 2011). Relational trust includes positive expectations of the trustee's intentions. (Ring and Van de Ven, 1992; Rousseau *et al*., 1998). It builds on past experience with an alliance partner or, if no past experience exists, on the experience with the partner that is accumulated during the alliance execution phase. Relational trust is therefore operationalized in the present paper by the extent to which the alliance partner did what he promised, the extent to which opportunistic behaviour occurred during the alliance collaboration and in how far misalignments of the various contributions were a problem.

The commitment to an alliance is positively related to the learning intent of the partner firms (Wu and Cavusgil, 2006), which is in turn expected to be positively related to the communication frequency among the alliance partners in terms of face-to-face, telephone and e-mail contact. A higher communication frequency is assumed to build relational trust and preserves it by providing clarification possibilities in cases of misunderstanding. To communicate frequently, sending all relevant memo's and team reports helps in creating a climate of trust (Omta and Van Rossum, 1999). However, whether a higher communication frequency will lead to a higher level of inter-organizational learning will depend on the ease of communication, whether it is easy to get in contact with those that possess the targeted knowledge. If there is a high risk perception concerning the leaking of confidential information, a high communication frequency does not necessarily lead to the exchange of key information, since people will hold back what they are afraid of losing. Clear upfront contractual and non-contractual agreements can reassure each alliance partner that the other(s) will not act opportunistically. In line with this reasoning, Tepic *et al*. (2010) found no transition from structural to relational governance mechanisms in less successful projects. Therefore, it is hypothesized:

Hypothesis 2: In a successful innovation alliance structural (contractual and non-contractual) agreements are needed to provide an assurance platform on which relational governance mechanisms can strive.

And:

Hypothesis 3: In a successful innovation alliance the frequency of communication will be positively related to relational trust (3a), while the increasing relational trust will ease the communication among the alliance partners (3b).

Knowledge resources exchange (explicit and tacit)

In KBV a distinction is made between knowledge creation, transfer and application, while all three processes are regarded as interrelated (Harryson *et al*., 2008; Meier, 2011). A distinction is also made between inter- and intra-organizational knowledge exchange (Van Wijk *et al*., 2008). In an innovation alliance both types of knowledge exchange are considered key elements of the collaboration process (see e.g. Grant and Baden-Fuller, 2003; Nooteboom, 2000). Knowledge exchange (also called 'knowledge transfer') is defined as the transmission process through which knowledge is transferred within or across firm boundaries (Collins and Hitt, 2006; Meier, 2011), while different phases of knowledge exchange are distinguished (Easterby-Smith *et al*., 2008; Harryson *et al*., 2008; Van Wijk *et al*., 2008). Nonaka (1994) identifies two forms of knowledge: explicit and tacit knowledge; and four ways in which knowledge can be exchanged: from explicit to explicit, from explicit to tacit, from tacit to explicit, and from tacit to tacit. In an innovation alliance tacit knowledge transfer is regarded as the most difficult, since it is: (1) non-verbalizable, context specific and personally bounded; and (2) alliance partners are reluctant to transfer such knowledge freely to the alliance partner, as it is perceived as particularly valuable (Meier, 2011). While explicit knowledge is stored in codified form and can be exchanged through documents, the transfer of tacit knowledge requires human interaction, i.e. through shared experience (Nonaka, 1994). Nonaka and Von Krogh (2009) therefore recommend human resource exchange as an effective way to transfer knowledge because it implies a flow of information comprising both tacit and explicit knowledge. Ambiguity of knowledge provides an additional burden (Van Wijk *et al*., 2008) that only human interaction can resolve. The operationalization of knowledge exchange in the present paper builds on the level of information exchange between the partners, as a measure of the explicit knowledge exchange, and on the level of human resource exchange, as a proxy for the tacit knowledge exchange. Faems *et al*. (2007) show in their case study that governance

mechanisms can indeed initiate knowledge exchange. We go a step further by suggesting that it is the structural governance mechanisms in particular that provide the platform for relational governance in innovation alliances, and that the combination makes optimal knowledge exchange in an innovation alliance possible. This leads us to the following hypothesis:

Hypothesis 4: In a successful innovation alliance the combination of structural and relational governance mechanisms will be positively related to knowledge resources exchange.

Material resources exchange

While the level of communication in an alliance provides the necessary flow of knowledge there can also be a need to exchange material resources to innovate in a time- and cost-efficient way. This might include the exchange of specific laboratory equipment and/or technological tools that one of the partners provides to the other partner(s) in the alliance. This might apply even more if there is a high complementarity not only in terms of knowledge but also in terms of equipment and tools. Following the idea behind task division in an alliance, to make best use of the scarce resources, material resources should be exchanged, or at least shared. Within an alliance, expensive tools and equipment that an alliance partner can provide should not be purchased. Depending on how difficult it is for the alliance partner(s) to use these tools and equipment, a knowledge resources exchange might also be needed. If we relate this back to the level of task division in an alliance to make most efficient use of a company's resources, it can be hypothesized:

Hypothesis 5: A higher level of task division will allow enhanced resources exchange in the alliance collaboration process.

Alliance performance phase

Performance can be assessed at the innovation process level (innovative performance) and at the industrial outcome level (industrial performance; Omta and De Leeuw, 1997). Since the present study focuses on innovation alliances, we are looking at performance at the alliance level. Alliance performance in the present paper therefore focuses on the output resulting from the collaboration. The output focus lies on the extent to which the alliance resulted in new products and processes (alliance outcomes) and takes into account the satisfaction of the alliance partners.

Alliance outcomes and satisfaction

Hamel (1991) distinguishes between value creation and value appropriation in an alliance. The alliance outcomes represent the value created due to the alliance. In the present paper, alliance outcomes are measured by the extent to which new products, processes and knowledge were developed as a result of the alliance. The value appropriation (Hamel, 1991) within an alliance is difficult to measure directly. We assume that in cases where the value appropriation failed or where the alliance value created was not distributed according to the alliance contributions of the partners, a lower level of alliance satisfaction can be expected. Therefore, alliance satisfaction was used as a proxy to measure value appropriation within an alliance. Alliance satisfaction is operationalized by measuring to what extent the partners' objectives were achieved and by the willingness to cooperate again with the same partner(s). Knowledge and material resources have to be exchanged among the partners to create and appropriate value within an innovation alliance. Therefore we hypothesize:

Hypothesis 6: The level of (knowledge and material) resources exchange will be positively related to alliance outcomes (6a), whereas alliances outcomes will be positively related to alliance satisfaction (6b).

3. Research methods

For the present study a sample was composed of SMEs and large firms and a number of knowledge institutions mostly active in the green and pharma biotech sectors. An online questionnaire to collect the data was pretested in two stages before launching it to the selected companies. A first pretest was performed in 13 companies and one knowledge institution using face-to-face interviews to find out if the questions were understood correctly. A second pretest of the online questionnaire was conducted in 4 companies. The respondents filled in the online questionnaire, and then participated in a follow-up face-to-face interview a few days later to discuss their answers. After the two pretests confirmed the reliability of the questionnaire, the firms were contacted by e-mail, with a link to the online questionnaire. Eighty-eight firms filled in the questionnaire, of which 77 were selected to participate in this study. They reported about 94 alliances. The items to measure each construct are listed in Table 1.

PLS software[1] was used to model the alliance collaboration process and to test the hypotheses. PLS delivers construct

[1] www.smartpls.de.

scores, i.e. proxies of the constructs, which are measured by one or several indicators (Henseler *et al.*, 2009). PLS is a causal modelling approach, applicable in strategic management research (Hulland, 1999). PLS is similar to regression, but simultaneously models the structural path (i.e. theoretical relationship among constructs) and the measurement path (i.e. relationship between a construct and its indicators, (Chin *et al.*, 2003). The procedure enables the modelling of constructs and gives more accurate estimates of interaction effects between constructs, as it takes into account the measuring errors in the underlying indicators.

PLS shows the significant effects of the different constructs on each other, while every construct itself is reflected by its indicators (measures). With the help of PLS (a series of ordinary least squares) the constructs are estimated as linear combinations of its measures by maximizing the explained variance for the indicators and the constructs. As a result the construct is not only maximally correlated with its own set of indicators, but also with the other constructs, according to the structure of the PLS model (Chin *et al.*, 2003). Although PLS can be used for theory confirmation, it can also be used to suggest where relationships might or might not exist and to suggest propositions for later testing (Chin and Newsted, 1999). Marcoulides and Saunders (2006) warn researchers not to use PLS as a 'silver bullet' while Hair *et al.* (2011) specify under which conditions PLS might indeed be a silver bullet. The scaling, the number of cases and distribution of the data has to be taken into consideration when deciding whether or not to use PLS. In contrast to

Table 1. Operationalization of constructs.

Constructs		Average variance extracted	Composite reliability	R^2	Cross -loadings	Indicator questions operationalized using 7-point Likert scales from 1 (not at all) to 7 (to a very large extent) unless indicated differently behind the question
Resource complementarity		0.59	0.85	_*	0.85	To what extent did the most important partner in this alliance work on a different research area from your company?
					0.81	To what extent did the most important partner in this alliance possess a different expertise from your company?
					0.78	To what extent did the most important partner in this alliance use a different technology from your company?
					0.61	To what extent were there differences in equipment, technology, and knowledge that were complementary?
Task division		0.68	0.81	0.21	0.88	Activities were outsourced to the alliance partner because of: limitations of the technical equipment of our company.
					0.77	Activities were outsourced to the alliance partner because of: limitations of the technical competences of our company.
Structural governance						
Structural agreements	Input-related agreements	0.61	0.82	_	0.83	To what extent were agreements made about division of tasks at the beginning of the alliance?
					0.77	To what extent were agreements made about distribution of financial input at the beginning of the alliance?
					0.74	To what extent were agreements made about distribution of input from staff at the beginning of the alliance?
	Output-related agreements	0.62	0.83	_	0.89	To what extent were agreements made about deliverables per 'go / no go' moments at the beginning of the alliance?
					0.76	To what extent were agreements made about property rights of revenues/results at the beginning of the alliance?
					0.69	To what extent were agreements made about confidentiality at the beginning of the alliance?
	Risk-related agreements	0.83	0.91	_	0.94	To what extent were agreements made about procedures for resolution of conflicts at the beginning of the alliance?
					0.89	To what extent were agreements made about early termination of the cooperation at the beginning of the alliance?

Table 1. Continued

Constructs		Average variance extracted	Composite reliability	R^2	Cross -loadings	Indicator questions operationalized using 7-point Likert scales from 1 (not at all) to 7 (to a very large extent) unless indicated differently behind the question
Relational governance						
Relational trust		0.57	0.80	_	0.84	The most important partner always did what he promised.
					0.78	In the alliance opportunism was not a problem.
					0.63	In this alliance the alignment of the various contributions was not a problem.
Communication	Frequency of communication	0.64	0.84	0.07	0.92	How often did you have telephone contact with the most important partner? 1=once per year or less, 2=once every 6 months, 3=once per quarter, 4=monthly, 5=once every two weeks, 6=weekly, 7=more than once per week
					0.90	How often did you have e-mail contact with the most important partner? 1=once per year or less, 2=once every 6 months, 3=once per quarter, 4=monthly, 5=once every two weeks, 6=weekly, 7=more than once per week
					0.51	How often did you have face-to-face contact with the most important partner? 1=once per year or less, 2=once every 6 months, 3=once per quarter, 4=monthly, 5=once every two weeks, 6=weekly, 7=more than once per week
	Ease of communication	0.55	0.71	0.19	0.85	It was very easy to speak with everyone you needed to, regardless of rank or position.
					0.62	The risk of leaking out confidential information was... (1=very large to 7=very small)
Resources exchange						
Material resources exchange		1	1	0.21	1	The most important partner supported us by delivering equipment and tools.
Knowledge resources exchange	Explicit knowledge exchange	0.86	0.93	0.50	0.96	The most important partner gave us the information we asked for.
					0.90	We gave our most important partner the information he asked for.
	Tacit knowledge exchange	0.68	0.81	0.11	0.92	Exchange of human resources was important in this alliance.
					0.73	Was there an exchange of employees to work in each other's company?
Alliance performance						
Alliance outcomes		0.60	0.86	0.44	0.83	This alliance resulted in synergy.
					0.79	This alliance has developed new knowledge.
					0.76	This alliance has developed new products.
					0.72	This alliance has developed new processes.
Alliance satisfaction		0.82	0.90	0.69	0.92	In a new project I would prefer to work with the most important partner again.
					0.89	In my opinion, the goals we had in mind with this alliance were achieved.

* For the independent constructs, with no predicting constructs, no R^2 can be calculated.

LISREL, PLS can deal with small samples, depending on the complexity of the model and the size of the effects to be detected (Chin and Newsted, 1999), and doesn't require a normal distribution of the data (Chin *et al.*, 2003). With 94 alliances, in the present study the necessary condition that the number of cases at least exceeds the number of indicators (Haenlein and Kaplan, 2004) was met. The significance of the interaction effects uncovered with PLS was tested with bootstrapping, a cross-validation method. It is a resampling procedure, which yields the same number of cases as in the original sample. As the bootstrapping is based on trial and error, it gives slightly different results every time it is used for the same model. The number of resamples was chosen to be 1000, exceeding the minimum 200 indicated by Chatelin *et al.* (2002).

Before testing the conceptual model with PLS the dataset was analysed for possible differences between respondent groups, employing the Man Whitney U Test. In the baseline description a number of significant differences (asymptotically, two-tailed, α=0.05) are discussed.

4. Results

Baseline description

In total, 77 respondents from companies and knowledge institutions provided answers on 94 innovation alliances; 17 respondents provided information about two alliances in which their company or knowledge institution was involved, and one respondent about three alliances of his organization. Information about 59 alliances was gathered from 49 respondents located in companies and knowledge institutions in the Netherlands; 25 alliances from 20 respondents of companies and knowledge institutions in Germany; 5 alliances from 4 respondents in Switzerland; 4 alliances from 3 respondents in Austria and 1 alliance from 1 respondent in Belgium. Information about 38 alliances was provided by respondents from green biotech companies, such as plant breeding, breeding support, crop protection companies; 14 alliances by respondents from pharma biotech companies, 28 by food (processing) companies and 14 by respondents from other high-tech sectors such as nano-electronics and embedded systems. In 64 alliances the respondent came from a SME, 21 alliance questionnaires were answered by large companies and in nine cases the respondents came from a knowledge institution.

In more than 50% of the cases more than 2 companies were involved in the alliance. Knowledge institutions were mentioned as the most important alliance partner in 24% of the cases. These alliances were characterized by the fact that on average more organizations were involved (6.2 on average), compared to 3 organizations in alliances where a company was the most important alliance partner. About half of the alliances are located in different clusters or cluster-like set-ups, such as incubator centres, university campuses or business parks (Table 2). Most of the alliances had a long history, 35% were older than 5 years and nearly half of the alliances (46%) were between 3 and 5 years old. Only 16% of the alliances were younger than 3 years old.

Respondents from companies located in clusters reported the highest frequency of telephone contacts with their most important alliance partner, while respondents from companies located in bioscience parks or university campuses indicated that it was easy to talk to anyone regardless of rank and position within their alliance. Moreover, in alliances with knowledge institutions as the most important alliance partner it was stated that it was easy

Table 2. Demographics of the respondents (n=77) and the alliances (n=94).

	Organization	Alliances
Bioscience parks, university campuses[1]	19	25
Clusters[2]	15	21
Not located in bioscience parks or related to clusters	43	48
Total	77	94

[1] Leiden Bioscience Park, Utrecht Science Park, Amsterdam Science Park, Maastricht Biopartner Center, Eindhoven TU, Agro Business Park Wageningen, Biopartner Center Wageningen, NXP Noviotech Campus Nijmegen, Biopark Regensburg, BioPharmPark Dessau, BioTechnikum Greifswald, Frankfurt Biotechnology Innovation Center (FIZ), Universitaetsklinikum Magdeburg, Zenit Technology Park Magdeburg, Ghent University Campus.
[2] Food Valley NL, Health Valley, Seed Valley, Amsterdam BioMed Cluster, Cluster Ernährung, Munich Biotech Cluster, BMD Life Sciences Agentur Sachsen Anhalt Cluster, BioCon Valley Mecklenburg-Vorpommern.

to talk to anyone in the partner organization, regardless of rank and position.

Respondents from SMEs reported on average a higher resource complementarity than the respondents from the large companies. This could be explained by the fact that SMEs cover a smaller material and knowledge resource field than big companies that are assumed to have rather a large spread of expertise due to the number and diversity of employees. The SMEs also indicated a lower level of upfront agreements but a higher level of synergy achieved per alliance. In addition, it is worth mentioning that in the perception of the SME respondents the results of the alliances are on average slightly (at a one-tailed level) better than the ones reported by respondents from the large companies concerning all performance measures.

Upfront agreements about property rights and revenues were mainly made in the green biotech company alliances. In the pharma biotech company alliances the opportunism level was lowest, it was easiest to talk to anyone and the willingness to collaborate in a new project was the highest.

Measurement model

Cross-loadings between the indicators and the constructs were checked to measure individual item reliability. Every indicator should have a cross-loading higher than 0.4, while higher than 0.7 is desirable, and indicators to which the constructs are not connected should not show higher cross-loadings than those to which they are connected (Hulland, 1999). Table 1 shows that the cross-loadings of the indicators fulfil these requirements.

To assess the convergent validity of the measurement model a choice can be made between Cronbach's alpha and the composite reliability, as developed by Fornell and Larcker (1981). Nunnally *et al*. (1978) suggests 0.7 as a benchmark and according to Hulland (1999) it can be used as a cut-off point for both measures. As Cronbach's alpha tends to underestimate the internal consistency in PLS path models (Henseler *et al*., 2009), the composite reliability was used to measure the convergent validity of the constructs. All Composite Reliability scores were above 0.7 (Table 1).

The traditional methodological complement to convergent validity is discriminant validity, which represents the extent to which measures of a construct differ from measures of other constructs in the same model (Hulland, 1999). By making use of the variance the construct shares with its indicators, compared to the variance it shares with the other constructs, the discriminant validity can be assessed by using the AVE (i.e. the average variance shared between a construct and its measures). The square root of the AVE should be higher than the construct correlations. Furthermore, all AVEs should be above 0.5. Table 3 shows that both requirements are met.

Structural model

The extent to which the path coefficient can be trusted depends on the significance level, verified by the t-values (Huber *et al*., 2007), that are generated with the bootstrapping procedure. For our model all path coefficients are significant at least at α=0.05. The significance of the estimated coefficients in the structural model can be seen in the t-values of Table 4. The extent to which the endogenous constructs are explained by the exogenous constructs in the model can be determined on the basis of the R^2 values (Table 1), where R^2 values of 0.67, 0.33, and 0.19 (with regard to PLS path models) are seen as substantial, moderate, and weak, respectively (Chin, 1998). Because the model was specified based on our hypotheses before the data were collected, the sample data were used to test the hypothesis only, and not to determine the structure of the model itself. Consequently there was no need for further model validation (Kumar, 2010). Figure 2 provides an overview of the significant paths in the PLS model of innovation alliances (the path coefficients are provided in Appendix 1).

The results presented in Figure 2 show that all the hypotheses are confirmed by the empirical model, except Hypothesis 3a (Table 4).

Figure 2 shows that the resource complementarity is positively related to the level of task division within the alliance, which confirms Hypothesis 1. Resource complementarity is also positively related to material resources exchange. There is also a positive relationship between the level of task division and the material resources exchange. The knowledge resources exchange splits into two constructs, the explicit and the tacit knowledge exchange. The level of task division positively relates to tacit knowledge exchange, whereas tacit knowledge exchange is positively related to explicit knowledge exchange. Material resources exchange, explicit and tacit knowledge exchange and relational trust all show a direct and positive relationship with alliance performance in terms of alliance outcomes, which confirms Hypothesis 5 and 6a, while alliance outcomes and the relational trust in an alliance are directly and positively related to alliance satisfaction, confirming Hypothesis 6b.

Table 3. Correlation matrix.[a]

	1	2	3	4	5	6	7	8	9	10	11	12	13	√AVE
1	1													0.78
2	0.38**	1												0.93
3	0.16	0.17	1											0.91
4	0.12	-0.01	0.53**	1										0.80
5	0.11	-0.21*	0.32**	0.44**	1									0.74
6	0.16	0.09	0.09	0.01	-0.05	1								0.79
7	0.13	-0.07	-0.02	-0.27**	-0.03	0.10	1							0.83
8	-0.04	0.04	0.07	-0.12	-0.19	0.44**	0.12	1						0.75
9	0.30**	0.44**	-0.04	-0.04	-0.13	-0.08	0.19	-0.17	1					0.77
10	0.11	0.19	0.27**	0.04	-0.06	0.63**	0.18	0.43**	-0.05	1				1.00
11	0.17	0.25*	-0.05	-0.11	-0.05	0.11	0.19	0.01	0.46**	0.21*	1			0.78
12	0.29**	0.25*	0.11	-0.03	0.00	0.52**	0.22*	0.19	0.24*	0.49**	0.42**	1		0.83
13	0.16	0.07	-0.06	-0.14	-0.03	0.71**	0.24*	0.34**	0.03	0.55**	0.32**	0.73**	1	0.91
√AVE	0.78	0.93	0.91	0.80	0.74	0.79	0.83	0.75	0.77	1.00	0.78	0.83	0.91	

* Pearson correlation significance at α=0.05 level (two-tailed).
** Pearson correlation significance at α=0.01 level (two-tailed).
[a] 1 = Resource complementarity; 2 = Task division; 3 = Input-related agreements; 4 =Output-related agreements; 5 = Risk-related agreements; 6 = Relational trust; 7 = Frequency of communication; 8 = Ease of communication; 9 = Material resources exchange; 10 = Explicit knowledge transfer; 11 = Tacit knowledge exchange; 12 = Alliance outcomes; 13 = Alliance satisfaction.

Table 4. Confirmation of hypotheses.

Hypothesis 1: In a successful innovation alliance a higher level of complementarity of material and immaterial resources will be positively related to a higher level of task division.	H. 1: confirmed
Hypothesis 2: In a successful innovation alliance structural (contractual and non-contractual) agreements are needed to provide an assurance platform on which relational governance mechanisms can thrive.	
Hypothesis 3: In a successful innovation alliance the frequency of communication will be positively related to relational trust (3a), while the increasing relational trust will help to ease the communication among the alliance partners (3b).	H. 3a: not confirmed; H. 3b: confirmed
Hypothesis 4: In a successful innovation alliance the combination of structural and relational governance mechanisms will be positively related to knowledge resources exchange.	H. 4: confirmed
Hypothesis 5: A higher level of task division will allow enhanced resources exchange in the alliance collaboration.	H. 5: confirmed

The structural input related agreements positively relate to explicit knowledge exchange. Moreover, relational trust positively relates to explicit knowledge exchange, confirming Hypothesis 4. Communication is represented by two constructs: frequency and ease of communication. Relational trust positively relates to ease of communication, whereas the ease of communication in turn positively relates to explicit knowledge exchange, leading to higher

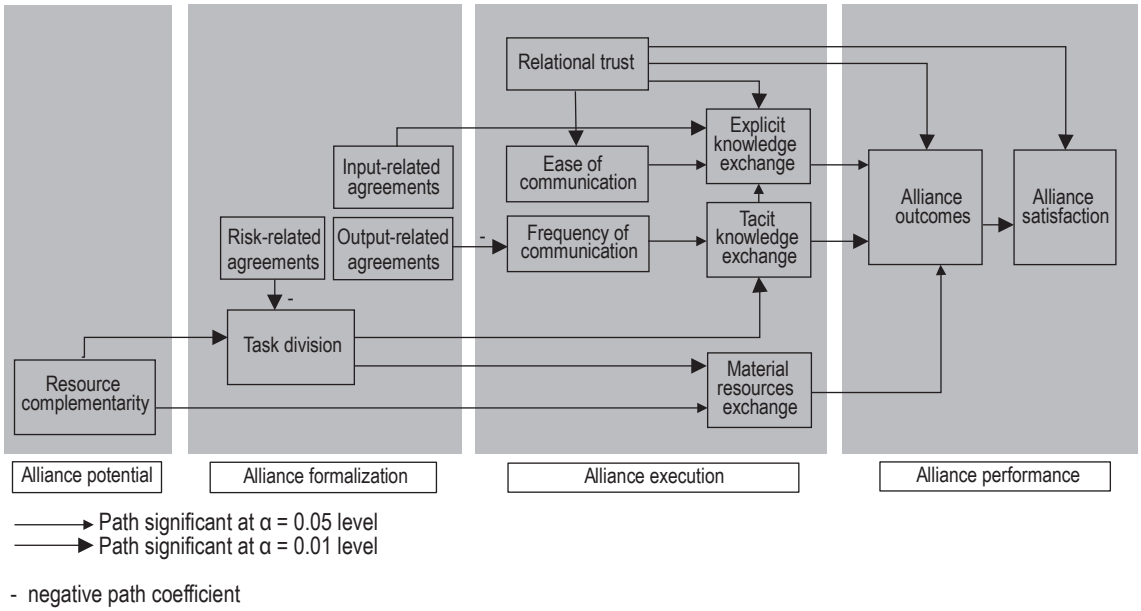

Figure 2. Significant paths in the PLS model of innovation alliances.

alliance performance, confirming Hypothesis 3b. No direct relationship between the frequency of communication and relational trust was found, which leaves Hypothesis 3a unconfirmed. The mediating effect of ease of communication on the positive relationship between relational trust and explicit knowledge exchange follows our argumentation in the theoretical framework. Better relational trust creates an ease of communication among the partners (and vice versa) leading to a higher level of (explicit) knowledge exchange.

There are two negative relationships found in the empirical model connected to the structural governance constructs output and risk-related agreements. The output-related agreements negatively relate to the frequency of communication. If we assume that the frequency of communication results on the one hand from the learning intent of the alliance partners, but on the other hand also from alliance coordination-related communication, then it can be argued that a higher level of output-related agreements reduces the need to re-negotiate during the alliance execution phase, which reduces the communication frequency. Or stated differently, if the communication channels are not exhausted by coordination-related communication, then there is more capacity to exchange learning-related content. The positive effect of communication frequency on tacit knowledge exchange is in line with this argumentation. Therefore we consider the negative relationship found between the output-related agreements and the frequency of communication as an approval of the hypothesized positive impact of structural governance mechanisms in terms of easing coordination during the alliance execution phase. The second negative relationship in the empirical model leads from the risk-related agreements to the level of task division. This connects to our theory part where a higher level of interdependency also connects to a higher alliance failure risk. With task division as a means to reduce the reciprocal interdependence in an innovation alliance, the negative connection can be explained by the argument that fewer risk-related agreements are needed in cases of reduced interdependency due to a higher level of task division. No further relationships where found between structural and relational governance constructs, which leaves Hypothesis 2 unconfirmed.

5. Discussion and conclusions

The present paper aims to analyse different stages in the innovation alliance collaboration process to identify the key factors influencing alliance performance. A higher alliance potential leads to a higher chance of positive alliance performance, especially if the structural governance mechanisms of a clear task division lower the level of interdependency in the alliance and allow an efficient use of a company's core resources. The best results are achieved if this is combined with clear up-front structural agreements in the alliance formalization phase to create a platform on which relational governance can thrive, easing coordination in the alliance execution phase, and thereby positively

influencing alliance performance. Relational trust facilitates communication among alliance partners and leads to a higher level of knowledge exchange. The communication level positively influences the knowledge exchange in an alliance. Frequent communication and shared codes are factors building trust (Omta and Van Rossum, 1999). A higher relational trust positively relates to alliance outcomes and ultimately to alliance satisfaction. Resources exchange, in terms of knowledge and material resources, can be regarded as the core of alliance execution. Trust is needed as a prerequisite for a higher level of communication. While communication frequency is not necessarily trust dependent, the ease of communication certainly is. If the doors to key contacts are locked, this limits alliance execution. Clear upfront agreements work to lower or even diminish the risk perception of the partners concerning the leaking of confidential information by providing assurance to each of the alliance partners that the other(s) will not act opportunistically. So structural governance mechanisms work as a door opener, allowing relational trust and a higher communication level, increasing knowledge exchange within an alliance.

The paper does not support the statement of De Man and Duysters (2005: 26) that 'alliances with similar companies have more potential for innovation'. Partners with a higher resource complementarity reported on average a higher alliance performance. This is in line with the findings of Keil *et al*. (2008), who compared intra-industry alliances with related industry and non-related industry alliances. Still, a higher level of complementarity of material and immaterial resources also means that knowledge exchange within the alliance is a greater challenge, and requires, in line with the findings of De Man and Duysters (2005), building up good alliance management capabilities. In this respect, the identification of the alliance formalization phase as a necessary stage in the alliance collaboration process preceding knowledge exchange, contributes to the research needs as indicated by Easterby-Smith *et al*. (2008) and Van Wijk *et al*. (2008). In this way the paper extends the findings of Poppo and Zenger (2002) by showing a limited substitutability between structural and relational governance mechanisms within innovation alliances. The exploratory case study findings of Tepic *et al*. (2013) concerning the role of structural and relational governance in innovation projects was empirically tested in our alliance collaboration model, and the important role of structural governance as a solid basis for creating trust, especially in alliances in which the partners do not know each other, was clearly shown.

We described an innovation alliance as a high (reciprocal) interdependence collaboration. Our results have shown that lowering the level of mutual interdependency by task division combined with a high level of resource exchange was positively related to alliance performance. As a result our findings challenge the conclusions of Sambasivan *et al*. (2011) who found a positive relationship between task interdependence and trust, commitment and communication. They are in line with those of Batterink (2009: 70) who found that a clear task division is a successful way to improve innovation performance in an innovation alliance, due to a more efficient use of alliance resources. The empirical test in our alliance collaboration model supports these findings of Batterink (2009). Our results are also in line with the findings of Victor and Blackburn (1987) who reported negative effects with increased interdependency due to the increased contingencies that have to be managed. In the literature (see e.g. Goh, 2002) frequent contact is are stressed to be important for knowledge exchange. We come to the same conclusion, since tacit knowledge transfer is positively related to communication frequency (by e-mail, telephone and face-to-face contacts).

A number of preliminary conclusions can be drawn from the group comparison. Knowledge institutions are chosen over companies for innovation alliances with a rather explorative character. The communication frequency and therefore probably also the collaboration interdependence is lower, while the communication lines are more open. As one of the interviewees remarked: 'When contacting a knowledge institution there are almost no restrictions on who to speak to'. The alliances by SMEs outperformed the alliances by big companies, although there were fewer upfront agreements and fewer people involved in the alliance collaboration. In addition, the resource complementarity with the alliance partner is greater for SMEs. SMEs clearly seem to transform this higher alliance potential effectively into a higher alliance value creation, which confirms the findings of other authors (see e.g. Nooteboom, 1994; Nooteboom and Vossen, 1995).

As far as the sector differences are concerned, it can be concluded that the green- and pharma-biotech use more structural governance mechanisms, make more upfront agreements, especially concerning intellectual property and use more technology mapping to keep track of it, than the nano-tech and food companies. At least for the pharma biotech it can be concluded that this results in lower opportunism and a higher willingness to cooperate with the same partner again. Therefore, the biotech sector seems to tackle the 'outlearn the partner problem'(Hamel, 1991) in a more systematic way than the other sectors, which could be related to the need to constantly engage in new alliances to continue innovation. Based on the significant group differences found, it can be further concluded that

knowledge valorisation has a more formal character in the biotech sector, while there is a tendency to a less formal approach when it comes to SMEs.

Scientific contributions

The innovation alliance collaboration model developed merges the insights gained from the resource/knowledge based view and governance perspective. As such it can be regarded as an extension of the alliance formation model developed by Chiesa and Manzini (1998) by implementing the findings concerning the impact of complementarity of resources (Nooteboom *et al.*, 2007) as well as the impact of interdependency (Thompson, 1967).

The findings of the present paper contribute to the controversy among authors suggesting a substitution possibility between structural and relational governance mechanisms in inter-organizational collaborations on the one hand (Adler, 2001; Dyer and Singh, 1998; Gulati, 1995; Larson, 1992), and authors that challenge the substitutability assumption on the other (e.g. Grandori, 2001; Gulati, 2007; Poppo and Zenger, 2002; Zheng *et al.*, 2008). Our findings clearly support the authors that challenge the substitutability assumption (see also Poppo and Zenger, 2002; Tepic *et al.*, 2011). But they go one step further by pointing to the essential role of structural governance mechanisms in creating a solid basis on which relational governance mechanisms can thrive, improving knowledge exchange that is especially important in alliances in which the partners do not know each other. This is in line with the findings of Dhanarag and Parkhe (2006) who also reported the positive effect of structural agreements on knowledge mobility. A positive effect of lowering the alliance interdependence due to task division was also shown.

Limitations and avenues for further research

Firstly, based on the empirically tested alliance collaboration model, it can be concluded that it is possible to develop an alliance collaboration model that displays the innovation alliance process at a higher abstraction level for the different respondent groups. However, it would be interesting to increase the number of respondents per group in order to be able to acquire more in-depth insights into the possible differences at group level (e.g. SMEs versus large companies, green versus pharma biotech). Secondly, the data we used to empirically test our hypotheses were collected at one 'moment-in-time'. It would be interesting to use longitudinal data to follow the different alliance collaboration phases. Thirdly, in the present study no clear distinction could be made between contractual and non-contractual agreements. Further research might involve capturing both dimensions to see how they relate to relational governance in the alliance collaboration.

Practical implications

Our findings firmly suggest that if innovation alliances are to be successful, companies should start by looking for partners that have complementary resources, in other words, companies offering something the company does not already possess. To make efficient use of these complementary resources a clear division of tasks between the alliance partners is needed. If companies do too many things together, this might create too large interdependencies that will be difficult to coordinate in the alliance execution phase. Managers should be aware of the important role of upfront structural agreements. Clear contractual and non-contractual up-front agreements create trust by lowering or even diminishing the risk of the leaking of confidential information. Following Omta and Van Rossum (1999) these structural agreements should codify at the very least:

- The financial and personal responsibilities of the partners.
- The division of the possible gains among the partners.
- The means of knowledge protection, including patent and trade secret rights and confidentiality agreements.
- Criteria for measuring and monitoring progress, so that deviations can be identified and potential problems can be overcome. This includes project milestones and deadlines, responsibilities and accountability of the project team and the founding of a steering committee.
- Penalty clauses to discourage opportunistic behaviour.

Even when starting with an alliance partner where relational trust already exists due to previous experience, structural governance mechanisms should be used to improve the coordination of activities throughout the alliance. As Omta and Van Rossum (1999) indicate, the partners should strive to achieve clear accountability through performance measures. A joint steering committee with enough authority should meet periodically to review goals and progress against schedules. This is very important, because it creates a feeling of urgency. In the home-companies of the partners there are always activities that seem more urgent then a collaborative project with a far-away partner. Strict deadlines do therefore help to prevent arrears and overrunning the budget. Only if these structural governance mechanisms have been properly implemented, can the alliance potential be fully exploited by building relational trust.

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Appendix 1. Significance of the estimated coefficients in the structural model.

			Path coefficient	T Statistics
Resource complementarity	--->	Task division	0.41	5.17[b]
Resource complementarity	--->	Material resources exchange	0.16	1.71[a]
Risk-related agreements	--->	Task division	-0.26	2.60[b]
Task division	--->	Tacit knowledge exchange	0.27	2.50[b]
Task division	--->	Material resources exchange	0.38	4.34[b]
Input-related agreements	--->	Explicit knowledge exchange	0.22	3.04[b]
Output-related agreements	--->	Frequency of communication	-0.27	2.70[b]
Frequency of communication	--->	Tacit knowledge exchange	0.21	1.67[a]
Relational trust	--->	Ease of communication	0.44	4.93[b]
Ease of communication	--->	Explicit knowledge exchange	0.19	2.12[a]
Relational trust	--->	Explicit knowledge transfer	0.51	5.97[b]
Relational trust	--->	Alliance outcomes	0.37	3.60[b]
Explicit knowledge transfer	--->	Alliance outcomes	0.21	2.13[a]
Tacit knowledge exchange	--->	Explicit knowledge exchange	0.17	2.19[a]
Tacit knowledge exchange	--->	Alliance outcomes	0.25	2.87[b]
Material resources exchange	--->	Alliance outcomes	0.17	1.91[a]
Relational trust	--->	Alliance satisfaction	0.46	6.90[b]
Alliance outcomes	--->	Alliance satisfaction	0.49	6.59[b]

[a] Path significant at α=0.05 level (one-tailed).
[b] Path significant at α=0.01 level (one-tailed).