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Abstract

Alliance researchers agree that the selection of development partners in terms of the distance between their knowledge bases is critical. However, research results differ concerning the most effective distance between development partners? knowledge bases. This paper strives for a more differentiated look at the knowledge base and, specifically, its content-related components. By drawing on theories of strategic alliances, innovation and knowledge-based view, we predict relations of knowledge distances of specific knowledge base components and innovation performance. We examined 53 development projects to determine the influence of development partners? knowledge distance on innovation performance, focusing specifically on content-related knowledge base components. The findings reveal differences and suggest considering the distances of knowledge base components separately for partner selection. We highlight the implications for researchers and managers.

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Distance between partners' knowledge base components

as an explanation of joint innovation performance

Alliance researchers agree that the selection of development partners in terms of the distance between their knowledge bases is critical. However, research results differ concerning the most effective distance between development partners' knowledge bases. This paper strives for a more differentiated look at the knowledge base and, specifically, its content-related components. By drawing on theories of strategic alliances, innovation and knowledge-based view, we predict relations of knowledge distances of specific knowledge base components and innovation performance. We examined 53 development projects to determine the influence of development partners' knowledge distance on innovation performance, focusing specifically on content-related knowledge base components. The findings reveal differences and suggest considering the distances of knowledge base components separately for partner selection. We highlight the implications for researchers and managers.

Keywords: Innovation; Development alliance; Knowledge base components; Knowledge distance; Absorptive capacity

In order to develop innovative products, firms often need to acquire knowledge that lies outside their core competencies (Cowan et al., 2009). The required knowledge can be attained quickly and easily by forming development alliances with other firms (Gulati, 1998; Faems et al., 2005; Grant et al., 1995; Grunwald et al., 2007). Specifically, firms' interaction with a dissimilar development partner can produce new knowledge that can be harnessed for innovation (Hargadon et al., 1997; Kanter, 1988; Leonard-Barton et al., 1998; Taylor et al., 2006). Alliance researchers agree that the selection of a development partner is critical with regard to the distance between their knowledge bases (e.g., Deeds et al., 1996; Gulati, 1995; Lane et al., 1998). Development partners' knowledge distance is determined by their respective knowledge bases in relation to those of the firm. The specific partner firm should have knowledge of this distance before entering into the alliance (Liyanage et al., 2003). Research results differ with regard to the most effective distance between development partners' knowledge bases (Rindfleisch et al., 2001).

Some researchers emphasize the necessity of choosing a development partner whose knowledge base is clearly different but complementary to one's own, in order to create innovative products (e.g., Nakamura et al., 1996). In line with this emphasis, knowledge base distance balances the costs-value ratio of an expensive development alliance, which results in great learning potentials, and enhances the opportunity of developing products with very high degrees of innovation (Kotabe et al., 1995). Furthermore, knowledge base distance prevents the alliance partner from absorbing of knowledge uninvited, which is important for protecting a firm's hard-earned market position (Baughn et al., 1997).

Contrary to these findings and arguments, there is empirical evidence for the value of development partners with very similar knowledge bases (i.e. a small knowledge base distance). Rindfleisch and Moorman (2001) find that redundant knowledge bases are the source of effective communications and actions, and therefore enhance new product creativity. In addition, a small knowledge base distance enables partners to identify the "intermediate learning "steps" between its present competence level and that of its partner" (Hamel, 1991, p. 97). Furthermore, Lane and Lubatkin (1998) argue that the ability to learn from each other depends on a small knowledge base distance between the development partners. They draw on absorptive capacity arguments to emphasize the need for similar knowledge bases that enable the partners to assess and absorb new knowledge into their existing business routines (Cohen et al., 1990). Consequently, new knowledge needs to relate to existing knowledge (Inkpen, 2000). Contrary to this argument, Ahuja and Katila (2001), and Laursen and Salter (2006) produce evidence indicating that a moderate knowledge base distance is most beneficial when attempting new product development jointly. These researchers agree with Cowan and Jonard (2009), Grant (1996), Simonin (1999), and Nooteboom (1999) by claiming that if partners are too close together, there is little point in sharing; if they are too far apart, they have difficulty in understanding each other, which makes sharing and recombining difficult.

While all of these studies add to our understanding of alliance partners' knowledge bases, none of them considers the specific contents of the knowledge bases – they do not differentiate between knowledge components. Another stream of research on collaborators' knowledge distance focuses on their technological knowledge (Cantwell et al., 2000; Liyanage et al., 2003; Mowery et al., 1998; Schoenmakers et al., 2006). These researchers find empirical evidence to support an inverted U-shaped relationship between knowledge base distance, knowledge integration, and innovation performance. Overall, they propose a moderate knowledge base distance. Table 1 provides an overview.

Place Table 1 about here

To summarize, conceptual and empirical findings on knowledge bases' optimal innovation distance are mixed. While researchers consistently find that a moderate distance between allied partners' technological knowledge is most beneficial for joint innovation, the results of studies that do not specify the knowledge components are inconsistent. We argue that these results indicate the need for a more differentiated look at the knowledge base, specifically its content-related components. Our study addresses this gap. In particular, we assume that, depending on the specific knowledge base components, there are dissimilar relationships between development partners' knowledge distance and innovation performance.

Consequently, we draw on strategic alliance theory, innovation theory, and the knowledge-based view of the firm. We develop a theoretical model and make predictions that relate specific knowledge base components' knowledge distance to product development partners' innovation performance (Cohen et al., 1990; Grant, 1996). We therefore seek to shed more light on the knowledge base and its components as important means of successfully integrating partners' knowledge for innovation purposes. We consequently aim to contribute to the emergent literature on partner selection (Emden et al., 2006), as knowledge distance seems to be of the utmost importance during alliance firms' selection process (Schoenmakers et al., 2006). Decisions can be made more effectively if there is a more differentiated perspective of the knowledge distance between potential development partners.

This paper is organized as follows: In the next section, we define innovation performance, as well as a firm's knowledge base, and describe knowledge base distance with respect to different knowledge base components. Based on the extant literature, we identify knowledge base components that are relevant for improving innovation performance through partnering with other firms. We then hypothesize the relationship between the degree of development of partners' knowledge distance per component, and innovation performance. In the fourth section, we test our hypotheses using data collected from 53 development alliances. These data were gathered in the automotive industry in the German speaking countries of Europe. We provide our empirical results in the fifth section. In the last section, we discuss our findings with regard to their implications for theory and management.

CONCEPTUAL BACKGROUND

Innovation performance

Hagedoorn (1993) states that the two basic motivations for creating development alliances are market and technology related. In this study, we thus define innovation performance as the degree to which the jointly developed product creates a novel customer benefit, improves the market position of at least one alliance partner (market dimension), and follows a technological principle that is new to the relevant unit of adoption (Dewar et al., 1986).

Knowledge base relevant for joint development

The extant literature has many references to a firm's knowledge base (e.g., Asheim et al., 2007; Corrocher et al., 2007; Escribano et al., 2009; Wolfe, 2007). Research into knowledge covers far-ranging spectrums of interest; Nonaka (2006), for instance, refers repeatedly to a company's knowledge base, while Cowan et al. (2009) examine the consequences of overlapping knowledge bases. Reich (2007) mentions a knowledge content taxonomy, but does not address this issue in depth, although she provides guidelines to successfully manage knowledge-based risk. Most researchers use the concept knowledge base without stating what they understand by it (e.g., Todorova et al., 2007). Escribano et al. (2009) define a firm's knowledge base as the "existing stock of knowledge […] which is embedded in its products, processes and people" (Escribano et al., 2009, p. 96), but does not specify the content.

However, according to the knowledge-based view of a firm, resources are required to show which firm has the more significant knowledge and to explain their competitive advantage value (Spender, 1996b). Spender (1996a) provides arguments underlining the importance of determining knowledge content for technology innovations. It may be very misleading if knowledge bases are understood as a mere inventory of generic knowledge resources with a broadly scoped content (Spender, 1996b), as this seems to imply almost "content-free" approaches to organizational knowledge (Spender et al., 1996c). However, "organizations imbue organizational knowledge with meaning" (King et al., 2003, p. 769). Consequently, we conform to the views of Liyanage and Barnard (2003), who argue that a firm's knowledge base comprises different content-specific components.

Thus, a more complete conceptualization of a knowledge base should incorporate heterogeneous taxonomic components that are important for development alliances, but that are independent of particular project objectives or partners' attitudes. In line with Faulkner and his colleagues (1994), we focus in greater detail on knowledge content. We strive to explicitly determine the specific components that are employed in joint development for our definition, and draw upon strategic alliance theory, innovation theory, and the knowledge-based view of the firm. Thereby, we identified two knowledge components relevant for allying partners.

Relevant components of the knowledge base: Partner-specific knowledge

Knowledge of each other's formal organizational structures, such as reciprocal regulatory approvals (Powers et al., 2010), causes less interpersonal tension, and allows partners to collaborate more smoothly. In turn, this enhances innovation performance. Hence, knowledge of these dimensions of an organization and of all organizational routines helps each partner to act efficiently in, or in conjunction with, the respective system (Spender, 1996).

While formal organizational structures are planned and stable for long periods, informal organizational structures are emergent and unplanned (Wang et al., 2003) and provide important context knowledge of actual organizational activities that "materialize only when esoteric experiential problem-solving knowledge is required. Once the problem is dealt with, they dissolve again, leaving hardly a trace upon the formal organization" (Rochlin, 1989, p. 161). Insufficient knowledge of the partners' informal organizational structures leads to more complex and time-consuming inquiries, and therefore, hampers innovation performance (Škerlavaj et al., 2010).

Furthermore, organizations are seen as cultural units (Brown et al., 1991) culture is a genuine societal level phenomenon, frequently described as values shared by its members (Cullen et al., 2004). It has particular characteristics, and includes the individual organizational population, organizational backgrounds, social norms, practices, rules, policies, etc. (e.g., Hofstede et al., 2005). In turn, these societal level properties influence individuals' attitudes and behaviors, as well as the functioning of small (e.g., teams) and large collectives (e.g., business organizations) within societies. Hence, knowledge of each other's organizational culture is indispensible for collaborating partners' innovation performance (Hurley, 1995; Koc, 2007). Consequently, we argue that partner-specific knowledge, comprising knowledge of the formal and informal organizational structures, as well as of organizational culture is a relevant knowledge base component for joint innovation performance.

Relevant components of the knowledge base: Project-specific knowledge

Many researchers agree on the importance of technological knowledge for innovation performance (Cantwell et al., 2000; Cohen et al., 1990; Faulkner, 1994; Liyanage et al., 2003; Mowery et al., 1998; Petersen et al., 2005; Schoenmakers et al., 2006). Technological knowledge consists of both scientific and practical experiences (e.g., Liyanage et al., 2003). In line with this, Spender (1996a), and McEvily and Chakravarthy (2002) address the importance of understanding how specific technology relates to other knowledge. Design literature distinguishes between the product as a whole system and parts of products (e.g., Marples, 1961; Nelson et al., 1982; Sanchez et al., 2002; Tushman et al., 1986). To ensure later integration of these product modules into the system development partners benefit from technological knowledge about the others' part (e.g., Baba et al., 1998; Sainter et al., 2000).

Moreover, knowledge of development processes is important to steer and coordinate the development project (Cooper, 1990). Processes form the guidelines that aid the firm in focusing, matching budget and time specifications, selecting relevant methods, tools, and approaches (Petersen et al., 2005; Ragatz et al., 1997), and in coordinating the development activities.

Knowledge of the partners' processes helps firms take the necessary steps to improve their joint innovation performance (Cooper, 1988; Crawford, 1984).

Development partners' knowledge distance

When firms enter development alliances, they seek to combine their knowledge for the purpose of developing an innovative product, software or process (e.g., Miotti et al., 2003). Before entering an alliance, the components of the firms' knowledge bases may include different pieces of knowledge and information. For example, while firm A possesses technological knowledge of sensors' reaction times, firm B's technological knowledge may include knowledge of real-time systems. Scholars recognize knowledge base distance as an important issue. Specifically, they believe that the distance between development partners' knowledge bases influences the likelihood of forming an alliance (Mowery et al., 1998), the value of integrating organizational structures (Grant, 1996), the degree of organizational learning (Baughn et al., 1997; Hamel, 1991; Inkpen, 2000; Lane et al., 1998; Liyanage et al., 2003; Nakamura et al., 1996; Nooteboom, 1999; Schoenmakers et al., 2006; Simonin, 1999), as well as the joint innovation performance (Ahuja et al., 2001; Cantwell et al., 2000; Cowan et al., 2009; Rindfleisch et al., 2001). These authors define knowledge base distance as the degree to which firms possess dissimilar types of knowledge and information. In our research we followed the majority of authors and built our arguments on knowledge distance.

Other researchers have an opposing view; they refer to a knowledge base overlap (i.e. commonality, redundancy, relatedness, and familiarity) in their studies (Cantwell et al., 2000; Kotabe et al., 1995; Mowery et al., 1998; Rindfleisch et al., 2001; Schoenmakers et al., 2006). They define knowledge base overlap as the degree to which firms possess similar types of knowledge and information.

With respect to the partially contradictory findings presented by existing studies, we concentrate on the content-related components of a knowledge base, rather than on its knowledge characteristics (such as knowledge's degree of tacitness). With this differentiated component view, we strive to separately identify the component-specific effect of partners' knowledge distance on innovation performance. Therefore, in this study, the development partners' knowledge distance is the degree to which the content of a specific knowledge component differs before the development project starts. In the following section, we present our hypotheses, which build on existing theories and literature.

HYPOTHESES

The Effect of Partner-specific Knowledge Distance on Innovation Performance

In alliances, decision making occurs along formal but also in informal organizational processes (Miles et al., 2001; Von Krogh et al., 2007). Unlike intra-firm development projects, joint development projects have to cope with different organization structures and routines. It is beneficial for firms to be familiar with partners' formal organizational structures and routines (Von Krogh et al., 2007). For example, identifying its decision makers, as well as those in the partner firm enables firms to make quick and valid decisions to develop the innovation project (Saxton, 1997). In order to assure an efficient collaboration, both partners should therefore understand their divisions and functions' hierarchical systems (Gupta et al., 1991). Futher, Ring and Van de Ven (1989) point to the informal connections' important role across organizations when transacting. Organizational members who have informal but strongly tied links are likely to share an understanding of each other's behavior. They will share opinions in strong, socializing relationships, which in turn influence their actions (Coleman et al., 1966). When alliance partners are familiar with each other's informal organizational structures, they can address the right people, interlink experts concerning specific tasks, and select appropriate interaction activities (Hansen, 1999; Wang et al., 2003). Hence, partner-specific knowledge tends to encompass inter-organizational routines. These routines force efficient partner interaction and, therefore, enhance innovation performance (Zollo et al., 2002).

Moreover, within development alliances, conflicts can arise from differences in organizational cultures (Sivadas et al., 2000). These differences might occur as a result of dissimilar histories, and are characterized by specific norms, value systems, and emotions (Hofstede et al., 2005). Such differences in values could lead to contrary behaviors and might therefore prevent effective progress on a good project (Urban et al., 1980). If the partners' political issues are handled explicitly or implicitly, this might distract the team from the development work, which would be counterproductive. Knowledge of the partner's organizational culture, which does not mean that they should necessarily have the same culture but that they should understand each other's culture, prevents cultural conflicts, provides conflict solutions, and facilitates joint innovation performance, as accurate and efficient interaction is possible.

Hence, the more the development partners become familiar with each other's structures, rules, and routines, the more likely innovation performance is to increase. In addition, familiarity enables those developing joint collaboration routines, which subsequently enhance knowledge transfer and partner-specific absorptive capacity (Dyer et al., 1998). Overall, we recognize the importance of a small distance regarding partner-specific knowledge. We therefore propose:

Hypothesis 1: *A large degree of knowledge distance regarding partner-specific knowledge is negatively related to innovation performance.*

The Effect of Project-specific Knowledge Distance on Innovation Performance

The literature provides contradictory empirical evidence with regard to the relationship between the degree of development partners' project-specific knowledge distance and innovation performance: On the one hand, we find persuasive evidence for a large knowledge distance (e.g., Kotabe et al., 1995). Nakamura et al. (1996), for example, state that different perspectives and solutions may produce innovative answers to problems. Moreover, if partners' technological knowledge is too similar, it could lack the desired complementary effects. The exchange of technological knowledge would then be redundant, and wouldn't improve innovation performance (Schoenmakers et al., 2006). Furthermore, successful product innovations frequently originate from outside the industry (Calantone et al., 1988; Kotabe et al., 1995).

A large degree of knowledge distance enables the partners to update their product modules and architectures by obtaining novel input from each other. With respect to the costs (resources, time, and money), the opportunity to obtain new input from the partner is particularly relevant. Innovation projects are always unique, therefore, new product development processes (Gemünden et al., 2005) require different tools and procedures to better direct the processes that need to be integrated (Crawford, 1984). Development partners with a large knowledge distance regarding new product development and production processes, possess learning potentials (e.g., Schoenmakers et al., 2006), as they may harbor a greater repertoire of instruments that satisfy specific project requirements. This may help partners create a process that allows the aspired innovation performance to be achieved.

Alternatively, some scholars argue that, between development partners, a small distance in technological knowledge (e.g., Mowery et al., 1998) is beneficial for innovation performance (Simonin et al., 1998). Firms need common knowledge to enable inter-organizational learning through the effective transfer of tacit knowledge and specialized skills, and for the absorption of new product knowledge (Cohen et al., 1990; Mowery et al., 1998). It is very difficult to combine unrelated technological knowledge in an innovative endeavor (Cohen et al., 1990).

The absorption of the partner’s technological and product-related knowledge is enhanced by the criteria with which the firms assess or even realize the importance of unrelated new knowledge (e.g., Liyanage et al., 2003; Petersen et al., 2005; Schoenmakers et al., 2006). This results in the recommendation to cooperate with partners who possess “ex ante technology-based capabilities that are similar in scale and scope” (Mowery et al., 1998, p. 511). In addition, joint knowledge of the new product development process, which is a basis for the project, is beneficial for innovation performance (Cooper, 1990). Joint knowledge provides an essential structure for coordinating the partners’ development work. Moreover, innovation always bears uncertainties with regard to potential changes in technologies, competition, and customer needs (Ruekert et al., 1987; Song et al., 2000). These uncertainties require close cooperation between the parties in order to accomplish the project objectives (Rindfleisch et al., 2001; Song et al., 1998). Besides, in practice, a newly developed product is usually produced at one partner firm, or one partner deploys the newly developed process.

Depending on the degree of innovation, the newly developed product, processes or software may require a radical change, or an adaptation to existing production processes. Existing manufacturing lines' requirements might, however, restrict development partners . Prior knowledge of the production processes' distance will thus enable the partners to gain insights into the consequences of their decisions (Baughn et al., 1997; Rindfleisch et al., 2001). Furthermore, the problems that arise can be solved by reflecting on the existing conditions. These considerations may prove useful for innovation performance.

Summarized, we find seemingly contradictive arguments and results: If the distance between partners' project-specific knowledge is too small, there is little point in sharing. If it is too large, the partners will struggle to understand one another, lack absorptive capacity, and co-development can be resource-consuming and costly (Dyer et al., 1998; Grant, 1996; Nooteboom, 1999). Hence, we agree with Cantwell and Colobo (2000) that it is optimal for partners to have a: "sufficient degree of complementarity in their […] competencies, which in turn provides a greater motive for cooperation and a greater ability to benefit from such alliances, owing to the existing possession of absorptive capacity in the relevant area" (Cantwell et al., 2000, p. 141). We therefore hypothesize:

Hypothesis 2: *The degree of knowledge distance regarding project-specific knowledge has an inverted-U relationship with innovation performance.*

METHOD

Research Setting

To test our hypotheses, we examined 53 inter-organizational development projects which two firms in the automotive supplier industry and located in Switzerland, Germany, and Austria conducted jointly. Their objective was to collaboratively develop an innovative and complex technical product, software or process. Owing to their innovative nature, the product, software or process was new to both allying partners (Inkpen, 2000). We only included projects that had been completed within the last three years. Hence, the respondents, who were chosen for their ability to provide inside information, could still recall information related to the relevant development projects (they could, for example, check survey studies), which allowed us to measure the innovation performance. Furthermore, we included both partners in order to receive unbiased data.

Data Collection

The selection of the projects was aided by an existing database of development projects, which had been complemented with secondary data from press releases on development cooperations. We contacted the R&D managers of the relevant projects telephonically to obtain project-details. Based on these details, we assigned the specific development partners as Partner A and Partner B. We then contacted multiple respondents to collect data on projects that the firms reported as having been completed within the preceding 36 months. Specifically, Partner A's project leader of and at least four randomly selected Partner A team members, as well as Partner B's project leader were contacted. The respondents' participation was strictly voluntary, and all respondents were assured absolute anonymity. All the respondents received a link to their personalized and standardized online questionnaire via email. The role that the respondents played in the project determined the type of questionnaire to which they were linked. The number of team members who answered depended on the response rate and project size. In total, we received 159 valid responses, which constitute 53 sets of data, with responses of both partners. The response rate of the firms requesting a link to the particular questionnaire was 88%, resulting in a final sample of 60 firms.

Measures

All constructs considered in this investigation refer to the development project as the unit of analysis. Since a joint project is the expression and realization of an alliance between two partner firms, all measures were specified on the project level. We followed the steps recommended by Churchill (1979), as well as Nunally and Bernstein (1994) during the measure development procedures. To attain content validity, we used construct definitions and measures gleaned from the literature wherever possible. The constructs innovation performance, degree of modularization, and partner firm's absorptive capacity investigated in this study were assessed using multiple questionnaire items. All questions in this study, except the antecedents and project outcome (i.e. product, processes, or software) were measured using a 5-point Likert-type scale, ranging from (1) "totally disagree" to (5) "totally agree." To answer the questions concerning the antecedents, the respondents had to quote percentages. Since the questionnaires were administered in German, translations are included in Appendix A.

Dependent Variable

We derived four items from Gemünden and Salomon (2005) to cover the innovation performance technological and market dimension (four-item scale, Cronbach's $\alpha = .87$, 5-point rating scale). Accordingly, we introduced one item in which we checked for new technological principles integrated into the newly developed product, process, or software. Furthermore, we investigated whether a new customer benefit was created and checked for improvement in the firm's market position resulting from the newly developed product, process, or software.

Antecedents

The knowledge distance regarding partner-specific knowledge (three-item scale, Cronbach's $\alpha = .84$, quotation) was one of our model's antecedents. We determined this to check the level of knowledge required from the partner with regard to formal/informal organizational structures and on the partner firm's culture. The respondents provided percentages by rating their partner's knowledge required for the project as either entirely irrelevant or totally relevant. The same approach was used to evaluate knowledge distance regarding project-specific knowledge (four-item scale, Cronbach's α = .85, quotation). We examined the knowledge required from the partner regarding technologies, products, development processes, and production processes. The answers provided indicated the partner's knowledge distance.

Control Variables

Since modularization allows alliance partners to develop separate modules independently, it reduces the need for intense interaction and a common knowledge base between the partners (e.g., Baldwin et al., 2000; Cowan et al., 2009; Nakamura et al., 1996). To control for this, we developed the construct degree of modularization (three-item scale, Cronbach's α = .84, 5-point rating scale). The first item builds on research done by Ethiraj and Levinthal (2004), and measures strong functional dependence during development. The other two items are derived from the work by Baldwin and Clark (2000), and control the importance of the partner's contributions to the joint product development. In addition, these items control whether the partners obtained specialized expertise during the development. Furthermore, the firm's experience in dealing with external knowledge transfers also has a significant impact on innovation performance (e.g., Szulanski, 1996), the partner firm must be able to evaluate and assimilate such external knowledge into its existing practices (Liyanage et al., 2003). To control for this, we developed the construct partner firm's absorptive capacity (three-item scale, Cronbach's α = .77, 5-point rating scale). This construct is derived from Fosfuri and Tribo's (2008) work, and investigates the partner firm's experiences with implementing knowledge, acquiring outside knowledge, and with searching for external knowledge sources.

The construct validity assessments, as well as the correlations of the study variables, are shown in Table 2.

Place Table 2 about here

Intentional trust – the acceptance of the subjective probability that the partner will not utilize opportunities opportunistically – is seen to be a very important precondition for alliance success as it enables an increase in mutual learning (Boutellier et al., 1998; Nooteboom, 1999; Schoenmakers et al., 2006). Alliance partners that trust each other are also more willing to exchange important ideas and information openly (Gulati, 1995; Inkpen, 2000). Hence, we controlled for trust, which may impact innovation performance. Moreover, given that the data sets originate from different development projects with different project objectives, we also controlled for project outcome (i.e. product, process, or software).

Multiple Informants

To ensure content validity and to avoid common source bias, data from different respondents were used to measure the variables. While Partner B's project leader was assigned the questionnaire with the independent constructs knowledge distance regarding partner-specific knowledge and knowledge distance regarding project-specific knowledge, Partner A's project leader was asked to evaluate innovation performance (dependent construct). We felt that trust could best be evaluated by affected participants and therefore asked Partner A's project team members to evaluate the open knowledge exchange with their partner. In addition, we questioned different team members to avoid single source bias (Sproull, 1995). The remaining controls were evaluated by Partner A's project leader. Table 3 provides an overview of the model constructs and the respective respondents.

Place Table 3 about here

In terms of trust, we questioned several of Partner A's team members working on the same project. Given the respondents' ratings, we used the multiple item estimators for within-group interrater agreement (r_{wg}) (James et al., 1984). George and Bettenhausen (1990) recommend an r_{wg} greater than, or equal to, .70 as this is considered an indicator of good agreement within a group. The intra-group reliability of this scale was .78, which further legitimizes the aggregation of the individual team member scores. Consequently, we aggregated these data by calculating the arithmetic mean.

Data Analysis

All analyses were conducted at the project level (N = 53). First, we conducted exploratory factor analyses to assess whether all predicted items pertain to the same latent construct, as previously explained. As all items scored high on the respective factor (> .67), we used them for a two-step hierarchical moderated regression analyses to test our hypotheses (Cohen et al., 2003). Further, we verified the normality of our residuals, as this is required for regression analysis (Field, 2009). To address concerns of multicollinearity between the main effects with their corresponding interaction term, we used Cronbach's transformation. Hence, the variables were centered to their means (Jaccard et al., 1996). In Model 1, we performed a regression analysis of the effect of the control variables (i.e. trust (T), the degree of modularization (DM), the partner firm's absorptive capacity (PAC), and the project outcome (PO)) on innovation performance (IP). In Model 2, we entered the direct effect of knowledge distance regarding partner-specific knowledge (KDpaK) with regards to innovation performance to test hypothesis H_1. In the regression approach, the relationship between knowledge distance regarding project-specific knowledge (KDprK) and innovation performance is formulated as linear. In order to test the inverted U-shaped effects predicted by H_2, and at the same time to avoid multicollinearity, we transformed this independent variable into the variable KDprK_meansquared (Haida et al., 2002) computed as:

$$\text{KDprK\_meansquared}_j = (\text{KDprK}_j - \text{mean}_{\text{KDprk}})^2$$

We subsequently also entered this variable into our Model 2. The collinearity statistics calculated for the regression analyses show no distortion of the results due to correlation between the independent variables (the variance inflation factor is 1.3).

FINDINGS

Table 4 illustrates the regression model based on the dependent variable innovation performance. It summarizes the results attained by entering the control variables (Model 1), followed by the antecedents (Model 2). In Hypothesis 1, we predicted a negative relationship between the knowledge distance regarding partner-specific knowledge and innovation performance. The regression analyses results support this significantly ($\beta = -0.47$, $p < 0.01$, two-tailed). Furthermore, we expected an inverted-U relationship between the knowledge distance regarding project-specific knowledge and innovation performance in Hypothesis 2. To test this, we introduced the transform variable KDprK_meansquared to Model 2 of the regression analysis. The regression model can be expressed as: $IP = \beta_0 + \Sigma\, \beta_j X_j$

where IP is innovation performance, X_j is an explanatory variable correlated with IP, and β_0 and β_j are regression coefficients (Haida & Muto, 2002). Model 2 can be read as follows:

$$IP \sim -2.44E\text{-}15 + 0.247T_j - 0.084PO_j - 0.013DM_j + 0.239PAC_j - 0.467KDpaK_j - 0.328(KDprK_j - m)^2$$

By entering the meanKDprK value into the formula, we get:

$$IP \sim -2.44E\text{-}15 + 0.247T_j - 0.084PO_j - 0.013DM_j + 0.239PAC_j - 0.467KDpaK_j -0\ .328(KDprK_j – 30.849)^2$$

Removing the bracket leads to the following:

$$\begin{aligned} IP &\sim -2.44E\text{-}15 + 0.247T_j - 0.084PO_j - 0.013DM_j + 0.239PAC_j - 0.467KDpaK_j \\ &\quad - 0.328\ ((KDprK_j - 30.849)(\ KDprK_j - 30.849)) \\ &\sim -2.44E\text{-}15 + 0.247T_j - 0.084PO_j - 0.013DM_j + 0.239PAC_j - 0.467KDpaK_j \\ &\quad - 0.328((KDprK_j)^2 - KDprK_j30.489 - 30.849KDprK_j + 951.667) \\ &\sim -2.44E\text{-}15 + 0.247T_j - 0.084PO_j - 0.013DM_j + 0.239PAC_j - 0.467KDpaK_j \\ &\quad - 0.328((KDprK_j)^2 + 61.698KDprK_j + 951.667) \\ &\sim 3.12E{+}02 + 0.247T_j - 0.084PO_j - 0.013DM_j + 0.239PAC_j - 0.467KDpaK_j \\ &\quad - 0.328(KDprK_j)^2 + 20.237KDprK_j \end{aligned}$$

Viewing the results shown in Table 4, Model 2, we find that the transformed variable KDprK_meansquared is significantly related to innovation performance (β = -0.33, $p < 0.01$, two-tailed). Solving the regression formula reveals two important insights: First, the transform variable KDprK_meansquared includes the original variable knowledge distance regarding project-specific knowledge and its quadratic term. Therefore, both these variables can be interpreted as significantly related to innovation performance. Second, as shown in the formula, the coefficients for knowledge distance regarding project-specific knowledge are positive, and negative for the variable's squared term, i.e. $(\text{KDprK})^2$. These findings support the argument that the relatedness of knowledge distance regarding project-specific knowledge has a curvilinear impact on innovation performance (e.g., Ahuja et al., 2001). Hence, H2 is supported by our data. In addition, Model 2's result support some control variables. Consequently, trust is significant, and partner firm's absorptive capacity is marginally positive in relation to innovation performance (β = 0.25, $p < 0.05$, two-tailed, and β = 0.24, $p < 0.1$, two-tailed).

Place Table 4 about here

DISCUSSION

Theoretical Contributions and Implications

Several alliance researchers have attempted to determine the degree of the development partner's prior knowledge distance that enhances innovation performance (Ahuja et al., 2001; Cantwell et al., 2000; Kotabe et al., 1995; Laursen et al., 2006; Liyanage et al., 2003; Mowery et al., 1998; Rindfleisch et al., 2001; Schoenmakers et al., 2006). These authors, who used knowledge bases as inventories of generic knowledge with broadly scoped contents, report contradictory results. Researchers who focused on content-related knowledge (i.e. technological knowledge) consistently emphasize the optimal value of the development partner's moderate degree of prior knowledge distance (Cantwell et al., 2000; Liyanage et al., 2003; Mowery et al., 1998; Schoenmakers et al., 2006). This indicated the importance of the particular knowledge base components for innovation performance. Consequently, we relied on the knowledge-based view, innovation, organizational learning, and alliance literature, and specified knowledge base components that are relevant for innovation performance.

The first component of this concept is knowledge distance regarding partner-specific knowledge. This component encompasses knowledge about the development partner that is relevant for innovation performance, namely knowledge of the partner's formal organizational structures, informal organizational structures, and organizational culture. The second component is knowledge distance regarding project-specific knowledge and encompasses knowledge of the product, process or software that is being developed. The knowledge falls into the following categories: technological knowledge, knowledge of the product, knowledge of development processes, and knowledge of production processes.

Analyzing data from 53 inter-organizational development projects, we found that the categories of knowledge resulted in different levels of innovation performance. While the concept knowledge distance regarding partner-specific knowledge has a negative influence, knowledge distance regarding project-specific knowledge has an inverted U-shaped effect on innovation performance.

Contrary to the most prevailing assumption regarding a moderate knowledge base distance being beneficial for innovation performance (e.g. Ahuja et al., 2001; Cantwell et al., 2000; Laursen et al., 2006; Mowery et al., 1998; Schoenmakers et al., 2006), we find that a small knowledge distance regarding partner-specific knowledge leads to optimal results. The results of our data show that the distance in partner-specific knowledge has a negative influence on innovation performance, and therefore, supported H1. Accordingly, before entering a development alliance, the partners should become familiar with each other's organizational characteristics, such as the formal and informal organizational structures, and organizational culture. This knowledge will enable them to interact effectively. By introducing the component partner-specific knowledge, we emphasize the specific requirements of inter-firm collaboration, and therefore, complement the empirical research by Cantwell and Colobo (2000), Liyanage and Barnard (2003), Mowery et al. (1998), Schoenmakers and Duysters (2006), Ahuja and Katila (2001), Kotabe and Swan (1995), and Laursen and Salter (2006). In addition, this result acknowledges the work done by Rindfleisch and Moorman (2001), Zollo et al. (2002), and Hoang and Rothaermel (2005). ”The refinement of partner-specific interfaces and the development of partner-specific decision making as well as conflict resolution routines should enhance subsequent alliance performance” (Hoang et al., 2005, p. 334).

Moreover, our data lend support to Hypothesis 2, and we propose that the relationship of development partners’ knowledge distance with project-specific knowledge and innovation performance is inversely U-shaped. Development partners are likely to require similar project-specific knowledge to facilitate knowledge exchange and development when the alliance has been established (Mowery et al., 1998). Knowledge exchange is enhanced over time, as valuable content is systematically identified and then transferred across organizational boundaries (Dyer et al., 1998). Furthermore, the distance between firms’ project-specific knowledge influences the ease with which new knowledge is integrated into existing knowledge (Cohen et al., 1990; Liyanage et al., 2003). On the other hand, the evidenced inverted U-shape relationship between knowledge distance regarding project-specific knowledge and innovation performance implies that a knowledge distance that is too small yields diminishing. From this point onwards, neither partner will receive much new knowledge from the other, thus the innovation performance is likely to be lower than that achieved through internal knowledge development. Another disadvantage of a very small knowledge distance is that unintentional knowledge transfer might occur (Zander et al., 1995).

These findings contribute to work by Mowery et al. (1998), Liyanage and Barnard (2003), and Schoenmakers and Duysters (2006). While their data confirm that a moderate distance between partners’ technological knowledge is beneficial for innovation performance, we feel that this applies to project-specific knowledge, including technologies, products, development processes, and production processes. In addition, our results confirm the arguments offered by Ahuja and Katila (2001), Cowan and Jonard (2009), Laursen and Salter (2006), Grant (1996), Simonin (1999), and Nooteboom (1999), who emphasize an inverted U-shaped relationship between knowledge distance and innovation performance. While these authors did not specify the content of the knowledge bases, we find that their assertion is true for project-specific knowledge.

In addition, we find that two control variables have a positive impact on innovation performance: First, trust has a positive impact on joint innovation performance. Therefore, our findings support the work by Gulati, (1995), Jarsson et al., (1998) and Boutellier et al. (1998). The partners need to trust that everyone involved is working towards the same goal and to the best of their abilities. This aids an open exchange of ideas and information needed for innovation performance. Second, the partner firm's absorptive capacity enhances innovation performance. Hence, our data support the findings by Fosfuri and Tribo (2008). These authors emphasize that firms that are experienced in searching for, transferring, and implementing knowledge into their organization are also more capable of knowledge exchange than firms with less experience in these areas. Consequently, more experienced firms stand a greater chance of successful innovation.

Previous research made contradictory recommendations regarding the optimal knowledge base distance between potential development partners (e.g., Kotabe et al., 1995; Rindfleisch et al., 2001; Schoenmakers et al., 2006). By raising awareness of a knowledge base's single components needed for joint innovation, we strived for greater, and more detailed, insight into the critical selection of a development partner in terms of the distance between their knowledge bases (e.g. Deeds et al., 1996; Gulati, 1995; Lane et al., 1998). Knowledge of a partner's formal and informal structures, as well as of their organizational culture increases over time (Gulati, 1995). Hence, we suggest that optimal results can be attained by selecting a partner for innovation projects with which the firm is already familiar. The partner's possible contributions to the development project need to be considered. The partner should ideally operate in different (for new knowledge) but related fields (for knowledge integration reasons). By detailing knowledge base components with respect to their contents, we are able to provide specific recommendations in terms of partner selection. Hence, our work supplements the literature on partner selection and complements research on knowledge-based theory (e.g., Asheim et al., 2007; Corrocher et al., 2007; Escribano et al., 2009) by expounding a knowledge base's content-specific components required for joint development. Carefully considering their individual contributions to collaboration bears much better fruit than "content-free" approaches to knowledge (King et al., 2003; Spender et al., 1996c).

Furthermore, our findings support the existing literature on absorptive capacity, which argues that too large a knowledge distance between partners hinders the absorption of each other's know-how (e.g., Cohen et al., 1990). We also corroborate the literature on new product development that shows that firms can improve their innovation performance by leveraging others' knowledge through collaboration and the transfer of knowledge (Kogut et al., 1992; Van Wijk et al., 2008).

Managerial Implications

Our findings draw managers' attention to several aspects of partner selection for joint innovation performance. First, this study indicates that partner-specific knowledge is indispensable for successful joint innovation. Hence, knowledge of a partner firm's formal and informal organizational structures, as well as of its culture enables firms to overcome barriers and produces optimal results. Therefore, it is a good strategy to consciously select a partner that is already known to the firm. In addition, trusting, long-term partnerships with strong interpersonal relationships can be expected to develop (Baughn et al., 1997). This is possible, since our data show that mutual trust enhances innovation performance.

Second, the study's results indicate that it is best to select a well known partner for development (i.e. the smaller the knowledge distance regarding partner-specific knowledge, the better), and that a moderate level of knowledge distance regarding project-specific knowledge is best. On the one hand, the distance between partners' project-specific knowledge needs to be large enough for them to gain added value from each other's knowledge bases. Whereas this might imply that it is best to select a development partner that has competences in a completely different area, the moderate relationship indicates that if partners operate in fields that are too different, this has a negative effect. This U-shaped effect might result from absorptive capacity's impact. Consequently, the partner firm's project-specific knowledge needs to be integrated into the existing contexts. This condition implies a mutual basic understanding of transfer-relevant knowledge and, therefore, shows that it is not optimal to choose a partner that operates in a domain that is absolutely unknown to the firm. Thus, from the partner selection standpoint, this research suggests that it is important to evaluate potential partners' knowledge portfolio in relation to the focal firms' knowledge portfolio. The firm should select a partner with a knowledge base distance that is beneficial for the planned innovation.

Limitations and Future Research

This study's limitations result in a number of promising opportunities for future research. The empirical test of our research model is clearly limited to the context of development partnerships in the automotive supplier industry. Given that development projects are applied in different contexts, future studies should apply our model to other industries as well. By definition, inter-organizational development projects involve at least two organizations, which often exist in a situation of power asymmetry (Easterby-Smith et al., 2008). Power relations, along with trust, risk, and social ties, are key factors that could moderate the effects on innovation performance. Here, further research is required.

Although this study strived for a better understanding of a firm's knowledge base by introducing two content-related components, a more detailed classification is possible. For example, Faulkner (1994) identified 15 types of content-related knowledge by focusing on the different objects to which the knowledge is related, like the natural world, design, or the final product. Further, Liyanage and Barnard (2003) state, that scientific knowledge is relevant. Future research on more detailed sub-categories could supplement our findings.

In addition, we did not take knowledge characteristics such as tacit or explicit (Nonaka, 1994) into account, as our study assumes that these characteristics are equally distributed across the identified knowledge base components. Future research could examine whether this assumption is reliable, or if knowledge characteristics moderate the identified knowledge components' relations with innovation performance (Cowan et al., 2009; Hamel, 1991; Nooteboom, 1999; Simonin, 1999).

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TABLE 1

Research on knowledge base distance

Source	Method	Industries	Knowledge base	Effect proposed	Results
Cantwell et al., 2000	empirical: 68 firms	IT	technological knowledge	The relation between knowledge overlap and innovation performance is **inversely U-shaped.**	empirical support
Liyanage et al., 2003	empirical: 65 firms	Biotech	(scientific), technological knowledge	The relation between knowledge overlap and knowledge integration (resulting in innovation performance) is **inversely U-shaped.**	empirical support
Mowery et al., 1998	empirical: 151 joint ventures	multi-industry	technological knowledge	The relation between knowledge overlap and the likelihood of the alliance (chances of innovation performance) is **inversely U-shaped.**	empirical support
Schoenmakers et al., 2006	empirical: 171 parent firms	multi-industry	technological knowledge	The relation between knowledge overlap and learning performance (resulting in innovation performance) is **inversely U-shaped.**	empirical support
Ahuja et al., 2001	empirical: 72 leading firms	Chemicals	not specified	The relation between knowledge distance and innovation performance is **inverse**ly **U-shaped**.	empirical support
Baughn et al., 1997	conceptual	multi-industry	not specified	The relation between knowledge distance and knowledge protection is **positive.**	explicitly conceptualized
Cowan et al., 2009	conceptual	not specified	not specified	The relation between knowledge distance and the expected benefit of the alliance is **inversely U-shaped.**	explicitly conceptualized
	conceptual	multi-industry	not specified	The relation between knowledge overlap and integration of organizational structures is **inversely U-shaped.**	explicitly conceptualized
Hamel, 1991	empirical: 9 alliances	multi-industry	not specified	The relation between knowledge distance and knowledge integration is **negative.**	side-focused
Inkpen, 2000	conceptual	multi-industry	not specified	The relation between knowledge distance and knowledge integration is **negative**.	explicitly conceptualized
Kotabe et al., 1995	empirical: 905 new product innovations	multi-industry	not specified	The relation between knowledge redundancy and innovation performance is **negative.**	empirical support
Lane et al., 1998	empirical: 69 alliances	Pharmacy Biotech	not specified	The relation between knowledge distance and knowledge integration is **negative.**	side-focused
Laursen et al., 2006	empirical: 2707 firms	Manufacturing	not specified	The relation between knowledge distance and innovation performance is **inversely U-shaped.**	empirical support
Nakamura et al., 1996	empirical: 41 subsidiaries	Manufacturing	not specified	The relation between different but complementary knowledge bases and new knowledge integration is **positive.**	side-focused
Nooteboom, 1999	conceptual	multi-industry	not specified	The relation between knowledge distance and new knowledge integration is **inversely U-shaped.**	explicitly conceptualized
Rindfleisch et al., 2001	empirical: 106 US firms	not specified	not specified	The relation between knowledge redundancy and innovation performance is **positive.**	empirical support
Simonin, 1999	empirical work: 147 multinationals	not specified	not specified	The relation between knowledge distance and knowledge integration is **inversely U-shaped.**	side-focused

TABLE 2

Construct Validity Assessments and Correlations

	Variable	*Mean*	*SD*	*Items*	*Alpha*	*1*	*2*	*3*	*4*	*5*	*6*
1	Trust	4.04	0.61								
2	Project outcome (product, process, software)	2.32	0.92			.117					
3	Degree of modularization	4.00	0.77	3	0.835	-.014	.038				
4	Partner firm's absorptive capacity	4.02	0.77	3	0.768	-.084	-.447***	.136			
5	Innovation performance	3.33	0.73	4	0.873	.210	-.169	.106	.187		
6	Knowledge distance regarding partner-specific knowledge	34.65	19.09	3	0.835	-.115	.051	.133	.055	-465***	
7	Knowledge distance regarding project-specific knowledge	30.85	15.04	4	0.852	-.054	-.119	.127	.012	-.257*	.288**

*** = significant at the 0.01 level (two-tailed)

N = 53

** = significant at the 0.05 level (two-tailed)

* = significant at the 0.1 level (two-tailed)

TABLE 3

Constructs and Respondents

Variables		Respondents Partner 1	Respondents Partner 2
Dependent variable	Innovation performance	Project leader	
Antecedents	Knowledge distance regarding partner-specific knowledge		Project leader
	Knowledge distance regarding project-specific knowledge		Project leader
Controls	Trust	1 to 4 team members	
	Degree of modularization	Project leader	
	Partner firm's absorptive capacity	Project leader	
	Project outcome (product, process, software)	Project leader	

TABLE 4

Regression Analysis

Dependent Variable:	Innovation performance					
	Model 1			Model 2		
	Coefficient		S.E.	Coefficien t		S.E.
›nstant)	-2.88E-15		0.132	-2.44E-15		0.103
ntrols						
ıst	0.249	*	0.134	0.247	**	0.106
ject outcome (product, process, software)	-0.144		0.149	-0.084		0.116
gree of modularization	0.073		0.137	-0.013		0.117
tner firm's absorptive capacity	0.214		0.160	0.239	*	0.124
lependent variables						
owledge distance regarding partner-specific knowledge				-0.467	***	0.108
ıowledge distance regarding project-specific knowledge - mean)^2				-0.328	***	0.116
R^2	0.14			0.51	***	
adjusted R^2	0.07			0.44		
change in R^2	0.14			0.36		
F value	2.01			7.88		
change in F	2.01			16.93		

N =5 3

' = significant at the 0.01 level (two-tailed)

= significant at the 0.05 level (two-tailed)

= significant at the 0.1 level (two-tailed)

APPENDIX A

Measurement of the Dependent Construct, the Antecedents, and the Controls

Antecedents	Items
Knowledge distance regarding partner-specific knowledge*	When running the development project, you needed relevant knowledge from your partner. How much knowledge did you need? 1) Knowledge of the partner's formal organizational structures (e.g., hierarchy and functions)
	2) Knowledge of the partner's informal organizational structures (e.g., informal networks)
	3) Knowledge of the organizational culture (e.g., social norms, rules, and policies)
Knowledge distance regarding project-specific knowledge*	When running the development project, you needed relevant knowledge from your partner. How much knowledge did you need? 1) Knowledge of the technologies (e.g., nano-technology)
	2) Knowledge of the products (e.g., steering column)
	3) Knowledge of the development processes (e.g., construction)
	4) Knowledge of the production processes (e.g., assembly-steps)

*Scale format: percentages

Dependent Construct	Items
Innovation performance	The new product/software/process… 1) …followed a new technological principle.
	2) …created totally new customer benefit.
	3) …improved our market position.
	4) …improved the partner's market position.

Scale format: 1= 'total disagree', 5='total agree'

Controls	Items
Trust*	Important ideas and information were openly exchanged between the alliance partners.
Project outcome**	What was the outcome of the joint development project?
Degree of modularization*	1) Functionally, our partner and we depended strongly while developing.
	2) The partner's contribution was very important for the joint development.
	3) Developing this component generated specialized expertise for both partners.
Partner firm's absorptive capacity *	1) We carried out development projects in collaboration with other firms in the past, during which we successfully implemented the partner's knowledge in our firm.
	2) We carried out development projects in collaboration with other firms in the past, during which knowledge transfer was a critical success factor.
	3) In the past, we also searched for specific outside know-how carriers (e.g., domain experts).

*Scale format: 1= 'total disagree', 5='total agree'; **Scale format: 1= 'process', 2='software', 3='product'