An empirical investigation of knowledge management and innovative performance: The case of alliances

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ABSTRACT

This paper examines firm-level performance implications of strategic alliances by employing knowledge management practices as intermediaries. Unlike previous research which focuses on partner firm factors, this study investigates how alliance characteristics (i.e., alliance scope and governance) affect interfirm knowledge sharing and creation, and how these two practices and their interaction in turn affect innovative performance. These questions are examined in a sample of 127 German partnering firms. Results show that joint ventures as opposed to contractual alliances are more effective and influential in facilitating knowledge sharing and creation. In contrast, the scope of alliance activities, while positively associated with knowledge sharing, has no direct relationship with knowledge creation. In addition to these results, the study also finds that knowledge sharing, knowledge creation and their interaction significantly contribute to partner firms’ innovative performance.

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1. Introduction

The impact that strategic alliances might have on firm-level performance has attracted much research interest. Successful alliances are typically supposed to improve performance for partner firms and their customers, especially those alliances that involve the transfer or pooling of technologies and knowledge (Doz and Hamel, 1998; Dyer and Singh, 1998). Empirical studies have also offered substantial evidence for this theoretical supposition (e.g., Stuart, 2000; Kale et al., 2002; Zaheer and George, 2004). Despite this rich research stream, however, what is not well understood is how alliances produce superior performance for the partners. In this regard, the extant literature has at least two limitations. One lies in the fact that the majority of prior research centers on assessments of performance, blurring performance processes and outcomes. The research findings show whether performance has been improved but tell little about how the process actually works. It is thus something of a “black box” in the alliance-performance relationship. The other challenging problem is the lack of consensus on the conceptualization and operationalization of the term performance itself. Consequently, performance measurement is still a controversial subject.

This study seeks to take two measures to fill the research gaps. First, it assesses the contribution of alliances to firm performance by employing knowledge management (KM) practices as intermediaries. Recent research indicates that intermediate KM activities may be a critical mediator in the alliance-performance relationship. Specifically, researchers have posited and subsequently validated that alliances facilitate the transfer, sharing and generation of critical information and knowledge (Inkpen, 2000; Simonin, 2004; Gomes-Casseres et al., 2006). Further, KM and organizational learning literatures also suggest that a firm’s ability to learn, acquire, utilize and diffuse knowledge within and across organizational boundaries, in turn, provides competitive advantage and produces improved performance for the firm (Grant, 1996; Nonaka, 1994; Jiang and Li, 2008). Collectively, these studies indicate that whereas an alliance itself has only a lagged effect on firm performance, it may be the different KM practices that are critical factors which mediate the relationship.

Second, this paper examines the impact of KM on a firm’s innovative performance rather than on a general assessment of its performance. Despite the evidence that effective KM makes a significant contribution to performance, some recent studies reveal that the direct impacts of some types of knowledge (especially tacit knowledge) and KM on the general business or economic performance remain inconclusive (Davenport, 1999; Lyles and Salk, 1996). But some scholars have produced direct evidence for the positive effects of KM practices on innovative performance (Caloghirou et al., 2004; Nesta and Savioi, 2005). In the same vein, this paper posits that KM does not always have a direct impact on business and economic performance. Instead, it may have a more direct impact on the firm’s innovativeness and innovative performance.
We propose a direct connection between KM and innovative performance for two reasons. First, traditional innovation research has long connected a firm’s performance to its ability to produce innovations and develop new products. It is commonly accepted that successful innovations are crucial to the growth and long-run performance of many firms and interfirm alliances (Hitt et al., 1997; Stuart, 2000). Although firms may have a variety of strategic motives in mind when they enter alliances, the most immediate goals may be the development of new products, processes and services (McEvily and Chakravarthy, 2002). According to these studies, technology innovation is a direct determinant of firm performance.

Second, in contrast with the traditional view of innovation as a process of invention or discovery, a parallel line of research in the broader innovation literature attempts to understand innovation activities from a knowledge-based perspective. For example, Kogut and Zander (1992) argue that innovation relates to a firm’s ability to “exploit its knowledge of the unexplored potential of technology” and “generate new combinations of existing knowledge” (p.391). Drucker (1993) defines innovation as “the application of knowledge to produce new knowledge” (p.173). Technical change theories also suggest that a firm’s innovativeness is the outcome of increasing its knowledge base or recombining existing knowledge into new syntheses (Griliches, 1990; Nonaka and Takeuchi, 1995). This increasing awareness of knowledge as a necessity for innovativeness indicates that technology innovation has become a knowledge-intensive activity. When firms cooperate with other organizations to develop new products and new processes, the transfer, sharing, and creation of knowledge become central to innovation success. Taken as a whole: then, research on the relationship between KM practices and innovative performance is in and of itself a worthwhile academic endeavor.

When investigating KM issues in the context of alliances, prior research usually focuses on firm or organizational characteristics and attempts to answer why and how partnering firms differ in their abilities to transfer and acquire valuable knowledge (e.g., Tsang, 2002; Gomes-Casseres et al., 2006). Yet the ease and effectiveness of interfirm knowledge movements may be affected not only by the organizational factors but also by the characteristics of the alliance itself. Hence, this study focuses on alliance-level variables and investigates (1) what type and scope of an alliance facilitate the transfer, sharing and generation of knowledge, (2) how these KM practices in turn serve as a means to produce superior performance for the partners, and (3) how the interaction between knowledge sharing and knowledge creation influences the partners’ innovative performance. As for the last question, we attempt to address whether combining KM practices is of greater value to innovative performance than adopting individual practices in isolation. We examine these questions in an empirical analysis utilizing a sample of 127 German firms which were engaged in alliances during the period of 2000–2005.

The rest of the paper is organized as follows. The second section reviews the literature, and the third section proposes hypotheses. The fourth section details the sample selection and method of data collection. The measurement and structural models are analyzed using a structural equation modeling. The fifth section gives discussion of the research findings. Limitations, future research directions and implications are presented in the final section.

2. Theoretical underpinnings

2.1. The scope of alliances

The choice of alliance scope is a very significant topic for alliance researchers. With few exceptions (e.g., Khanna, 1998; Oxley and Sampson, 2004), however, prior research has devoted only limited academic interest to this topic. Khanna (1998) understands alliance scope in terms of private benefits and common benefits. Alliance scope is defined as the intersection of both partners’ temporary private and common benefits. Yet Oxley and Sampson (2004) argue that such a conceptualization is itself abstract and therefore not appropriate for empirical operationalization.

In the lone comprehensive empirical study of the concept, Oxley and Sampson (2004) classify alliance scope into two types, horizontal and vertical. The vertical or functional dimension of alliance scope is defined as “to what extent the partners combine multiple and sequential functions or value chain activities within the alliance, such as R&D, manufacturing and/or marketing” (p.726). This dimension takes into account that an alliance agreement can involve one or more of the three functional areas: R&D, manufacturing, and marketing. Some cooperative arrangements are limited to a single activity while others involve a combination of activities. Generally, the scope of a multiple-activity or mixed-activity alliance is broader than that of a single-activity alliance.

The horizontal dimension of alliance scope is “related to the size, complexity, and uncertainty of the particular project” (Oxley and Sampson, 2004, p.726). But because “evaluation of horizontal scope is a much more subjective and challenging exercise” (p.726), the authors discuss little about this dimension and focus their attention only on the simple measure of vertical scope. It is necessary to stress that our concept of alliance scope is based heavily on Oxley and Sampson’s (2004) work and also that we restrict our theoretical and subsequent empirical work to the vertical dimension of alliance scope.

2.2. Knowledge sharing and creation

During the past decade, ever-increasing theoretical as well as empirical attention has been focused on the process of interfirm knowledge transfer and sharing (e.g., Mowery et al., 1996; Simonin, 1999; Muthusamy and White, 2005). At its core, knowledge sharing is about how individuals, groups and organizations communicate and learn from each other. A wide range of factors influencing the extent and efficiency of knowledge transfer and sharing have been raised in the literature. The most important ones include these six: (1) the amount of transferable knowledge flows, (2) the amount of the recipient’s accumulated knowledge stocks, (3) the attribute of knowledge transferred (Chen, 2004), (4) learning intent of the recipient (Simonin, 2004), (5) absorptive capacity of the recipient, and (6) communication frequency, which refers to the degree of intensity of communication among partners.

In the alliance context, knowledge sharing may occur in two patterns. First, it occurs within alliances (Mowery et al., 1996; Inkpen and Dinur, 1998). That is, the members of one firm who work in an alliance transfer their private knowledge from their parent firm to the alliance. The alliance members of other firms gain access to and acquire this knowledge via communication and learning. In this instance, knowledge is shared, learned and used in the alliance. Second, it occurs in partner firms through alliances (Inkpen, 2000). Here, knowledge sharing consists of the sequential processes of (1) transfer of a firm’s private knowledge to an alliance, (2) another partner’s imitation and acquisition of the knowledge within the alliance, (3) transplantation of the imitated knowledge from the alliance to the parent, and (4) replication of the knowledge within the organizational settings of the parent. In this sense, alliances are only a vehicle or a medium which is simply conducive to transferring existing knowledge directly from one firm to another. This paper focuses in particular on the latter pattern where partner firms share knowledge through alliances.
While the topic of KM has received growing attention from alliance researchers, the focus of prior research has generally tended to be on knowledge transfer and sharing as discussed above. With a few exceptions (e.g., Inkpen, 1996; Inkpen and Dinur, 1998; Phan and Peridis, 2000), the mainstream literature has so far largely neglected the dynamic process of knowledge creation in alliances. In particular, even when acknowledging its importance, the literature still lacks empirical investigation. The paucity of well-founded empirical research results in insufficient insights into the essence of interfirm knowledge creation.

We argue here that some particular form of organizational learning plays a crucial role in the process of knowledge creation in alliances. To illustrate this argument, we will first distinguish between two conceptually distinct forms of learning. We call one form absorptive learning, which is akin to what has been called “acquisitive learning” (Zahra et al., 1999) or “exploitive learning” (March, 1991). Absorptive learning points to knowledge sharing and exploitation activities. Its aim is to access, assimilate, absorb and exploit existing knowledge beyond its boundaries to create value. This acquired knowledge does not have to be newly created, only new to the recipient firm (Davenport and Prusak, 1998). Therefore, absorptive learning is by nature incremental and exploitation-oriented.

By contrast, the other form of learning, creative learning, is radical and exploration-oriented. It occurs largely inside a firm’s boundaries and generates tacit and novel knowledge that is distinctive to that firm. The newly created knowledge can thereby be used by the firm to enhance its own strategy and operations. It is analogous to what is called “experimental learning” (Lei et al., 1996) or “explorative learning” (March, 1991). Different from absorptive learning, the prime aim of creative learning is to develop a new and original knowledge that didn’t exist in either partner before. A firm’s creative learning capability is thus one of the pillars in its knowledge creation process.

In a complete sense the creation of new knowledge is a complex, nonlinear and interactive interorganizational learning process. It embodies a continuous, multi–stage learning process: learning from experience1 (1 Absorptive learning). Absorptive learning and creative learning. These three forms of learning occur in an iterative fashion and play a complementary role as firms engage repeatedly in knowledge creation activities. Their interaction in nature constitutes another continual, upward spiral of organizational knowledge movement (cf. Nonaka, 1994).

Similar to the process of knowledge sharing, the creation of new knowledge in an alliance context can occur in two ways. First, knowledge is created within alliances. Partners pool their complementary knowledge resources into an alliance, and new knowledge is generated within the alliance. The newly created knowledge can be used in the alliance or be diffused to each partner. Second, knowledge is created in partner firms through alliances. Here, the alliance is a vehicle for transferring knowledge from one firm to another. The recipient firm then develops new knowledge based on the combination of its own knowledge stocks and the shared knowledge flows. Again, our analysis which follows focuses on the latter pattern.

2.3. Innovative performance

Innovative performance, which captures the critical domains of firms’ competitive advantage, is defined here as the contribution of product and process innovations to firm performance. Given this definition, a firm’s innovative performance is determined by its innovation activities, such as R&D expenditure, patents, and new products.

Prior research has widely used R&D expenditure or R&D intensity as an indicator of innovative performance (Chang, 2003; Caloghirou et al., 2004). Also, patents have long been used as an indicator of innovativeness because of their advantages in comparatively accurately reflecting the locus of the firm’s technology and capability development (Griliches, 1990). But the measure of patent counts has some serious limitations. Not all inventions or new technologies are patentable, and not all patentable technologies are patented; many patents are not or not immediately commercialized, and their economic value may differ greatly among industries and technologies (Griliches, 1990; Laursen and Salter, 2006). Therefore patent counts can reflect only the quantitative aspect of innovations.

By contrast, patent citations offer significant advantages over the simple patent statistics. For example, the number of patent citations more correctly reflects the quality of innovativeness by providing a more useful way to identify innovations of higher technological significance (Beneito, 2006). Patent citations also correctly reflect the contributions of prior work in current innovation activity (Jaffe et al., 1993).

Counts of new product announcements are another commonly used indicator of innovative performance. In the literature there is little debate on this measure itself, but there is criticism that points to the methods of relevant data collection. Prior studies typically gather the data from various archival sources. This measure is thus subject to the problems of how to correctly select data sources and how to appropriately classify the innovations (Beneito, 2006).

Beneito (2006) suggests that the choice of innovative performance indicators should “be based both on the particular objectives of the analysis to be performed and on data availability” (p.503). In the context of viewing knowledge as a requirement for innovativeness, this paper incorporates R&D expenditures, patents, patent citations and new products as one construct to assess innovative performance (Hagedoorn and Cloodt, 2003).

3. Hypotheses

3.1. Alliance scope and knowledge management

Alliance scope is the number of functional areas involved within an alliance, including R&D, manufacturing and marketing activities. Given this definition, a broader scope implies a greater variety of cooperative activities, a higher specificity of resource commitments, increased chances for the exchange of ideas, and access to more diverse technologies, skills and capabilities (Pisano, 1989; Oxley and Sampson, 2004). In a multiple-activity alliance, it would be absolutely necessary for the partners to cooperate extensively and interact frequently with each other in order to coordinate and implement the complex activities. This constant contact and communication facilitates the development of knowledge sharing routines and thus enables partner firms to identify valuable knowledge and effectively share it across organizational boundaries. Hence:

H1. The broader the scope of an alliance, the more the shared knowledge an alliance firm will obtain from its partners.
The knowledge-based view suggests that social networks such as strategic alliances facilitate the creation of new knowledge among organizations (Inkpen, 1996; Inkpen and Dinur, 1998). An alliance with multiple activities has a considerable positive effect on partners’ ability to acquire external knowledge and convert it into new types of knowledge. As argued above, a broad alliance causes the existence of heterogeneous knowledge and provides partners with opportunities to gain access to and acquire external knowledge. Given a firm’s sufficient creative learning capabilities, a broader scope enriches the possibility of new combinations of existing knowledge and enhances the likelihood of the creation of new organizational knowledge for the partners. Hence:

H2. The broader the scope of an alliance, the more the knowledge an alliance firm will create within its organizational boundaries.

3.2. Alliance governance and knowledge management

Prior empirical studies have identified the critical importance of appropriate governance structure in promoting interfirm sharing of knowledge and technologies. Equity-based alliances have been found to facilitate more efficient knowledge sharing than non-equity alliances (Mowery et al., 1996; Chen, 2004). In particular, when the knowledge that is being transferred is tacit and complex, firms in JVs may find transferring this type of knowledge more convenient and effective than those in contractual alliances (Kogut, 1988). Generally, JVs promote frequent and direct interactions among partners which in turn provide a variety of advantages in facilitating knowledge sharing activities. These advantages include increasing mutual understanding, enhancing knowledge transparency, reducing knowledge transfer costs, and enabling a better opportunity for interactive learning (Inkpen, 1996). Hence:

H3. Joint ventures will facilitate more knowledge sharing than contractual alliances.

Due to the paucity of research on knowledge creation in the alliance literature, there is little direct evidence to verify the relationship between alliance governance and knowledge creation. But prior studies have provided some clues that JVs may be more suitable than contractual alliances for developing new knowledge. For example, Madhavan and Rajiv (1998) propose that an important process variable for the effective and efficient creation of new knowledge is rich interpersonal interaction. Obviously, JVs create such an environment in which partners interact frequently and effectively. Through the active involvement of the members and frequent interactions between the partners, JVs facilitate rapid collection, storing, and sharing of knowledge, thereby helping partners play more active roles in knowledge creation activities. Moreover, with more commitments and a higher level of mutual trust, JVs develop a deeply ingrained learning culture and thereby foster all modes of knowledge creation (Inkpen, 1996; Inkpen and Dinur, 1998). Hence:

H4. Joint ventures will promote more knowledge creation than contractual alliances.

3.3. Knowledge management and innovative performance

Recent research attempts to understand innovation activities from a knowledge-based perspective and posit that the transfer, sharing, and creation of knowledge become central to innovation success (Griliches, 1990; Nonaka and Takeuchi, 1995). In view of this previous research, we expect a positive impact of knowledge sharing on innovative performance. Generally, continuous innovations require incessantly acquiring diverse knowledge from all kinds of possible sources. Knowledge acquisition in turn increases the firm’s ability to exploit such knowledge to invest in R&D activities, develop new products, processes or services and thus enhance its innovation outcomes and performance. Some empirical studies find that the sharing and application of knowledge will have a direct impact on the firm’s internal R&D, patents and other innovation outcomes (Tsai, 2001; Caloghirou et al., 2004). Hence:

H5. The amount of knowledge a firm shares from its partners will be positively related to its innovative performance.

Although there is only limited evidence of the direct impact of knowledge creation on innovative performance, a common theme in the literature is that the creation of new knowledge is critical for a firm’s dynamic capabilities, competitive advantage, and long-term growth (Nonaka, 1994; Lee and Choi, 2003; Bogner and Bansal, 2007). These studies suggest that it is not enough for partner firms to enhance innovative performance by acquiring knowledge only from external sources. They must simultaneously undertake the more important challenges of integrating existing knowledge into new knowledge and converting this knowledge into the production of complex goods and services (Nonaka and Takeuchi, 1995; Cloodt et al., 2006). In other words, the goal of the knowledge creation processes is not only to produce a stock of knowledge as an outcome. A more important goal is to employ the newly created knowledge to develop new products and produce valuable innovations. Hence:

H6. The amount of knowledge a partner firm creates within its boundaries will be positively related to its innovative performance.

3.4. Interaction effect

As a primary point of view of this paper, knowledge that is new to a firm can be obtained in two general ways: external acquisition from the partners and internal creation on its own. We have postulated in H5 and H6 that both KM practices may have direct effects on innovative performance. However, we have so far very little information about whether these two ways of KM may interact to affect firm performance. That is, we still don’t know whether the combination of KM practices will contribute more to innovative performance than the adoption of any single practice. Therefore, to detect and accurately examine their interaction effect is a critical issue in the context of this paper. Below, we will empirically test whether KM practices, when used in association with each other, predict better performance.

H7. The interaction of knowledge sharing and creation will be positively related to partner firms’ innovative performance.

The research model, based on the foregoing hypotheses, is depicted in Fig. 1.

4. Methodology

4.1. Data

The relationships depicted in Fig. 1 were examined using data collected in a survey of German firms that had been engaged in strategic alliances in the time period 2000–2005. The questionnaire was developed on the basis of a thorough literature review, first in English. The English questionnaire was then translated into German for facilitating understanding and answering of the questions. Finally, the questionnaire in German was again back-translated into English to ensure the precise meaning and cross-cultural equivalence of the language (Berry, 1980).

This paper adopted a web-based e-mail survey design to collect data (Simsek and Veiga, 2001). Participating firms were selected in two general ways. First, they were randomly identified through
4.2.1.1. Alliance scope. The measure of alliance scope was based on the concept of a dummy variable which equals 0 if an alliance involves a single activity (either joint R&D or manufacturing or marketing), and equals 1 if it involves two or all of the three activities.

4.2.1.2. Alliance governance form. Alliance form was separated into two categories: JVs and contractual alliances. The former category involves equity participation and the establishment of a legal entity or new firm, while the latter does not. The variable was constructed as a dummy where 1 indicated that the alliance of concern was an equity JV, and 0 that it was a contractual arrangement.

4.2.2. Dependent variables

4.2.2.1. Knowledge sharing. Knowledge sharing was operationalized using a six-item scale, following and adapting the measures developed in prior research on interfirm learning and knowledge transfer in alliances (Lyles and Salk, 1996; Tsang et al., 2004). Specifically, the informants were asked to assess if they had (1) transferred new knowledge; (2) managerial techniques; (3) R&D progress; (4) product/process development; (5) manufacturing process; and (6) new marketing expertise.

4.2.2.2. Knowledge creation. Since at the time of the study no measure was found in the alliance literature for operationalizing knowledge creation, we developed a new response scale that captures the different outcomes of knowledge creation as perceived by the managers. The theoretical domain for the scale items was based on Nonaka (1994) and Nonaka and Takeuchi (1995). Six items were used, focusing on (a) whether the creation of new knowledge was one of the most important cooperative motives; (b) after the alliance was established, whether they had generated or built the following five types of knowledge with the partners: (1) new operational ideas, (2) new ways to perform the task, (3) new product-specific technologies, (4) new manufacturing-specific skills, and (5) new marketing expertise.

4.2.2.3. Innovative performance. Unlike prior studies that relied on archival or other secondary data sources to collect the data on innovation input and output, we used a self-reported questionnaire survey of managers, asking them directly for information pertaining to innovative performance. In comparison with those publicly reported data, self-report approaches have the obvious advantage of providing more accurate and reliable data (Beneito, 1977).
Table 1
Measurement model: parameter estimates and reliability measures.

<table>
<thead>
<tr>
<th>Construct/indicator</th>
<th>Standardized loadings</th>
<th>CR (^a)</th>
<th>Cronbach alpha</th>
<th>Variance extracted</th>
</tr>
</thead>
<tbody>
<tr>
<td>Knowledge sharing</td>
<td>0.886</td>
<td></td>
<td></td>
<td>63.9%</td>
</tr>
<tr>
<td>1. Communication</td>
<td>0.821</td>
<td><em>b</em></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. Managerial techniques</td>
<td>0.758</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. R&amp;D progress</td>
<td>0.739</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4. Product/process development</td>
<td>0.723</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5. Manufacturing process</td>
<td>0.713</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6. Marketing expertise</td>
<td>0.760</td>
<td></td>
<td></td>
<td>9.262**</td>
</tr>
<tr>
<td>Knowledge creation</td>
<td>0.887</td>
<td></td>
<td></td>
<td>64.0%</td>
</tr>
<tr>
<td>1. Motive for knowledge creation</td>
<td>0.787</td>
<td><em>b</em></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. New operational ideas</td>
<td>0.716</td>
<td></td>
<td></td>
<td>8.260**</td>
</tr>
<tr>
<td>3. New ways to perform the task</td>
<td>0.772</td>
<td></td>
<td></td>
<td>9.020</td>
</tr>
<tr>
<td>4. New product-specific technologies</td>
<td>0.720</td>
<td></td>
<td></td>
<td>8.308**</td>
</tr>
<tr>
<td>5. New manufacturing-specific skills</td>
<td>0.716</td>
<td></td>
<td></td>
<td>8.254**</td>
</tr>
<tr>
<td>6. New marketing expertise</td>
<td>0.806</td>
<td></td>
<td></td>
<td>9.478**</td>
</tr>
<tr>
<td>Innovative performance</td>
<td>0.857</td>
<td></td>
<td></td>
<td>70.8%</td>
</tr>
<tr>
<td>1. R&amp;D expenditures</td>
<td>0.713</td>
<td><em>b</em></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. Patent counts</td>
<td>0.789</td>
<td></td>
<td></td>
<td>8.081**</td>
</tr>
<tr>
<td>3. Patent citations</td>
<td>0.867</td>
<td></td>
<td></td>
<td>8.624**</td>
</tr>
<tr>
<td>4. New product counts</td>
<td>0.759</td>
<td></td>
<td></td>
<td>7.809**</td>
</tr>
</tbody>
</table>

\(^a\) CR is the critical ratio obtained by dividing the estimate by its standard error (Arbuckle, 2005). This statistic is equivalent to \(t\)-statistic and it can be used to assess the statistical significance of the coefficient estimates.

\(^b\) Coefficient of leading indicator for each construct was set to 1.0 to establish scale.

*** significant at the \(p < 0.001\) level.

2006). Specifically, informants were asked to assess if the following four indicators have greatly increased within their firms after the alliance was formed: R&D expenditures, patent counts, patent citations and new product counts (Hagedoorn and Cloodt, 2003).

4.3. Control variables

Three control variables were included. Firm size equals 0 if the firm was small or medium-sized (fewer than 500 employees) and 1 if it was a large-sized firm. Alliance number equals 0 if the firm had only one alliance case in the past six years, and 1 if it had two or more alliances. Past alliance experience equals 0 if the firm had no prior alliance experience and 1 if it had such experience.

5. Results

The hypotheses proposed above were tested using a latent structural equation modeling approach on the sample of 127 German firms. The data analysis for this study was performed in two steps by using SPSS 14.0 with the maximum-likelihood AMOS 6.0 program (Arbuckle, 2005). In the first step, a measurement model that describes the relations among the latent constructs identified in Figure 1 was developed and assessed to determine whether the latent variables were defined appropriately and were measured consistently. In the second step, a structural model based on the stated hypotheses was tested to identify the interrelationships among the variables, with a set of simultaneous equations.

5.1. Measurement model

This study conducted a confirmatory factor analysis (CFA) to test the measurement model. The procedures used to validate the measures include convergent and discriminant validity of the constructs. The CFA results are presented in Table 1.

5.1.1. Reliability and convergent validity

Analysis of internal consistency of the latent variables was conducted by calculating the Cronbach’s alpha for each scale. Table 1 shows that all the coefficient alpha values for the items within each construct exceed the threshold value of 0.70, providing evidence of measure scale reliability (Nunnally, 1978).

Convergent validity was assessed by examining both factor loadings and the average variance extracted (AVE). Table 1 shows that all factor loadings of the observed items on the latent constructs were highly significant at the 0.001 level, with a critical ratio equivalent to \(t\)-statistics ranging between 7.809 and 9.478 (all greatly larger...
than 1.96). These results indicate good definitions of the underlying factors (Anderson and Gerbing, 1988). Moreover, we calculated the AVE, which measures the overall proportion of the variance in the indicators accounted for by the latent construct. Table 1 shows that all the shared variances were well above the recommended threshold level of 50%, thus supporting the convergent validity of the scales (Bagozzi and Yi, 1988).

5.1.2. Discriminant validity

Discriminant validity was assessed with a common test suggested by Fornell and Larcker (1981). They recommend comparing the variance shared between the constructs with the AVE for each individual construct to assess discriminant validity. Table 2 presents the square roots of the AVE for each construct along the diagonal, and the correlation coefficients among all theoretically related constructs in the off-diagonal elements. The discriminant validity of a construct is adequate when the diagonal element is greater than each of the off-diagonal elements in the corresponding rows and columns. Obviously, the data in Table 2 have such characteristics, thus supporting the discriminant validity of the constructs.

5.2. Structural model

To examine the main effects and the interaction of KM practices, we tested a structural model as depicted in Fig. 1. The approach used to test the interaction effect was Ping’s (1995) two-step procedure that advocates conducting analysis in two steps, separating the model with interaction from the model without interaction. In the first step, the latent variable interaction effect was estimated in a structural model using the loadings and error variances of the latent product variable derived from the first step as fixed values.

5.2.1. Structural model fit

This paper aims to examine the direct and interaction effects on firm performance in a single analysis. In order to validate whether the model with interaction is better than one without interaction, we tested two models. The first (without interaction) was modeled by fixing the value of the path coefficients associated with the interaction variable and innovative performance to zero. The second one (with interaction) allowed the interaction variable and innovative performance to be freely correlated with each other. Comparison of the model without interaction ($\chi^2 = 222.2$, d.f. = 205, $p$-value = 0.195, CFI = 0.983, RMSEA = 0.026) and the model with interaction ($\chi^2 = 219.3$, d.f. = 204, $p$-value = 0.221, CFI = 0.985, RMSEA = 0.024) indicates that the one with interaction is a better-fitting model. Hence, the model with interaction should and can be used to test the stated hypotheses.

5.2.2. Hypotheses testing

Given the reasonable acceptance of the model with interaction, it is possible to test the stated hypotheses by examining the coefficients. Table 3 summarizes the results of hypothesis testing, providing the standardized path coefficients, critical ratio values, and the corresponding significance level.

The path from alliance scope to knowledge sharing is positive and statistically significant. This result is consistent with the expectation and provides empirical support for H1. The relationship between alliance scope and knowledge creation is not significant ($p > 0.10$), indicating that these two variables may be not causally associated. Thus H2 is not supported. We will further discuss this finding in the next section.

The test of Hypothesis 3 has a very notable result that consists of the significant positive effects of governance structure on knowledge sharing. The results provide strong support for H3. Likewise, governance structure displays a significant positive effect on knowledge creation in support of H4.

H5 and H6 state that knowledge sharing and creation may contribute to innovative performance. The results in Table 3 show that both knowledge sharing and knowledge creation contribute positively and significantly to innovative performance in support of H5 and H6, respectively.

Turning to the interaction effect of KM practices, the coefficient of the interaction effect on performance is positive and significant. The introduction of the interaction term resulted in a significant increase in squared multiple correlation (similar to $R^2$ in OLS) and...
explains 2% of variance in innovative performance (the squared multiple correlations without and with the interaction were 0.204 and 0.224, respectively). This significant result provides support for the presence of an interaction between knowledge sharing and creation. Therefore, H7 is supported.

6. Discussion and conclusions

6.1. Discussion

The firm-level performance implications of strategic alliances have been an enduring research theme in the fields of strategic management and organization theory. But extant literature has devoted only limited empirical attention to the question of how strategic alliances produce superior performance for their partners. The various key variables proposed in this paper have received only partial and independent attention in prior research. To fill these gaps, this paper developed an initial framework for studying the simultaneous relationships between alliance characteristics, KM practices and innovative performance. The unit of analysis for this study is at the partnering-firm level.

As indicated in the literature, strategic alliances facilitate inter-firm KM activities, but effective and efficient KM in any given alliance may depend on a wide range of specific factors, including the attributes of knowledge, the particular alliance characteristics and the organizational contexts (e.g., Simonin, 1999, 2004; Chen, 2004; Gomes-Casseres et al., 2006). Focusing on the specific characteristics of the alliance rather than other factors, this study has provided new empirical evidence of the key role of strategic alliances in promoting inter-firm knowledge sharing and creation, which in turn contribute to partner firms’ innovation and performance.

As to the relationship between alliance scope and knowledge sharing, a broad alliance is found to have a positive effect on knowledge transfer and sharing. Large numbers of alliance activities will improve knowledge sharing among partners for many reasons. The most critical one is that firms with a broad cooperative scope may have access to a variety of information and knowledge in a way that firms within a narrow alliance do not. As highlighted by both the knowledge-based view and organizational learning theory, knowledge access is a necessary premise of acquiring and internalizing external knowledge (Tsai, 2001; Grant and Baden-Fuller, 2004). Moreover, the broader the scope, the greater is the opportunity for the partners to interact, to share ideas, and to develop mutual understanding and trust. By contrast, although narrower scope requires less coordination activities among partners and leads to fewer inter-firm conflicts, a smaller number of alliance activities yields diminishing and even negative returns because neither firm has much to learn from the other, thus inhibiting knowledge sharing among them.

The results indicate that broad scope has no statistical correlation with partner firms’ internal knowledge creation activities. In this regard, alternative explanations can be put forward from both theoretical and methodological points of view. Theoretically, it is possible that the level of a firm’s knowledge creation may be driven more by the firm’s internal capabilities than by external factors such as alliance-level factors highlighted in this paper. As argued earlier, a firm’s ability to create new knowledge is in nature determined by the firm’s internal creative learning capability. Firms that specialize in creative learning are expected to generate or develop more new knowledge that is distinctive to the organization than firms without such capability. As contended by Grant and Baden-Fuller (2004), the primary advantage of alliances is in accessing rather than acquiring knowledge. Following this logic, although broader alliances provide the partners with more accessible knowledge flows, knowledge access is a necessary but not sufficient condition for knowledge creation. That is, whether the creation of new knowledge really occurs in a firm may rely more on the firm’s in-house knowledge base, technical expertise and learning capability.

The other potential concern about the finding of an insignificant path from alliance scope to knowledge creation is the possibility of two methodological causes. First, as an emerging concept, alliance scope has received limited academic attention, with only the one empirical research by Oxley and Sampson (2004). Consistent with their treatment, this paper has focused on only one dimension, i.e., the vertical scope of the alliance. The horizontal dimension has been completely neglected, thus creating an important limitation of this paper, one which may lead to inaccurate results. Second, the finding of an insignificant path may be a result of using newly developed scales of knowledge creation. The validity and usability of this measure need to be further tested in future research.

The results also indicate that knowledge flows between firms in JVs are greater than between those in contractual alliances. The role of alliance governance in successful knowledge sharing has been the focus of research (Kogut, 1988; Chen, 2004). As to this line of research, the findings drawn here provide additional insights from three vantage points. First, the results reveal the appropriate governance form (i.e., the more hierarchical JV) in which knowledge can be most effectively transferred and shared. The second advantage is with respect to the transfer of tacit knowledge. Kogut and Zander (1992) argue that a more hierarchical structure is a superior means to transfer knowledge or other tacit information because the knowledge to be transferred is organizationally embedded (Kogut, 1988). The more hierarchical features such as close cooperation and frequent interactions within a self-governed entity endow JVs with native advantages in facilitating inter-firm sharing and creation of complex technologies and tacit skills. Third, JVs have been found to have higher levels of mutual trust among partners, an indispensable precondition and base for knowledge transfer and sharing (Chen, 2004; Muthusamy and White, 2005), and for knowledge conversion and creation (Nonaka et al., 2000; Lee and Choi, 2003).

The findings regarding the links between KM and firm performance are also important. This paper contributes to this line of research by showing both direct and interaction effects of knowledge sharing and creation on innovative performance. The direct positive effects suggest that effective management of inter- and intra-firm knowledge may significantly enhance the firm’s innovative yields. Firms are increasingly turning to alliances in order to learn from each other and to exploit that learning in order to develop new knowledge and to produce new goods and services. As a result of their doing so, they are obtaining superior innovative performance. This is consistent with previous findings made by Ahuja and Katila (2001), Caloghirou et al. (2004), Nesta and Saviotti (2005), Laursen and Salter (2006), and Sammarra and Biggiero (2008).

The focus of this paper has gone beyond the impact of these direct effects. We have further investigated the relatively unknown impact of the interaction effect of KM practices. Our results show that the interaction effect on innovative performance is significant, albeit weak, thus indicating that KM practices do interact with each other to influence firm performance: the more the KM practice in one area (i.e., knowledge sharing or knowledge creation), the higher the impact on performance of the other practice.

Prior research shows that an environment of knowledge sharing simultaneously involves and promotes the creation of new organizational knowledge (Nonaka and Takeuchi, 1995; Kogut and Zander, 1992). Generally, knowledge sharing among partners provides opportunities for mutual learning and cooperation that stimulate the firm’s creation of new knowledge. The externally acquired knowledge, combined with its internal capabilities, improves the firm’s existing knowledge structure, decreases its risks of internal learning and R&D activities, and thus contributes to the firm’s abil-
ity to innovate. As such, knowledge creation needs the support of externally acquired knowledge to produce more innovations. Therefore, when each of the activities is carried out, it should be accompanied by the other one in order to lead to a higher level of innovation outcomes. This confirms Vekstein’s (1998) finding that in the automobile industry the complementary use of external and internally developed knowledge is an important source of superior corporate performance.

6.2. Limitations and future research

There are several theoretical and empirical limitations to this study, which may, in turn, offer possible directions and avenues for future research. First, when this study focused on interfirm knowledge sharing and creation, it neglected an important KM practice highlighted in prior studies: knowledge protection (e.g., Oxley and Sampson, 2004). Studies in transaction cost economics suggest that an appropriate governance structure such as the more hierarchical equity JV will simultaneously promote knowledge sharing and enhance knowledge protection (Pisano, 1989; cf., Sampson, 2004). But there is no single “appropriate” scope that can provide such a mechanism. A broader alliance may facilitate knowledge sharing but at the same time increase the risks of unintended knowledge leakage. Therefore, if this research had considered the effects of knowledge loss, the results presented here might be different. In the future, KM practices should be studied from broader angles and in more detail.

Second, this paper has focused on a special form of firm performance—innovative performance. The performance variable was evaluated by firm managers in terms of their overall satisfaction of the extent to which the innovation objectives have been achieved. Moreover, the observations on the other variables were also gathered by means of managers’ subjective assessments. This self-reporting method has, however, potential limitations. For example, the answers can be affected by subjectivity (Weterings and Koster, 2007). Although we have provided a number of tests to rule out possible biases, the fact remains that data collection from multiple sources (e.g., senior management, employees and archival or public sources) would provide a stronger test of the model.

Third, we have tested the model solely in the German context by using a medium-sized sample. Although we believe that the findings will also hold when applied to firms originating from different countries, the relatively small size of the sample is still a problem. The next step will be to introduce a cross-cultural dimension in the context and to cross-validate the model in different settings based on a large-sized sample analysis.

6.3. Implications for theory

The aim of this study was to advance our understanding of the performance implications of strategic alliances at the theoretical, methodological and practical levels. Theoretically, the contributions are manifold. First, this study helps us understand how partner firms acquire and use valuable knowledge from an important external source, i.e., strategic alliances. This paper was a preliminary attempt that has drawn some interesting and novel conclusions about what scope and type of alliances may better facilitate interfirm knowledge sharing and creation. Second, while previous studies have provided rich evidence of the positive impacts of alliances on performance, our understanding of the performance process is limited. The use of KM practices as intermediaries may at least in part advance our knowledge of the “black box” in the alliance-performance link.

Third, Nonaka (1994) argues that knowledge creation is an upward spiral movement process through the interplay between explicit and tacit knowledge. From a new organizational learning perspective, we posit that learning from experience, absorptive learning and creative learning constitute another upward spiral process, and that creative learning lies at the apex of this process.

Finally, a careful literature review shows that there are few, if any, major theories in strategic management and organization studies areas that include hypothesized or confirmed interaction effects. This study has provided such additional knowledge. Our relevant finding is interesting and novel. When adopting multiple KM activities that interact with each other, the direct effect of one activity on innovative performance may be enhanced by the indirect effect of the other activity on the same performance. The interaction effect underscores for KM research the importance of examining the combination of KM practices rather than merely a sole practice.

Methodologically, this study overcomes some weaknesses observed in prior research. Few empirical studies in extant literature measure KM practices, especially knowledge creation, in an alliance context. This study adapted existing measures and developed new response scales to assess KM practices. These measures have distinctly captured the nature of both knowledge sharing and creation. In addition, in order to avoid the incompatibility of data from different sources, this paper assessed the interactions and interdependence between KM and innovative performance by collecting data from one source, i.e., the senior managers of firms.

With these theoretical and methodological improvements, the findings here have potentially important implications for our understanding of the economics of knowledge and the role of alliances in enhancing firm performance. The firm’s competitive position and performance is determined by the level of its knowledge stocks, including both the knowledge acquired from the partners and the newly developed knowledge. Firms can enhance their innovative performance at a faster rate when they develop mechanisms or routines that are purposefully designed to share, accumulate, exploit, integrate and diffuse the relevant knowledge, especially via alliances.

6.4. Implications for practice

This analysis also yields some conclusions that are potentially important for firm managers and alliance practitioners. A first managerial implication is regarding the choice of moderate alliance scope. The findings reported above suggest that broad scope has on one hand a weak significant effect on knowledge sharing, and on the other hand no statistical correlation with knowledge creation. Considering the need for knowledge protection, firm managers should choose a relatively narrow scope of joint activities in practice. This is also consistent with the finding by Oxley and Sampson (2004).

A second managerial implication results from the findings that, irrespective of other factors such as the costs of setting up JVs or their inflexibility, JVs are superior to contractual alliances in fostering knowledge sharing and creation. In addition, prior research from transaction cost economics also recommends that alliance firms’ opportunistic behaviors can be alleviated through equity-based governance structures (e.g., Kogut, 1988). Therefore, JVs should be preferred as the appropriate governance mode for knowledge transfer and sharing. At the same time, firms that decide to enter JVs should negotiate an ex-ante detailed contract as well as a secrecy agreement to restrict opportunistic behaviors and prevent knowledge from unintended leakage to a third party, especially competitors. Taking the first and second implications together, firm managers should simultaneously choose fewer joint activities and more hierarchical governance structure to achieve a balance between sufficient knowledge sharing and effective knowledge protection.

A third managerial implication is that having some prior investments in KM and innovation activities, either by means of experience or by prior R&D efforts, leads to better results, such
as generating new products and achieving better economic outcomes. Therefore, when forming alliances, firms should have the purpose of organizational learning and knowledge acquisition in mind. More importantly, firms’ emphasis on the combination of KM practices that interact with each other will be more beneficial.

Acknowledgements

We would like to thank Michael A. Hitt, Günter Specht, and Mingfang Li for helpful discussions. We also thank Professor Nick van Tunzelmann (the editor) and three anonymous reviewers for constructive comments. Financial support by NSFC (No.70741420172, No.70671082 and No.70772111) is gratefully acknowledged.

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