Title	Does knowledge base compatibility help or hurt knowledge sharing between suppliers in coopetition? The role of customer participation
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Citation	Ho, H., & Ganesan, S. (2013). Does knowledge base compatibility help or hurt knowledge sharing between suppliers in coopetition? The role of customer participation. Journal of marketing, 77(6), 91-107.
Date	2013
URL	http://hdl.handle.net/10220/24169
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Hillbun (Dixon) Ho & Shankar Ganesan

Does Knowledge Base Compatibility Help or Hurt Knowledge Sharing Between Suppliers in Coopetition? The Role of Customer Participation

Competing suppliers that collaborate to serve downstream original equipment manufacturer customers often encounter partners with overlapping and compatible knowledge bases. Such knowledge base compatibility provides supplier partners the opportunity to exchange knowledge efficiently, leading to greater knowledge sharing. However, the ease of misappropriation of the shared knowledge can offset this beneficial effect. This research proposes that the effect of knowledge base compatibility on supplier partners' knowledge sharing is moderated by the customer's participation in the collaborative effort and by the customer value such effort creates. The results of two empirical studies show that when levels of both customer participation and customer value are high, knowledge base compatibility between supplier partners leads to greater knowledge sharing. In contrast, when customer participation is high but customer value is low, knowledge base compatibility leads to lower levels of supplier knowledge sharing. This investigation validates the importance of key factors related to supplier partners' opportunity and motivation to share knowledge in coopetitive partnerships.

Keywords: buyer–seller relationships, knowledge governance, knowledge sharing, customer participation, survey methodology

Online Supplement: http://dx.doi.org/10.1509/jm.11.570

In today's turbulent business environment, firms often enter into collaborative relationships to access and leverage partners' knowledge assets. Extant literature has shown that collaborative relationships between suppliers and buyers create mutual value and opportunities for interorganizational learning (Cannon and Perreault 1999; Ganesan 1994; Palmatier, Dant, and Grewal 2007; Wuyts et al. 2004). Although these studies advance the understanding of vertical collaborations, knowledge about horizontal collaborations (i.e., partnerships between competing firms) remains scarce. This limitation is critical because horizontal collaborations have become a popular vehicle for firms to access and leverage partners' technological capabilities and tacit know-how (Capron and Hulland 1999; Heiman and Nickerson 2004).

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In business markets, horizontal collaborations[1] between upstream suppliers are often established to satisfy the sophisticated procurement needs of downstream customers, typically original equipment manufacturers (OEMs) in technology-based industries (Liker and Choi 2004). Suppliers collaborate by pooling resources and technological expertise. Sharing specialized knowledge enables supplier partners to learn from each other, leverage partner expertise, and create collective knowledge, resulting in superior solutions for customers (Mesquita, Anand, and Brush 2008). For example, in the semiconductor industry, an increasingly popular practice is for suppliers to develop new products or production processes for OEMs through the sharing of technological knowledge (Clark 2010). These developments require marketing scholars to understand conditions that facilitate or hinder supplier knowledge sharing.

Previous research has shown that collaborating partners' knowledge sharing and learning depends on opportunity and motivation (Inkpen 2000; Nahapiet and Ghoshal

[1]Conceptually, "collaboration" can refer to either long-term partnerships (often known as collaborative relationships) or episodic collaborative efforts aimed at solving relatively short-term problems (Zacharia, Nix, and Lusch 2011). Although our theoretical arguments apply to both situations, our discussion and empirical studies focus on the episodic efforts.

ISSN: 0022-2429 (print), 1547-7185 (electronic)

1998).[2] Effective knowledge sharing requires collaborating suppliers to understand, value, and absorb the partner's knowledge (Cohen and Levinthal 1990). However, organizational knowledge is often sticky, tacit, and causally ambiguous, requiring supplier partners to possess overlapping knowledge bases to overcome the barriers in the knowledge exchange processes (Szulanzki 1996). We refer to this as "knowledge base compatibility," which at high levels provides supplier partners the opportunity to share knowledge effectively in the collaborative effort. Extending prior research that emphasizes the benefits of knowledge base compatibility (Dyer and Singh 1998), our study points to the increased exchange hazards that knowledge base compatibility can create. These hazards discourage suppliers from sharing valuable knowledge (Makhija and Ganesh 1997), especially when the supplier partners compete in overlapping market segments or for the same OEM customer's business. Thus, knowledge base compatibility could either facilitate or impede supplier partners' knowledge sharing; its eventual effect is likely to depend on other important conditions, such as suppliers' motivation. Without sufficient incentives, supplier partners are unlikely to identify and make use of the knowledge exchange opportunities available in the collaborative partnership.

Therefore, the present study examines two factors related to supplier partners' motivation to share knowledge with each other. Because a collaborative partnership between two competing suppliers serving a downstream customer constitutes a triadic "compound relationship" (Ross and Robertson 2007), the customer could directly or indirectly motivate the supplier partners to share knowledge. The first factor we examine is the customer's participation in the supplier collaboration. Customer participation could engender a cooperative atmosphere that mitigates supplier partners' concern regarding exchange hazards, increasing their motivation to share knowledge. The second factor is the strategic value of the supplier collaboration to the customer. When their collaborative effort creates significant customer value, supplier partners can benefit from repeat business from the customer, thus motivating them to participate in knowledge exchange activities.

This research makes several key contributions to the marketing literature. First, in response to the increasing importance of supplier partnerships to OEM customers, our study helps academics and managers gain a deeper understanding of the key conditions that promote supplier partners' knowledge sharing in coopetitive partnerships. Second, by integrating the literature on interfirm learning and transaction cost economics, this study provides theoretical explanations for and empirical evidence on the divergent effects of knowledge base compatibility under different conditions. In particular, this research shows how factors related to supplier partners' motivation (including customer participation and customer value) moderate the effects of knowledge base compatibility on suppliers' knowledge sharing. Thus, this research helps supplier firms understand the positive and negative consequences of selecting partners with overlapping knowledge bases. Third, this study sheds light on the governance implications of the customer's involvement in its suppliers' collaborative effort when the supplier partners are also competitors.

The remainder of the article is organized as follows. We begin with an explication of how the present research adds to extant literature. We then lay out the theoretical foundations of our conceptual framework and develop hypotheses based on a synthesis of the literature. Subsequently, we present the methodology, results, and analysis of two empirical studies. We conclude by discussing the theoretical and managerial implications of our findings and the limitations of the study.

Literature Review

The growing importance of interfirm collaborations and learning alliances has stimulated extensive research examining the determinants, management, governance, and outcomes of the collaborating parties' knowledge-sharing efforts. The literature on learning alliances suggests that knowledge sharing and learning between alliance partners depends heavily on the accessibility of the partners' knowledge assets (with such access depending on the partners' motivation to share knowledge), characteristics of the partners' relationship, and the governance mechanisms used to control knowledge flow between the partners (Hamel 1991; Inkpen 2000; Li et al. 2008; Phelps 2010; Srivastava and Gnyawali 2011). Among these factors, attributes of partner relationships are widely examined determinants of knowledge sharing (Van Wijk, Jansen, and Lyles 2008). Partnerships characterized by trust, shared goals, and similar organizational processes promote knowledge sharing because these factors can broaden communication scope, nurture cooperative norms, and develop relationship-specific routines (Frazier et al. 2009; Heiman and Nickerson 2004; Lane, Salk, and Lyles 2001; Rowley, Behrens, and Krackhardt 2000). Thus, alliance partners can more readily comprehend and learn each other's specialized knowledge and tacit know-how in the presence of relational ties (Hansen 1999). This stream of literature mainly emphasizes the advantages of partnerships between compatible firms. However, it does not address the negative aspects of such partnerships.

The literature also examines knowledge spillover and misappropriation as hazards to alliance success (Hamel 1991). Scholars contend that firms should manage such hazards by choosing specific governance mechanisms, including formal and informal safeguards, that align with the attributes of partnerships (Dyer and Singh 1998; Lavie 2006). Informal safeguards such as trust are self-enforcing and essential, because they engender relational behaviors and lower transaction costs in crafting contracts and instituting monitoring mechanisms (Das and Teng 1998). Informal safeguards can complement formal safeguards in miti-

[2]For example, in the case of New United Motor Manufacturing Inc. (NUMMI), a joint venture between General Motors (GM) and Toyota, GM initially struggled to learn the Toyota production system. The knowledge transfer took a decade to materialize because the operations of Toyota's system differed substantially from GM's experience, culture, and systems, thus limiting opportunities for learning. In addition, a "not-invented-here" syndrome inhibited the GM engineers' motivation to learn Toyota's tacit know-how (Inkpen 2005).

gating opportunism (Inkpen and Tsang 2005; Rowley, Behrens, and Krackhardt 2000). In addition, previous research has shown that the severity of hazards in partnerships focused on knowledge exchange determines governance choices (e.g., equity-based vs. non-equity-based alliances, repeated partners vs. new partners) (Li et al. 2008; Oxley and Sampson 2004). Although this literature acknowledges the threat of knowledge misappropriation and its implications for governance, prior empirical studies have examined limited types of governance choices, such as forms of alliances.

Previous research on collaborative buyer–supplier relationships and supplier development programs has highlighted the increasing importance of knowledge sharing and its impact on partner performance (e.g., Cheung, Myers, and Mentzer 2011; Dyer and Hatch 2007; Kotabe, Martin, and Domoto 2003). Empirical evidence indicates that buyers' sharing of operational and technological knowledge boosts supplier performance. This literature stream has stressed how customers' actions help suppliers develop capabilities and how knowledge transfer results in superior supplier and customer performance. However, these studies have not adequately addressed the hazards of suppliers' misappropriation of knowledge shared by the customer or other knowledge providers.

This review suggests that several important issues deserve attention from marketing scholars. First, previous research has inadequately addressed the negative ramifications of collaborative partners possessing similar knowledge and skills. Investigating this aspect of partnerships can provide insights into firms' selection of partners when entering into collaborative relationships. Second, although supplier collaboration involving a customer (i.e., a triadic partnership) is an increasingly important supplier management practice, theoretical expositions and empirical evidence on the governance functions of customer involvement remain scarce. Examination of supplier collaborations serving a single customer can broaden academics' understanding of both the viability of current practices for managing such partnerships and the applicability of theories used for explaining firm behaviors in dyadic partnerships to triadic partnerships.

Conceptual Framework and Hypotheses

Knowledge Sharing in Supplier Coopetition

We define "knowledge sharing" as the intensity of supplier partners' exchange of valuable knowledge (e.g., technical skills, product knowledge, manufacturing processes) in their coopetitive partnership. A high level of knowledge sharing implies that the supplier partners not only share substantial and valuable knowledge but also help each other leverage such knowledge into productive use for collaborative effort. Thus, this definition is consistent with extant literature that emphasizes not only the exchange of knowledge but also the utilization and the quality of the shared knowledge (Haas and Hansen 2007; Hansen, Mors, and Løvås 2005).

Knowledge that contributes to firms' competitive advantage is usually tacit and embedded in organizational capabilities (Grant 1996). Thus, suppliers can exploit their partners' specialized knowledge and capabilities only when a significant degree of knowledge sharing occurs (Hansen 1999). Substantial knowledge sharing in collaborative interactions would help supplier partners better understand the customer's sophisticated procurement needs and enable them to formulate solutions to meet those requirements. Moreover, because knowledge sharing reflects supplier partners' commitment to collaborating toward specific goals for the customer (e.g., new product development), it is likely to produce positive collaborative outcomes. Previous research has provided ample evidence of the positive outcomes of interfirm collaborations in technological innovation, new product introduction, and capability development (Ganesan, Malter, and Rindfleisch 2005; Lane, Salk, and Lyles 2001; Mesquita, Anand, and Brush 2008).

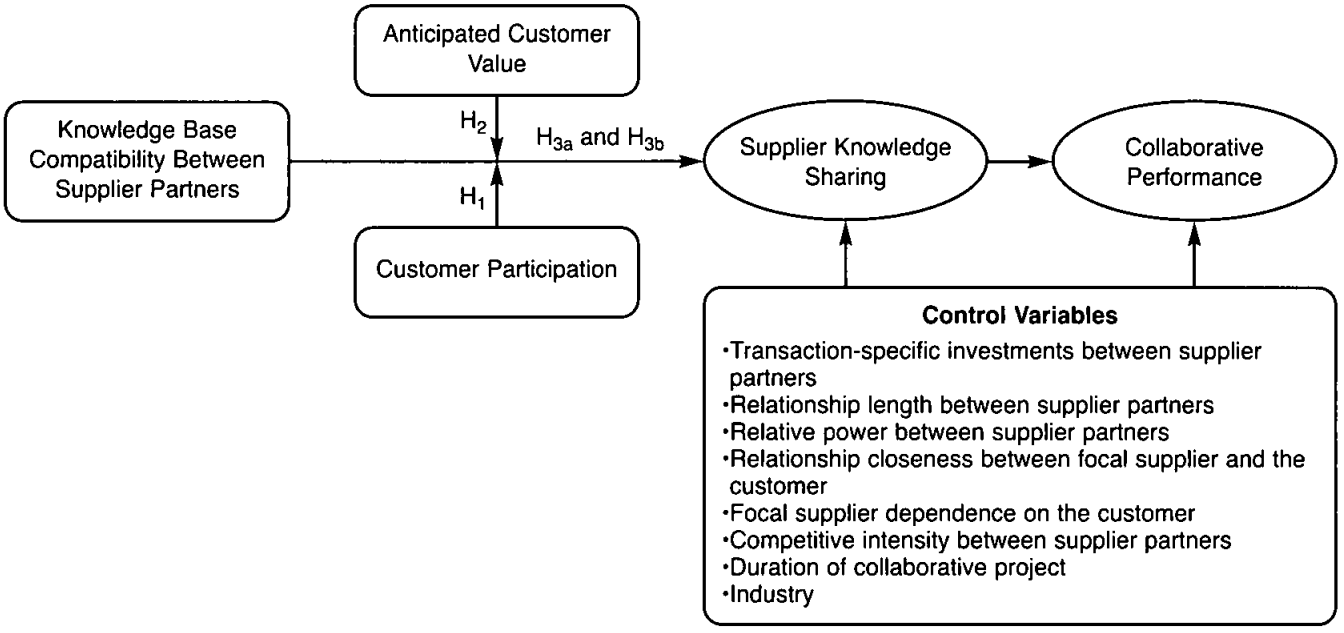
We suggested previously that the occurrence of knowledge sharing between supplier partners depends on their motivation and the opportunities available in the collaborative effort. Our conceptual framework focuses on the opportunity offered by supplier partners' knowledge base compatibility, because this factor may either facilitate or impair knowledge sharing. The motivating factors are the customer value that the supplier collaboration could generate and the customer's participation in the collaboration. These three factors individually provide a necessary but insufficient condition for supplier knowledge sharing to occur. We suggest that it is important to consider their joint effects. Figure 1 depicts the conceptual framework.

Knowledge Base Compatibility Between Supplier Partners

Firms' knowledge bases are the codified and tacit knowledge embedded in organizational capabilities, practices, and routines (Grant 1996). Knowledge base compatibility is a dyad-level factor that captures the extent to which the collaborating parties possess overlapping knowledge and compatible skills. We suggest that knowledge base compatibility can facilitate or hinder knowledge sharing between supplier partners, and we explain these effects in the following subsections.

Benefits of knowledge base compatibility. Although collaborative partnerships provide firms with opportunities to access their partners' knowledge resources and skills, knowledge sharing and collective learning do not necessarily occur, because valuable knowledge such as a manufacturing process is usually sticky, embedded in organizational routines, and difficult to transfer (Szulanski 1996). When the shared knowledge is tacit and complex, the recipient can only learn it from direct experience, firsthand observation, and trial and error (Hansen 1999). In addition, the knowledge provider must customize the shared knowledge to the receiving firm's unique circumstances. Therefore, to overcome obstacles in knowledge exchange, the collaborating partners must have similar cognitive frameworks and experience and use technical languages that both parties can understand (Hansen 1999; Heiman and Nickerson 2004).

FIGURE 1
Conceptual Framework



When supplier partners possess overlapping knowledge and compatible skills, they can communicate effectively, draw on the partner's expertise and experience, and use similar approaches to solve problems and address the learning environment. Therefore, knowledge base compatibility is likely to result in greater comprehension of partner knowledge and appreciation of its value. Overlapping knowledge bases also imply greater cross-understanding (i.e., understanding what the partner knows and does not know) between the boundary-spanning personnel of the collaborating firms. Cross-understanding can enhance the emergence and elaboration of task-relevant information, resulting in greater learning and superior collaborative outputs (Huber and Lewis 2010). In contrast, when the knowledge bases of the collaborating partners are too dissimilar, high costs and the effort involved in explaining, understanding, and assimilating the disparate knowledge prohibit the partners from sharing knowledge effectively.

Our assertion that knowledge base compatibility increases learning efficiency is in line with the absorptive capacity literature (Lane, Koka, and Pathak 2006), which suggests that the extent to which new external knowledge relates to a firm's knowledge bases determines the firm's potential to absorb new knowledge (Zahra and George 2002). Alliance partners' ability to recognize, assimilate, and use partner knowledge depends on the similarity of their basic knowledge, organizational structures and policies, and technological interests (Lane and Lubatkin 1998; Lane, Salk, and Lyles 2001; Mowery, Oxley, and Silverman 1996). This evidence supports our contention that high levels of knowledge base compatibility offer opportunities for supplier partners to achieve greater knowledge sharing.

Hazards arising from knowledge base compatibility. Paradoxically, overlapping knowledge bases may also hamper knowledge sharing by exposing supplier partners to the hazard of knowledge misappropriation due to spillover. Spillover is the unintended leakage of knowledge and skills from the knowledge provider to the recipient during day-to-day collaborative activities (Kang, Mahoney, and Tan 2009). When suppliers collaborate, their boundary-spanning employees, such as engineers and technical specialists, interact frequently in professional and social arenas, making the organizational boundaries permeable (Kale, Singh, and Perlmutter 2000). Although firms may establish formal procedures and policies to control the flow of proprietary information and knowledge, tight control systems can result in little collective learning and may even compromise the performance of the partnerships (Makhija and Ganesh 1997). Thus, when supplier partners' knowledge bases overlap significantly, partners could easily acquire and assimilate partner knowledge that is beyond the purview of the collaborative arrangement (Li et al. 2008). In addition, the knowledge recipient can use the knowledge obtained from spillover for private benefits, making knowledge sharing a risky endeavor for the knowledge provider (Hamel 1991; Khanna, Gulati, and Nohria 1998). The hazard of knowledge misappropriation intensifies when the partners are also competitors and the collaboration involves technology exchange (Gulati and Singh 1998). As a result, high levels of knowledge base compatibility are likely to make supplier partners alert to partner opportunism and cautious about the potential hazards and, thus, reduce the intensity and effectiveness of knowledge exchange effort.

This discussion suggests that supplier partners' knowledge base compatibility enhances learning efficiency but also increases the hazards of knowledge misappropriation. Because these two opposing forces exist simultaneously, the eventual effect of knowledge base compatibility on sup-

plier knowledge sharing depends on other factors pertinent to the supplier collaboration. Previously, we commented that in addition to opportunity, motivation is another essential condition for knowledge sharing to occur. Thus, this investigation focuses on two motivating factors—customer participation and customer value—that provide supplier partners with incentives to share knowledge. The study also examines how these factors moderate the effects of knowledge base compatibility.

The Moderating Effect of Customer Participation

According to transaction cost economics, information asymmetry and behavioral uncertainty in collaborative partnerships lead to opportunistic behaviors such as shirking, cheating, and withholding information (Rindfleisch and Heide 1997). In addition, because collaborative activities inevitably involve sharing of valuable tacit know-how and skills, which are difficult to circumscribe and codify, the potential for opportunism increases. Although transaction cost economics suggests that collaborating firms can restrain their counterparts' opportunism through formal safeguards, the ambiguity in assessing the value and flow of knowledge compromises the effectiveness of formal safeguards in partnerships focused on knowledge creation and exchange (Gulati and Singh 1998). Whereas previous studies have suggested that social relationships can temper partners' misappropriation of knowledge assets (Kale, Singh, and Perlmutter 2000), competitive tension between the supplier partners makes the development of trust and commitment difficult; thus, supplier partners may need to seek other safeguards.

Case studies of supplier networks have proposed that powerful customers can take on managerial and governance roles in their supplier networks. For example, in Toyota's supplier network, Toyota establishes collective goals, nurtures trust among members, develops a shared identity, and executes various managerial functions (Dyer and Nobeoka 2000). A powerful customer may also be involved in selecting qualified suppliers, conducting joint improvement activities, and implementing control systems (Liker and Choi 2004). Finally, the customer can orchestrate knowledge transfer within its supplier network (Dhanaraj and Parkhe 2006; Dyer and Nobeoka 2000). Overall, these qualitative studies suggest that customer participation can enhance supplier capabilities, encourage cooperative behavior, and motivate suppliers to work toward collective goals. These collaborative advantages provide customers with incentives to maintain their engagement.

We propose that in a triadic partnership, a customer's participation in its suppliers' collaborative effort could motivate the suppliers to share knowledge more intensively. We define customer participation as the customer's engagement in its suppliers' collaborative efforts, including such actions as coordinating collaborative activities, mediating conflicts between supplier partners, and providing technical assistance. Customer participation could suppress supplier opportunism through social control processes. First, the customer's participation puts social pressure on the supplier partners, increasing self-deterrence (Rindfleisch and Moorman 2003). The suppliers' reputation and repeat business opportunities with the customer are held hostage (Parkhe 1993). Suppliers may fear that the customer's discovery of their opportunistic actions against the partner would lead to exclusion from future business (Lavie 2006) and negative word of mouth among other buying firms regarding the suppliers' trustworthiness.

Second, intensive interactions between the supplier partners and the customer enable collective trust and cooperative norms to develop in the customer–supplier–supplier triad, as in clan controls (Inkpen and Tsang 2005; Ouchi 1979). Clan controls are essentially a normative process in which the members of a system adopt the norms, values, and goals of the system through socialization processes. Consequently, opportunism is suppressed through members' self-control (Ouchi 1979). The network literature has also suggested that alliance network members who share common third-party ties embrace reciprocity norms and have generalized trust, both of which are transferable from one dyad to another (Phelps 2010). For example, when the customer provides technical assistance to a supplier, the supplier can reciprocate by offering comparable assistance to its collaborating partners within the customer's supplier network (Dyer and Nobeoka 2000).

These arguments suggest that customer participation could attenuate the exchange hazards that supplier partners encounter in their collaboration. The avoidance of knowledge misappropriation assures suppliers of an equitable return on the sharing of valuable knowledge with their partners. Therefore, when a customer participates intensively in its suppliers' collaborative efforts, the supplier partners are motivated to take part in knowledge exchange that leads to the fulfillment of the customer's procurement needs.

We stated previously that customer participation and knowledge base compatibility are factors that affect suppliers' motivation and opportunity to share knowledge. We predict that high levels of customer participation mitigate suppliers' concerns about knowledge misappropriation. As a result, the learning efficiency afforded by knowledge base compatibility becomes a sufficient and facilitative condition for supplier partners to share knowledge. Thus, compatibility has a positive impact on supplier knowledge sharing. In contrast, when customer participation is minimal, self-deterrence and social controls are absent. As a result, suppliers' concern regarding knowledge misappropriation arising from overlapping knowledge bases is elevated, and knowledge base compatibility alone is not a sufficient condition for supplier knowledge sharing to take place.

H_1: Under high levels of customer participation, knowledge base compatibility is positively related to knowledge sharing between supplier partners. Under low levels of customer participation, knowledge base compatibility is not related to supplier knowledge sharing.

The Moderating Effect of Anticipated Customer Value

Previous research has shown that firms can capitalize on their partnerships to generate both collaborative and partner-specific value (Kale, Dyer, and Singh 2002). Collaborative

value refers to the value the partner firms create collectively, such as innovative outputs and new products (Madhok and Tallman 1998). In supplier collaborations, supplier partners pursue a common goal of producing superior products, services, or solutions for the customer. Thus, collective value manifests as customer benefits created, such as cost reduction, quality improvement, or short inventory cycle. We refer to the value that supplier collaborations generate for the customer as "anticipated customer value." We focus on anticipated customer value as a motivating factor for supplier partners to participate in knowledge sharing, because this factor is closely related to the future business that the supplier partners may gain from the customer.

Knowledge sharing is a costly and risky endeavor with uncertain results, and in projecting the long-term payoffs, supplier partners must assess their collaboration's strategic value to the customer. When the supplier collaboration creates significant customer value, the supplier partners are likely to gain repeated and expanded business from the customer. According to expectancy theory, the amount of effort a person exerts in a given task or course of action depends on the value he or she assigns to the expected outcome (Van Eerde and Thierry 1996). Thus, the anticipated rewards of specific actions motivate a person to participate in such actions. Likewise, game theory posits that the behaviors or actions of organizational actors result from their evaluation and comparison of the expected payoffs of alternative strategic options (Parkhe 1993). Previous research has also shown that tangible incentives strongly motivate managers to share knowledge with members in the same organizational unit (Quigley et al. 2007). In keeping with these theoretical perspectives, we suggest that the customer value that supplier partners expect their collaboration to create provides incentives for them to take part in knowledge sharing. When anticipated customer value is high, supplier partners foresee greater future business opportunities. Thus, supplier partners are more eager to put effort into knowledge exchange activities in the current collaborative effort.

We noted previously that anticipated customer value and knowledge base compatibility are complementary factors that affect supplier partners' motivation and opportunity to share knowledge. Thus, we predict that these two factors have an interaction effect. Specifically, supplier partners that anticipate high customer value are more likely to focus on the learning efficiency afforded by overlapping knowledge bases and on how to exploit this advantage. As a result, knowledge base compatibility should have a positive impact on supplier knowledge sharing. In contrast, supplier partners that anticipate low customer value would have less incentive to participate in knowledge sharing. They might become more concerned with the misappropriation risks associated with overlapping knowledge bases, rendering knowledge base compatibility insufficient to drive supplier knowledge sharing.

H_2: Under high levels of anticipated customer value, knowledge base compatibility is positively related to supplier knowledge sharing. Under low levels of anticipated customer value, knowledge base compatibility is not related to supplier knowledge sharing.

We also argue that when supplier partners anticipate that collaboration will create significant customer value, they will consider the customer's participation more acceptable and legitimate because the customer has a high stake in the collaborative arrangement. As we discussed previously, customer participation is likely to increase social interactions among the employees of the customer and the supplier partners, and as a result, cooperative norms develop in the customer–supplier–supplier triad. More importantly, customer participation in terms of technical support, sharing of product information and tacit know-how, and mediation of supplier conflicts can improve the effectiveness of collaborative interactions. Therefore, high levels of customer value coupled with high levels of customer participation strongly motivate supplier partners to engage in knowledge exchange activities. In this situation, supplier partners are likely to focus on exploiting the learning opportunities provided by knowledge base compatibility. As a result, the supplier partners would consider the facilitative power of knowledge base compatibility to outweigh the potential hazards, leading to a positive effect of compatibility on supplier knowledge sharing.

In contrast, when customer participation is low, supplier partners would have little incentive to take part in knowledge sharing because of the absence of adequate safeguards. As a result, even when suppliers anticipate that customer value to be generated by collaborative effort is likely to be high, they would fail to exploit the benefits of knowledge base compatibility because of a fear of potential hazards, resulting in a nonsignificant relationship between knowledge base compatibility and supplier knowledge sharing.

H_{3a}: Under high levels of anticipated customer value, knowledge base compatibility is positively related to supplier knowledge sharing when customer participation is high and not related to supplier knowledge sharing when customer participation is low.

We also suggest that when supplier partners anticipate that their collaborative effort will have limited strategic value to the customer, they foresee the future payoffs and business opportunities arising from the collaboration as uncertain and as not justifying the risks involved in working with a competitor. Thus, supplier partners are not willing to participate in costly and risky knowledge exchange activities. In addition, because the supplier partners perceive the customer as having a low stake in the collaborative arrangement, they are likely to view any participatory actions of the customer as unnecessary intervention and may question the customer's intentions. Customer participation often requires suppliers to adapt their operational procedures, such as setting up a special task force and information-sharing system to support the customer's involvement, and in this case, the suppliers may view such adaptations as unjustifiable when they anticipate relatively low customer value and uncertain future payoffs. Prior research has suggested that when buyers' excessive intervention lacks legitimacy, suppliers react negatively—for example, by engaging in noncooperative behavior and exhibiting negative sentiments (Heide, Wathne, and Rokkan 2007).

Overall, we propose that when supplier partners anticipate that their collaborative effort could only create limited customer value, they will be reluctant to accept customer participation and may even react against it. Thus, low anticipated customer value coupled with high customer participation provides minimal or even negative motivation for supplier partners to share valuable knowledge with each other. With negative motivation, suppliers are not only reluctant to participate in knowledge sharing but also unappreciative of the value of their partners' knowledge and skills. Such negative motivation and sentiments are likely to cause suppliers to view overlapping knowledge bases with their partners unfavorably, escalating their concerns of knowledge misappropriation. Suppliers would become more averse to the damage that results from knowledge misappropriation, and their negative attitude toward knowledge sharing could induce reciprocal responses from their partner. In these situations, knowledge base compatibility should be negatively related to supplier knowledge sharing.

H_{3b}: Under low levels of anticipated customer value, knowledge base compatibility is negatively related to supplier knowledge sharing when customer participation is high and not related to supplier knowledge sharing when customer participation is low.

In the following sections, we present the research methods and results of two empirical studies. In Study 1, we conducted a scenario experiment with responses from students in an executive master's program in business administration (MBA). In Study 2, we used mail surveys to collect data from executives working in technology-based firms.

Study 1

In Study 1, we used a between-subjects scenario experiment to test the proposed hypotheses. Previous studies on distribution channels have employed scenario-based experiments to examine managers' attitudes and decisions under different circumstances and roles (e.g., Ganesan et al. 2010; Wathne, Biong, and Heide 2001). Use of an experiment can control for extraneous factors that may confound the results, such as supplier and industrial characteristics.

Experimental Design and Procedures

We recruited 121 participants enrolled in an executive MBA program at a large public university. All were full-time executives or managers in organizations in the southwestern United States. On average, they had eight years of full-time work experience, and 68% were men. A majority of the respondents worked in information technology, pharmaceuticals, and defense industries. We employed a 2 (anticipated customer value: high vs. low) × 2 (knowledge base compatibility: high vs. low) × 2 (customer participation: high vs. low) between-subjects factorial design. Each participant responded to a scenario randomly drawn from eight different scenarios that corresponded to a combination of the three factors manipulated at either the high or the low level. To assess the realism and relevance of the scenario, we pretested it among another group of participants in the same executive MBA program. The manipulation for each factor was grounded in its conceptual meaning and reflected key characteristics of the latent constructs. Web Appendix W1 presents the manipulations used in Study 1.

In all conditions, participants assumed the role of the director of product development in a fictitious microchip manufacturer, MicroTech. They then read the descriptions of the key aspects of the collaboration in which the manipulations for the three factors were embedded. After reading the scenario, participants indicated how willing they were to share knowledge with a competitor participating in the collaboration (Innova) and then responded to the manipulation checks. We captured participants' intention to share knowledge with three items rated on nine-point scales: (1) "How willing is your company to share knowledge with Innova in this collaboration?" (1 = "not willing at all," and 9 = "very willing"), (2) "How motivated is your company to share knowledge with Innova?" (1 = "not motivated at all," and 9 = "highly motivated"), and (3) "How likely is it that your firm will take the initiative to share knowledge with Innova?" (1 = "very unlikely," and 9 = "very likely"). Reliability of the measure as assessed by Cronbach's alpha was .87. In the scenario experiments, we could measure only participants' intention to share knowledge, not their actual knowledge sharing.

Manipulation Checks and Assumptions Testing

We used a full factorial analysis of variance (ANOVA) to perform the manipulation checks. The results indicate that the manipulations were effective: customer value (7.91 vs. 5.98; $F = 42.00$, $p < .001$), knowledge base compatibility (6.93 vs. 5.97; $F = 11.39$, $p < .001$), and customer participation (6.28 vs. 4.92; $F = 17.23$, $p < .001$). In each check, only the focal variable had a significant main effect on the dependent measure, and no other main or interaction effects were significant. We tested the assumption that knowledge base compatibility has a positive effect on both learning efficiency and knowledge spillover risk. We used a single item to assess learning efficiency ("The employees of Innova can learn and acquire knowledge from MicroTech effectively") and a single item to assess spillover risk ("Proprietary knowledge can be leaked from MicroTech to Innova unintentionally"). We used a seven-point Likert scale (1 = "strongly disagree," and 7 = "strongly agree") to measure both items. The results of a one-way ANOVA show that learning efficiency (6.47 vs. 5.02; $F = 12.52$, $p < .01$) and spillover risk (7.03 vs. 4.17; $F = 21.11$, $p < .01$) were greater in the high knowledge base compatibility condition than in the low knowledge base compatibility condition. A single item also tested the assumption that customer participation deters suppliers' opportunistic behavior ("The customer's involvement in its suppliers' collaborative activities may prevent the suppliers from acting opportunistically, such as stealing their partner's valuable knowledge"). We measured this item on a seven-point Likert scale (1 = "strongly disagree," and 7 = "strongly agree"). The results of the one-way ANOVA show that perceived opportunism was lower in the high customer participation condition than in the low customer participation condition (6.04 vs. 5.01; $F = 7.05$, $p < .01$).

Results

The results of a 2 × 2 between-subjects ANOVA indicate that both anticipated customer value ($F = 22.35$, $p < .01$) and customer participation ($F = 19.03$, $p < .01$) have a significant and positive effect on suppliers' intent to share knowledge. As predicted in H_2, the two-way interaction of anticipated customer value × knowledge base compatibility is significant ($F = 6.45$, $p < .01$). However, the interaction of customer participation × knowledge base compatibility is not significant ($F = .29$, n.s.). Thus, the two-way interaction hypothesized in H_1 is not supported. More important, the results indicate a significant three-way interaction between anticipated customer value, knowledge base compatibility, and customer participation ($F = 7.69$, $p < .01$). As Figure 2 illustrates, this three-way interaction involves two two-way interactions of opposing patterns.

Under the high customer value condition (right panel), the knowledge base compatibility × customer participation interaction is significant ($F = 4.01$, $p < .05$), consistent with H_{3a}. To understand this interaction further, we conducted a simple effects analysis. The results indicate that when customer participation is high, knowledge-sharing intent is significantly greater in the high knowledge base compatibility condition than in the low knowledge base compatibility condition (6.67 vs. 5.75; $F = 9.43$, $p < .01$). In contrast, when customer participation is low, we find no significant difference in knowledge-sharing intent between the high and low compatibility conditions (5.52 vs. 5.50, n.s.).

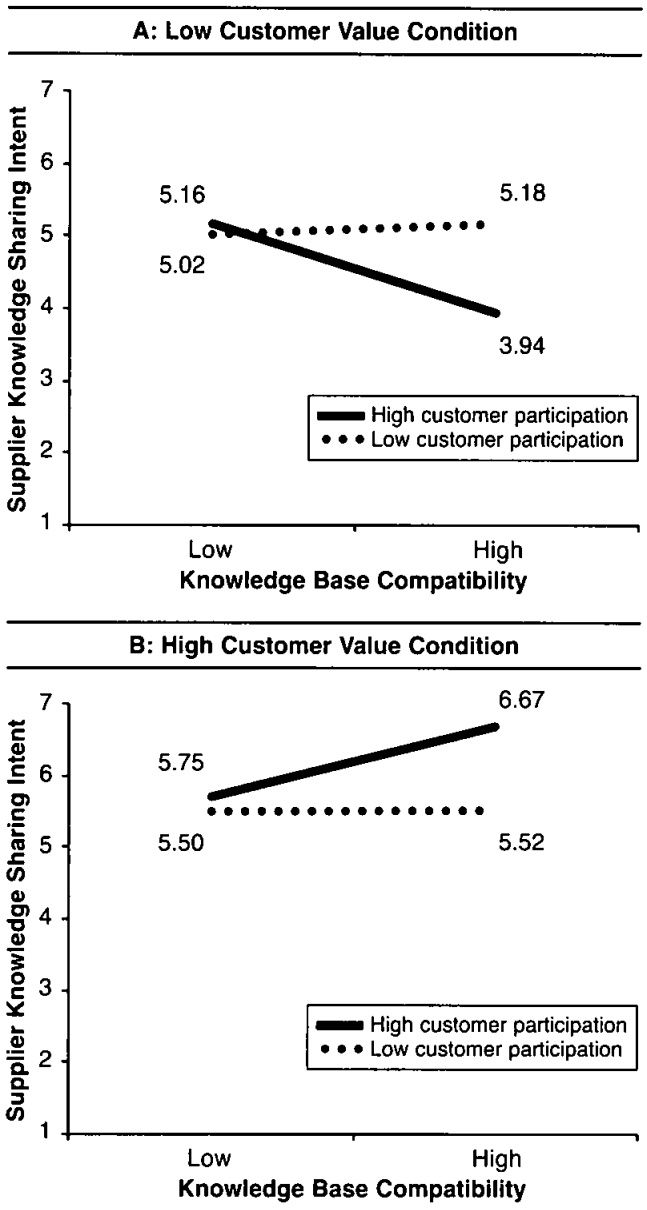
An opposing pattern of results appears in the low customer value condition.[3] When customer value is low (Figure 2, Panel A), the knowledge base compatibility × customer participation interaction is significant ($F = 4.46$, $p < .05$), consistent with H_{3b}. The follow-up simple-effects analysis indicates that when customer participation is high, knowledge-sharing intent is significantly lower in the high compatibility condition than in the low compatibility condition (3.94 vs. 5.16; $F = 11.07$, $p < .01$). In contrast, when both customer value and customer participation are low, results indicate no significant difference in knowledge-sharing intent between the high knowledge base compatibility and the low knowledge base compatibility conditions (5.18 vs. 5.02, n.s.).

Discussion

Study 1 shows how knowledge base compatibility, customer participation, and anticipated customer value jointly affect suppliers' intention to share knowledge with their partner in a coopetitive partnership. The results suggest that customer participation can temper suppliers' concern for knowledge misappropriation. In addition, suppliers view overlapping knowledge bases as both facilitating knowledge exchange and creating the misappropriation hazard.

The significant three-way interaction shows that when both customer value and customer participation are high, knowledge base compatibility has a positive effect on suppliers' intention to share knowledge. This finding is consistent with our conjecture that when both customer value and customer participation are high, suppliers focus on the learning efficiency benefits that arise from the presence of overlapping knowledge bases with the partner rather than focusing on the misappropriation hazard. More important, when customer participation is high but customer value is low, knowledge base compatibility has a negative effect on suppliers' intention to share knowledge. This result suggests that high customer participation combined with low customer value could trigger suppliers' negative motivation. Therefore, suppliers are likely to perceive the misappropriation hazard as detrimental, superseding the advantages that stem from knowledge base compatibility. In addition, the results show that when customer participation is low, regardless of the level of customer value, the effect of

FIGURE 2
Study 1: Anticipated Customer Value × Knowledge Base Compatibility × Customer Participation Interaction



[3]The two opposing patterns of two-way interactions between customer participation and knowledge base compatibility may explain the insignificant result for H_1.

knowledge base compatibility on suppliers' intention to share knowledge is insignificant. This result suggests that in the absence of a social control, suppliers have a low incentive to share knowledge.

Overall, the empirical results in Study 1 support most of our hypotheses. The findings identify the conditions under which customer participation is beneficial, benign, or harmful. The findings also show that knowledge base compatibility can have both positive and negative impacts on supplier knowledge sharing—conditional on the level of motivating factors such as customer participation and anticipated customer value.

Using experiments as the method in Study 1 ensures that our empirical results have high internal validity by keeping key extraneous factors constant across experimental conditions. However, the scenarios we used might be too restrictive, diminishing the generalizability of the findings. To address this limitation, in Study 2 we conducted a mail survey of supplier firms. The use of primary company data to test the research hypotheses can demonstrate the robustness of our empirical findings and increase their generalizability.

Study 2

Sample and Procedures

In Study 2, we used mail surveys to collect data from optics, computing, and automotive firms to test the hypotheses. We chose these technology-based industries because formal and informal collaborations among firms are common and previous studies have examined knowledge transfer and collaborations in these industries (Dyer and Hatch 2007; Ganesan, Malter, and Rindfleisch 2005). Collecting data from supplier firms of various sizes across multiple industries enables us to assess the generalizability of the findings in Study 1. In line with previous studies of interfirm collaborations (Rindfleisch and Moorman 2001; Rowley, Behrens, and Krackhardt 2000), we constructed a database of manufacturers from the membership directories of the largest associations for each industry (e.g., American Precision Optics Manufacturers Association, Original Equipment Suppliers Association). The sampled firms are all manufacturers in the private sector and thus exclude government organizations, trading companies, distributors, and services companies.

After compiling the sampling frame, we identified a specific key informant in each firm by searching company databases, social network websites, and company websites. Informants were vice presidents, directors of research and development or manufacturing, or people in executive positions who had an extensive understanding of their firms' collaborative activities with other firms. Our final sampling frame consisted of 610 manufacturers for which we could identify informants who were likely to be involved in their firm's collaborations with partners.

Before mailing the surveys, we contacted each informant by telephone to solicit voluntary participation and assess whether the informant possessed the relevant knowledge. If the informant was not involved in the firm's collaborative efforts, we asked him or her to provide the contact information of an appropriate person. We then mailed each informant a cover letter, questionnaire, and postage-paid reply envelope as well as a $10 gift card as an incentive. Three weeks later, we sent a reminder letter, followed by telephone calls. We mailed a second set of surveys to informants who did not respond within eight weeks. After collecting the surveys and discarding those with substantial missing data, we had a final sample of 110 of the 610 firms in the sampling frame, representing a response rate of 18%. This response rate is comparable to studies of distribution channels using mail surveys (Heide, Wathne, and Rokkan 2007; Noordhoff et al. 2011). The size of the sample firms ranged from fewer than 200 employees to more than 10,000, and annual sales ranged from less than $5 million to more than $1 billion. Among the sample firms, 54% came from the optics industry, 13% from the computing industry, and 33% from the automobile industry.

We assessed potential nonresponse bias by comparing early and late respondents and found no significant differences in means for key constructs, suggesting that nonresponse bias was not a major problem (Armstrong and Overton 1977). In response to our validity check, respondents reported that they were highly involved with and knowledgeable about the collaborative project (M = 5.8 on a seven-point scale) and had worked for their firms for an average of 15.4 years. Of the respondents, 75% were chief executive officers, presidents, or directors.

In the survey, we asked the informants to report their experience with a recently completed or nearly completed collaborative project with assessable performance indicators between their firm (i.e., the focal supplier) and another supplier firm (i.e., the partner supplier) that they viewed as a direct or indirect competitor. The collaborative project needed to meet several criteria. First, the purpose of the collaboration was to provide services or goods to a specific customer firm. Second, the partner firm was either a direct competitor (both firms supplied the same products to the customer) or an indirect competitor (with overlapping target markets). Third, the ownerships of the informants' firms, the partner firm, and the customer were independent. Because either the customer or the supplier could initiate the supplier collaboration, we assessed whether the level of supplier knowledge sharing differed between these two groups. The ANOVA results indicated no significant difference ($M_{\text{Customer initiated}} = 4.81$ vs. $M_{\text{Supplier initiated}} = 4.68$, n.s.) in the sample.

Measures and Validation

We developed and refined the measurement scales using field interviews and a pretest of the survey with purchasing personnel and marketing faculty at a public university. The Appendix presents specific items of these measures and their reliabilities. Descriptive statistics of the measures appear in Web Appendix W2. The assessment of scale properties and common method variance appears in Web Appendix W3.

Dependent variables. Supplier knowledge sharing refers to the intensity of supplier partners' exchange of valuable knowledge that can be used for collaborative effort. Thus, the operationalization of this construct assesses three ele-

ments of knowledge sharing: the intensity of the exchange, the value/quality of the shared knowledge, and the use of such knowledge. Because no existing scale for knowledge sharing assesses all three of the aforementioned elements, we developed a seven-item scale after reviewing various studies in the learning alliances literature. We assessed collaborative project performance, which refers to the extent to which the collaborative project achieves target goals and fulfills the customer's procurement needs from the perspective of the focal supplier. Because of the diverse nature of the collaborative projects among the firms sampled, we could not determine specific project goals a priori. Therefore, we developed a three-item scale to assess this construct without referring to specific project goals.

Independent variables. Knowledge base compatibility refers to the extent to which the collaborating parties possess similar and compatible knowledge, skills, and capabilities that enable them to work together effectively. No existing scales for this construct appear in the literature. The most relevant one is the scale from Rindfleisch and Moorman (2001) that measures knowledge redundancy between alliance partners. Therefore, we developed a five-item scale to assess this construct. Customer participation refers to the customer's active involvement in its suppliers' collaboration, such as gathering production information, mediating supplier partners' conflicts, providing technical assistance, and coordinating collaborative activities. In the absence of an existing scale, we developed a five-item scale that assessed the customer's facilitative and supportive role in collaborative projects between the suppliers. Anticipated customer value refers to the tangible value the focal supplier expects its collaborative effort to create for the customer. We used a new three-item scale to assess the focal supplier's expected impact of the collaborative project on the customer's profitability and the extent to which the project was valuable to the customer.

Control variables related to alternative governance mechanisms. To rule out the possibility that alternative governance mechanisms might motivate supplier partners to participate in knowledge sharing, we controlled for two factors: supplier partners' relationship length and transaction-specific investments. Prior research has shown that collaborating partners' relationship length and transaction-specific investments are safeguards that mitigate opportunism and encourage cooperative behaviors (Kale, Singh, and Perlmutter 2000; Rindfleisch and Moorman 2001). Firms use governance modes such as equity-based alliances (high levels of transaction-specific investment) to cope with severe hazards in knowledge exchange partnerships (Li et al. 2008; Sampson 2004). Relationship length fosters trust and relational norms and reduces information asymmetry, while transaction-specific investments act as mutual hostages that induce self-deterrence. Thus, these two factors serve as governance functions similar to customer participation. Adding these control variables enables us to determine whether customer participation has unique explanatory power after the effects of these safeguards are partialed out. We assessed relationship length in terms of number of years the supplier partners had business dealings before the examined collaborative project. We measured transaction-specific investments using a two-item scale that captured the level of supplier partners' investment of resources in the collaborative project.

Additional control variables. We controlled for two factors related to the relationship between the focal supplier and the customer: relationship closeness and the focal supplier's dependence on the customer. The nature of the customer–focal supplier relationship might motivate the focal supplier to make a greater effort in the collaborative project to ensure relationship continuance. We measured relationship closeness using a three-item scale adapted from Rindfleisch and Moorman (2001) and focal supplier dependence using a three-item scale adapted from Ganesan (1994). We controlled for competitive intensity between supplier partners by assessing the extent of competition between them across different product markets as well as for the customer's business using a new three-item scale. Because prior research has indicated that competitive intensity increases exchange hazards between collaborating partners (Sampson 2004), this factor would reduce supplier partners' willingness to share knowledge. In addition, we controlled for the relative power between the supplier partners in the collaborative effort, because this factor might affect suppliers' motivation to share knowledge. We used a single item to assess the asymmetric benefits that the supplier partners obtained from the collaborative project. We also controlled for the duration of collaborative projects, assessing project duration in terms of number of months. Finally, we controlled for industrial heterogeneity using a binary categorical variable (optics related vs. automobile). Because the sample firms from the computing industry were related to the production of optical drives, we combined firms from these two industries into one group.

Two-Stage Least Squares Regression Results

To test the hypotheses, we conducted a two-stage least squares (2SLS) regression analysis. This estimation procedure enabled us to correct for endogeneity through the use of instrumental variables. Endogeneity is a common estimation problem due to omitted variables and self-selection (Bascle 2008). In our conceptual model, customer participation may be endogenous and thus may lead to biased coefficients if estimated through ordinary least squares (OLS) regression. In the first stage, we regressed customer participation and all interaction terms involving customer participation on the instrumental variables and the control variables. We chose three instrumental variables[4] on the

[4]To meet the condition that the number of instruments must be greater than the number of endogenous variables, we created additional instrumental variables by multiplying the three instruments with customer value and knowledge base compatibility. We tested the validity of the set of instrumental variables using the Sargan test (Bascle 2008). The result indicated that the set of instrumental variables were exogenous ($\chi^2 = 7.49$, $p > .10$). We assessed the strength of the set of instrumental variables using the Anderson–Rubin test that applies to multiple endogenous variables (Bascle 2008; Wooldridge 2010). The result showed that the set of instrumental variables was strong ($F = 2.27$, $p < .05$) (i.e., the error term is uncorrelated with all instruments).

basis of their relevance to customer participation: relationship length between the customer and the focal supplier, the customer's dependence on the focal supplier, and whether the customer initiated the collaborative project.

In the second stage, we replaced the original values of customer participation and the interaction terms involving customer participation with predicted values estimated from the first-stage regression. Subsequently, we regressed supplier knowledge sharing on the antecedents, interaction terms, and control variables. We assessed endogeneity of customer participation and the related interaction terms using the Wu–Hausman test (Wooldridge 2010). The results indicate that at least one of these variables was endogenous ($F = 1.58$, $p < .10$), suggesting that 2SLS regression is the appropriate estimation procedure. We report the results in Table 1.

Before the 2SLS regression analysis, we mean-centered the independent variables that were part of the interaction term and then multiplied these variables to create the two- and three-way interaction terms (Aiken and West 1991). As a result, for all the variables that form the interaction terms, the regression coefficients are interpreted as simple (conditional) effects. These coefficients represent the effect of an independent variable on knowledge sharing at the mean value of other independent variables in the interaction term. We first assessed the significance of the three-way interactions in the regression model and then decomposed the significant interactions and tested the simple effects embedded in the significant interactions.

TABLE 1
2SLS Results: Study 2

Variables	Supplier Knowledge Sharing
Independent Variables	
Anticipated customer value	.05 (.41)
Customer participation	−.05 (.31)
Knowledge base compatibility	−.15 (1.17)
Customer value × customer participation	−.11 (.99)
Customer value × knowledge base compatibility	.23 (2.08)**
Customer participation × knowledge base compatibility	.15 (1.76)*
Customer value × customer participation × knowledge base compatibility	.18 (2.63)**
Control Variables	
Transaction-specific investments	.50 (6.26)***
Relationship length between supplier partners	.39 (1.30)
Relative power between supplier partners	−.13 (1.65)*
Competitive intensity between supplier partners	.12 (1.55)
Relationship closeness between focal supplier and customer	−.02 (.2)
Focal supplier dependence on the customer	.18 (1.86)*
Project duration	−.55 (1.32)
Industry	.11 (.47)
Adjusted R-square	.52

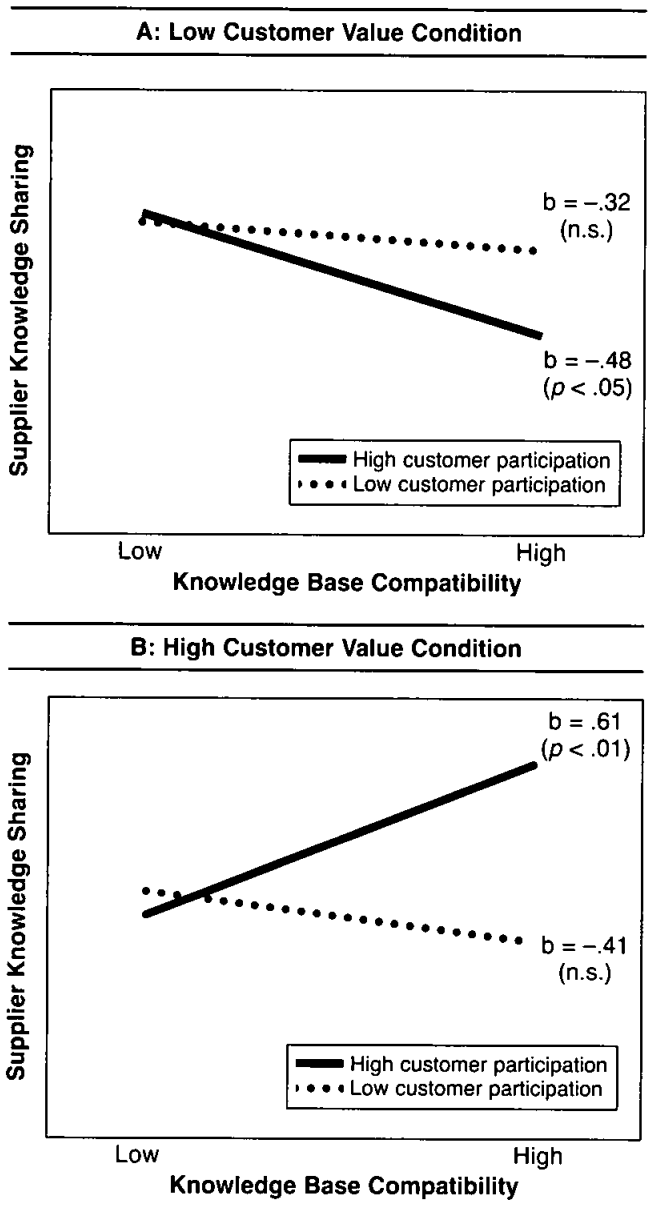
*$p < .10$.
**$p < .05$.
***$p < .01$.
Notes: Numbers are unstandardized coefficients with t-values in parentheses.

Supplier knowledge sharing. The 2SLS regression results indicate that the main effects of knowledge base compatibility (b = −.15, n.s.), customer participation (b = −.05, n.s.), and anticipated customer value (b = .05, n.s.) are not significant. As we hypothesized, the customer value × knowledge base compatibility × customer participation three-way interaction is highly significant (b = .18; t = 2.63, $p < .01$), suggesting that the knowledge base compatibility × customer participation interaction differs between the high and low customer value conditions. To determine the nature of the interaction effect, we tested the simple effect of knowledge base compatibility on knowledge sharing conditional on different levels of customer participation and customer value. We defined high and low levels of customer participation as one standard deviation above and below the mean, respectively. Similarly, high and low customer value was one standard deviation above and one below the mean, respectively. We then calculated the slopes (coefficients) and standard errors of knowledge base compatibility at high and low levels of customer participation along with high and low levels of customer value. We tested the significance of these coefficients using t-tests. Figure 3 presents these simple effects.

As we predicted in H_{3a}, when both customer participation and customer value are high, knowledge base compatibility increases knowledge sharing between supplier partners (b = .63; t = 4.04, $p < .01$). In contrast, as we predicted in H_{3b}, when customer participation is high but customer value is low, knowledge base compatibility is negatively associated with knowledge sharing (b = −.48; t = 2.01, $p < .05$). These divergent responses show that the customer's involvement in the suppliers' collaborative effort can be either constructive or destructive. The results are consistent with our conjecture that customer participation could mitigate suppliers' concern for opportunism and motivate them to take advantage of having overlapping knowledge bases with the partner or that it could arouse suppliers' negative sentiments and discourage them from sharing knowledge due to misappropriation risk. Nevertheless, when customer participation is low, knowledge base compatibility has no significant effect on knowledge sharing across different levels of customer value (b = −.32 when customer value is low, and b = −.41 when customer value is high). This result suggests that in the absence of customer participation as a social control, supplier partners lack the motivation to exploit their overlapping knowledge bases to facilitate knowledge transfer.

In addition to the significant three-way interactions, the interaction between customer participation and knowledge base compatibility is marginally significant and positive (b = .15; t = 1.76, $p < .10$), suggesting that the simple slope of knowledge base compatibility is greater in the high customer participation condition than in the low customer participation condition, while customer value is at the mean. This result supports H_1. Likewise, the interaction between

FIGURE 3
Study 2: Anticipated Customer Value × Knowledge Base Compatibility × Customer Participation Interaction



customer value and knowledge base compatibility is significant (b = .23; t = 2.08, $p < .05$), suggesting that the simple slope of knowledge base compatibility is greater in the high customer value condition than in the low customer value condition, while customer participation is at the mean. Thus, H_2 is supported.

Finally, among the control variables, transaction-specific investments have a significant and positive effect on supplier knowledge sharing (b = .50; t = 6.26, $p < .01$). This result suggests that transaction-specific investments act as safeguards that can promote greater knowledge sharing. In addition, the focal supplier's dependence on the customer (b = .18; t = 1.86, $p < .10$) and the relative power between the supplier partners (b = –.13; t = 1.65, $p < .10$) are also marginally associated with supplier knowledge sharing. These results indicate that knowledge sharing is greater when the focal supplier is substantially dependent on the customer for revenue and profits and when the focal supplier gains greater benefits from the collaborative effort than its partner does. No other control variable has a significant effect.

Post Hoc Analysis

Customer participation. In a post hoc analysis, we used OLS regression to find factors that increase the customer's participation in suppliers' collaborative projects. We regressed customer participation on all the control variables as well as three customer-related variables: the length of the customer's relationship with the focal supplier, the dependence of the customer on the focal supplier, and whether the customer (vs. suppliers) initiated the collaborative project (the same as the instrumental variables used in the 2SLS regression analysis). The results indicate that the level of customer participation is greater in supplier collaborations initiated by the customer than in those initiated by suppliers (b = 1.11; t = 3.20, $p < .01$). In addition, the customer's dependence on the focal supplier (b = .32; t = 2.31, $p < .05$) and the length of the customer's relationship with the focal supplier (b = –.90; t = 1.89, $p < .10$) are related to customer participation. No control variable has a significant effect.

Collaborative performance. Although we do not formally hypothesize the effect of supplier knowledge sharing on collaborative project performance, we tested this important relationship. Using OLS regression, we regressed collaborative project performance on supplier knowledge sharing and all the control variables. The results indicate that knowledge sharing has a significant and positive effect on performance (b = .25; t = 2.12, $p < .05$; $R^2 = .41$; F = 6.24). Among the control variables, the focal supplier–customer relationship closeness (b = .52; t = 4.40, $p < .01$) and supplier partners' transaction-specific investments (b = .27; t = 1.78, $p < .10$) have significant and positive effects. No other control variable has a significant effect. These results indicate that knowledge sharing helps supplier partners achieve greater collaborative performance and that the performance increment can be explained only partially by supplier partners' resource commitment and the focal supplier's relationship with the customer.

Discussion

Collaborations among competing suppliers within a customer's supplier network have become increasingly important to improve supplier productivity and meet the customer's sophisticated procurement needs. However, existing empirical studies on such collaborations are scarce and confined to reports of best practices and analysis of limited cases (e.g., Dyer and Nobeoka 2000; Wu, Choi, and Rungtusanatham 2010).

To advance the understanding of this phenomenon for academics and managers, this research investigates the collaborative effort between two competing suppliers serving a downstream OEM customer in a business-to-business con-

text. We focus on supplier partners' knowledge sharing in collaborative efforts and examine a few major antecedents. In our conceptual framework, knowledge base compatibility between the supplier partners represents the opportunity to share knowledge effectively with each other, because this factor helps them overcome communication and learning barriers. In addition, the customer value the collaboration is expected to create and the customer's participation in the collaboration are two motivating factors that moderate the impact of knowledge base compatibility on supplier partners' knowledge sharing. Thus, these three factors reflect the opportunity for and motivation of supplier partners to share valuable knowledge in their collaborative effort aimed to fulfill the customer's procurement requirements.

We examine these three factors jointly because each of them provides a necessary but insufficient condition for supplier knowledge sharing to occur. We tested the research hypotheses using data gathered from a scenario-based experiment and a survey study. In these two studies, we controlled for key extraneous factors including those related to the relationship between the supplier partners and the relationship between the focal supplier and the customer. Similar patterns of results appear across the two studies. Therefore, our empirical findings are robust and valid.

The results from the two studies provide strong empirical evidence in support of the hypothesized three-way interaction between knowledge base compatibility, customer participation, and anticipated customer value. Specifically, the results show that knowledge base compatibility has a positive impact on supplier partners' knowledge sharing when both anticipated customer value and customer participation are high. In contrast, knowledge base compatibility is negatively associated with knowledge sharing when anticipated customer value is low but customer participation is high. In addition, when customer participation is low, irrespective of the level of anticipated customer value, knowledge base compatibility has no significant effect on supplier knowledge sharing. These findings demonstrate that knowledge base compatibility can help or hinder supplier knowledge sharing under different motivating conditions. Importantly, our findings reveal that in a supplier collaboration serving a common customer, customer-related factors such as customer participation and anticipated customer value can alter the impact of knowledge base compatibility on supplier knowledge sharing from positive to null to negative. Previous research on knowledge transfer in collaborative partnerships has mainly used secondary data such as patent citations as a proxy for knowledge transfer (e.g., Mowery, Oxley, and Silverman 1996). In this regard, the present study provides new and direct evidence of both the beneficial and detrimental consequences of supplier partners' overlapping knowledge bases for knowledge sharing. In addition, this study identifies the boundary conditions of the effects of knowledge base compatibility.

Our research sheds light on the governance role of the customer in coopetitive supplier partnerships. We argue that the hazards arising from overlapping knowledge bases discourage supplier partners from participating in knowledge exchange activities. Drawing on extant literature, we conjecture that customer participation in the suppliers' collaborative effort could engender collective trust and cooperative norms within the triadic partnership (Wu, Choi, and Rungtusanatham 2010). We also suggest that supplier partners' reputation and future business opportunities lead to self-control (Parkhe 1993). These social processes would mitigate supplier partners' concerns for opportunism. As a result, customer participation motivates supplier partners to focus on exploiting the learning efficiency advantages of compatible knowledge bases rather than on the potential hazards, resulting in greater supplier knowledge sharing. Although the two empirical studies do not explicitly examine the occurrence of the micro governance processes, the results after ruling out the effects of alternative governance mechanisms, including transaction-specific investments and prior relationships, are consistent with our predictions. Therefore, customer participation has a unique explanatory power for supplier knowledge sharing, and the results provide tentative evidence in support of the governance role of customer participation.

This research also identifies the conditions that could increase a customer's participation in its suppliers' collaborative efforts. The post hoc analysis results suggest that when the customer initiates the supplier collaboration, the customer depends on the suppliers for resources, and the relationship length between the customer and the suppliers is relatively short, the customer is more likely to engage in suppliers' collaborative arrangements. Overall, this research not only demonstrates the importance of customer participation in supplier collaboration but also provides preliminary evidence on factors that drive such participation.

Finally, the post hoc analysis shows that supplier knowledge sharing significantly contributes to collaborative performance in terms of fulfilling the customer's procurement needs. This performance enhancement can only be partially explained by the amount of resources the supplier partners invest into the collaborative effort.

Managerial Implications

This research offers several broad managerial insights. First, we discuss the dilemma that suppliers encounter when they collaborate with partners that have overlapping and compatible knowledge bases. Although compatibility simplifies and facilitates the exchange of information, ideas, and tacit know-how, resulting in greater knowledge transfer and positive collaborative outcomes, it also creates a greater risk of knowledge misappropriation. Therefore, suppliers must understand the implications of choosing a partner with similar know-how and capabilities. Suppliers should also note that when the collaboration involves exchanging mostly tacit know-how such as that embedded in capabilities (Ganesan, Malter, and Rindfleisch 2005), high knowledge base compatibility is an essential condition for effective knowledge transfer to occur. Paradoxically, because knowledge embedded in capabilities holds strategic value, any unintended leakage could cause substantial damage to the suppliers. Thus, suppliers face a serious dilemma when sharing skills and capabilities with their partners. The

potential threats are further aggravated when the supplier partners are also competitors.

Second, suppliers should systematically evaluate the benefits and costs of sharing knowledge with partners. Although knowledge sharing contributes to positive collaborative outcomes, it also entails substantial costs in establishing routines and governance, especially for long-term partnerships. Suppliers must develop knowledge-sharing routines to facilitate knowledge flow across organization boundaries and set up task forces or assign specific personnel to oversee knowledge-sharing activities. Simultaneously, suppliers must assess the likelihood and potential damage of unintended knowledge spillover and choose an effective governance mechanism. Suppliers should understand the efficacy and implementation costs of different types of formal and informal safeguards and select the governance mechanism that aligns with the goals of the collaborative effort and the collaborative history of the partners.

Third, our findings suggest that customer participation likely tempers supplier partners' concern for partner opportunism, thus ensuring the learning efficiency advantages of compatible knowledge bases between supplier partners. Nevertheless, suppliers should understand the circumstances under which they can rely on customer participation as a feasible safeguard. First, a customer might not have sufficient motivation or legitimate power to participate in its suppliers' collaborative arrangement. Second, suppliers might lack the bargaining power to prescribe the activities with which the customer should get involved. Therefore, suppliers face challenges in evaluating the efficacy of governance processes the customer can introduce in the collaborative arrangement before its formation. Suppliers should take these issues into consideration in planning for partnerships.

For the customer firm, this research underscores the importance of motivating supplier partners to share valuable knowledge in their collaborative efforts. Because rivals cannot imitate or easily acquire effective supplier partnerships, customers should attempt to facilitate the development of collaborative partnerships among their suppliers. To motivate supplier partners to exchange valuable know-how, the customer (if it has legitimate power and expertise) should take part in such activities as mediating conflicts, providing technical consultation, and dedicating engineers to supplier sites. Importantly, the customer's participatory actions should aim not only to improve collaborative effectiveness but also to nurture collective trust and cooperative norms among the suppliers. In addition, customers must understand suppliers' opportunity and motivation concerns with respect to knowledge sharing so that they can offer incentives and formulate policies to overcome suppliers' fears and resistance. For example, customers can establish a supplier association and use it as a platform for increasing opportunities for suppliers to access one another's technical expertise and problem-solving experience. Customers can also share new product, manufacturing, and technological knowledge with suppliers through supplier development programs. As the literature has suggested, such programs not only enhance supplier capabilities but also promote social interactions and reciprocity norms among the customer and suppliers (Cheung, Myers, and Mentzer 2011). Over time, a cohesive supplier community can emerge, conferring competitive advantages on the customer (Dyer and Nobeoka 2000).

This research also suggests that a customer should recognize that the value the supplier partners expect their collaboration to create and its own participation level are motivating factors that increase supplier partners' willingness to take part in knowledge-sharing efforts. However, the customer must be aware that if supplier partners are uncertain about the strategic value of the collaboration for the customer, they may consider some of the customer's participatory activities intrusive and overbearing, resulting in resistance and negative consequences. Therefore, to benefit from the learning-efficiency advantages of supplier partners' overlapping knowledge bases, a customer should explicitly disclose to its suppliers the long-term strategic value of the collaborative partnership and convince them that its participatory actions could help prevent partner opportunism and mitigate exchange hazards.

Limitations

This research has several limitations. First, we examined knowledge sharing between supplier partners in a collaborative partnership aimed at serving a downstream OEM customer. However, we did not evaluate how collaborative goals and other factors affect suppliers' intention to form a partnership in the first place. Second, we assessed the independent and dependent variables of the conceptual model from a single supplier's perspective. Because the data collected are not dyadic, the focal supplier's perceptions may not be identical to those of the partner supplier. In addition, the items used to measure collaborative project performance and supplier knowledge sharing in Study 2 were rather broad. We did not capture specific types of knowledge (e.g., product or process knowledge) shared between the supplier partners. Because we did not restrict the scope and purpose (e.g., new product development, process refinement) of the supplier collaborations we examined, we could not develop measures that would reliably capture specific types of shared knowledge and specific collaborative performance criteria.

Third, this study did not address the implications of various knowledge characteristics, such as complexity, depth, and breadth, for supplier knowledge sharing. These characteristics may facilitate or impede the process of knowledge sharing independently or interact with knowledge base compatibility. Fourth, this study examined the impact of customer participation on suppliers' collaborative efforts without addressing the customer's motivations for participation. In addition, although we argue that customer participation can mitigate supplier opportunism, our empirical studies did not directly capture the incidences of such microprocesses in the supplier collaboration.

APPENDIX
Study 2 Measures

Construct and Composite Items	α	Average Variance Extracted	Composite Reliability	Factor Loading
Collaborative Project Performance	.94	.84	.87	
1. The collaborative project has reached our pre-specified goals.				.94
2. The collaborative project has achieved our target performance.				.97
3. The collaborative project has met the procurement needs of the customer.				.82
Knowledge Sharing	.92	.61	.87	
1. My firm and the partner have shared a significant amount of knowledge with each other.				.86
2. My firm and the partner have created new skills and knowledge by working together.				.87
3. My firm has exchanged many ideas with the partner about how to improve each other's capabilities (in manufacturing, research and development, logistics, etc.).				.82
4. In general, the skills and knowledge that have been shared between my firm and the partner are:				
a. A limited amount/substantial amount.				.83
b. Basic/advanced.				.72
c. Of little value to both parties/of significant value to both parties.				.64
d. Of limited use/of significant use.				.69
Anticipated Customer Value	.70	.50	.66	
At the time when your firm's collaboration with the partner was ongoing, your firm expected that this collaboration would:				
1. Create superior value for the customer.				.74
2. Have a significant impact on the profitability of the customer.				.73
3. Become a valuable resource to the customer.				.63
Customer Participation	.82	.61	.83	
1. The customer's involvement is integral to the collaborative project.				.65
2. The customer has been regularly informed of the progress of the collaborative project.				.70
3. The customer has provided technical assistance to my firm and the partner.				.79
4. The customer has helped to mediate and resolve conflicts arising in the collaborative project.				.87
5. The customer has been involved in coordinating the collaborative activities between my firm and the partner.				.88
Knowledge Base Compatibility	.73	.51	.77	
1. My firm's employees understand the partner's skills and technologies.				.75
2. My firm's skills and technologies are compatible with those of the partner.				.65
3. My firm's approach to learning new skills and technologies is similar to those of the partner.				.81
4. My firm's capabilities (in manufacturing, research and development, logistics, etc.) are similar to those of the partner.				.63
5. The partner's employees understand my firm's skills and technologies.				.73
Transaction-Specific Investments	.89	.61	.66	
1. My firm has committed a significant amount of resources and efforts to the collaboration.				.76
2. The partner has committed a significant amount of resources and efforts to the collaboration.				.81
Competitive Intensity	.82	.65	.77	
1. My firm competes directly with the partner for the customer firm's business.				.80
2. My firm's target markets are similar to those of the partner.				.51
3. My firm considers the partner a major competitor in various product markets.				.88
Relationship Closeness Between Focal Supplier and Customer	.83	.64	.76	
1. My firm's relationships with this customer can be described as mutually gratifying.				.84
2. My firm expects to do business with this customer in the long run.				.81
3. My firm's staff have close, social interactions with this customer's staff.				.75

APPENDIX
Continued

Construct and Composite Items	α	Average Variance Extracted	Composite Reliability	Factor Loading
Focal Supplier Dependence on Customer	.84	.72	.80	
1. It would be difficult for my firm to replace this customer's business.				.86
2. My firm is dependent on this customer for sales.				.89
3. This customer accounts for a high percentage of my firm's sales.				.80
Relative Power Between Supplier Partners[a]				
Which party benefits more from the collaborative effort?				

[a]Measured on a seven-point Likert scale (1 = "my company," and 7 = "the partner company").

Notes: All measures used seven-point Likert scales (1 = "strongly disagree," and 7 = "strongly agree") except for the "Knowledge Sharing" section, which used seven-point Likert scales for the first three items and sematic differential scales for other items.

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