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COMPARING THE RESOURCE-BASED AND RELATIONAL VIEWS: KNOWLEDGE TRANSFER AND SPILLOVER IN VERTICAL ALLIANCES

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We compare resource-based and relational perspectives to examine competitive advantages within the context of vertical learning alliances. Previous research has shown that through such alliances suppliers acquire knowledge to forge new capabilities and attain performance improvements. We ask whether such improvements are exclusive to the learning partnership, or are available in other average partnerships of this supplier. We posit that the extent to which such performance improvements are partnership exclusive depends on whether the newly forged capabilities lie entirely within the supplier firm's boundaries, or at the learning dyad level. As such, we untie two forms of performance improvements arising from learning dyads. While the resource-based view helps explain the performance gains learning suppliers deploy across average partners, the relational view reveals the additional performance edge that remains exclusive to the learning partnership. Based on empirical evidence from a survey of 253 suppliers to the equipment industry, we find that partnership exclusive performance (i.e., 'relational performance'), the true source of learning dyads' competitive advantage, is a function of suppliers acquiring know-how within the dyad, developing dyad-specific assets and capabilities, and structuring buyer-supplier relational governance mechanisms. We discuss implications for research and practice.

INTRODUCTION

Recently, both the resource-based view (RBV) and the relational view have been perceived as influential theoretical frameworks to explain firms' competitive advantages. Proponents of the RBV explain that competitiveness arises from valuable firm-level resources and capabilities that are costly to imitate (Barney, 1991; Dierickx and Cool, 1989). Relational view scholars in turn explain that such competitiveness arises not from *firm*, but *interfirm* sources of advantage (Dyer and Singh, 1998; Gomes Casseres, 1984; Smith, Carroll, and Ashford, 1995; Lavie, 2006). Given the seemingly

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equivalent nature of the two views, some scholars have highlighted the difficulties, except for their respective units of analyses, of telling them apart (e.g., Molina, 1999; Dyer and Singh, 1999). In this article, we seek to explore the boundaries of the resource-based and relational views by theoretically and empirically unraveling the different types and levels of competitive advantages that each framework helps explain.

To help readers weigh the importance of our endeavor, let us quickly explore an example of the strategic challenges involved in vertical learning alliances. Based on the RBV (Barney, 1991; Peteraf, 1993)—and its correlate, the dynamic capabilities approach (Teece, Pisano, and Shuen, 1997)—learning alliance scholars often explain that firms earn advantages by forging new capabilities through knowledge acquisition (e.g., Anand and Khanna, 2000; Dussauge, Garrette, and Mitchell, 2004; Dyer and Hatch, 2006; Grant, 1996; Hatch and Dyer, 2004; Kale, Singh, and Perlmutter, 2000; Khanna, Gulati, and Nohria, 1998; Mowery, Oxley, and Silverman 1996, 1998; Simonin, 1999, 2004; Spender, 1996; von Hippel, 1988). Following this rationale, several industries that experienced the dismantling of vertically integrated empires and saw the matter of managing supplier networks become more salient (e.g., automobiles, semiconductors) also saw the emergence of supplier development programs, that is, concerted knowledge transfer efforts whereby buyers educate suppliers on the principles of advanced production systems, such as 'lean,' 'flow,' or 'just in time' (Dyer and Hatch, 2006; Dyer and Nobeoka, 2000; Kotabe, Martin, and Domoto, 2003). The logic is rather simple: buyers accumulate a body of cutting-edge knowledge, taking advantage of their network center hub position, and then teach less knowledgeable suppliers in order to garner supply chain competitiveness.[1]

But it is not clear if, or under what conditions, buyers stand to gain from training their suppliers. Though trained suppliers may outperform untrained ones, if this performance gain is not exclusive to the learning partnership, then training buyers would provide no advantages to their knowledge transfer efforts, as other buyers could potentially 'free ride' the investments by simply partnering with the trained supplier. The magnitude of this problem is immediately apparent in the examples of Toyota and John Deere. These two companies, leaders in the automotive and equipment industries respectively, have made substantial investments in their supplier development programs, believing they can establish a supply-base advantage (Dyer and Nobeoka, 2000; Stundza, 2001). Some of their rivals, however, have taken strikingly different approaches. One leading contender of Deere, for example, prefers to routinely pick first-rate suppliers from the market and pressure them to continuously upgrade their capabilities with investments of their own—an approach we refer to as '*cream off* the supplier market'—in an attempt to accrue similar supply chain benefits. An executive of this firm remarked to us during an interview, 'If Deere invests so much in knowledge transfer to suppliers, if the market also offers numerous training programs, and if the costs of training suppliers are as large as benefits are uncertain, why not just cream the market off?' This paradox translates back to the RBV framework as follows: if suppliers' performance gains are not exclusive to the learning partnership, then Deere would see no advantages to its training investments, as competitors can potentially 'free ride' them.

In the event that Toyota's and Deere's beliefs are correct in that their trained suppliers' superior performance is partnership exclusive, the following research question results: what factors explain a supplier's performance gains materializing exclusively within its learning alliance? A related question would be, in the event Deere's competitor above is correct in that it can 'free ride' Deere's supplier training investments, to what extent do the trained supplier's performance gains permeate its average customer base?

We believe that by integrating and contrasting theory elements from the resource-based and relational views, we can precisely delineate the extent to which these seemingly analogous perspectives help explain the above performance advantage conundrum. Specifically, we argue that the RBV helps explain how trained suppliers outperform untrained ones through the acquisition of valuable and costly to imitate capabilities. Concomitantly, we argue that the RBV is less useful to explain a supplier's superior performance that is exclusive to the learning partnership. Here, relying instead

[1] For matters of simplicity we take the knowledge source's and recipient's identities to be those of buyers and suppliers respectively. We acknowledge these identities can also function in reverse, for example, suppliers to buyers.

on the relational view, we argue that the extent to which a trained supplier's performance advantage is partnership exclusive depends on the locus of its acquired capabilities. If these are held at the trained supplier/training buyer dyad interface, they will be exclusively deployable in that very partnership; but if they reside entirely within the trained supplier boundaries, they will be redeployable across to other average buyers. Additionally, we theorize that partnership exclusive performance also depends on how the trained supplier's capabilities were forged; particularly, we argue that partnership exclusive performance associates with special forms of knowledge transfer as well as interfirm governance mechanisms. We test this model with survey data from 253 U.S. parts suppliers.

As we detail in our conclusion section, our study contributes to the RBV, relational view, and learning alliances literatures. Previous learning alliance research primarily builds on the RBV and dynamic capabilities frameworks to explain the association between a trained firm's competitive advantages and their valuable but difficult to acquire capabilities; our study, in contrast, also integrates insights from the relational view (Dyer and Singh, 1998) to investigate the knowledge transfer processes resulting in superior performance exclusively within the learning alliance. Thus our concern with spillover relates not to leakage of precious knowledge to competitors (e.g., our concern is not with Deere's competitors acquiring Deere's capabilities), but to leakage of superior performance to learning dyad outsiders (i.e., our concern is with trained suppliers' ability to redeploy superior competencies outside the learning dyad). Ultimately, by contrasting processes leading to a supplier's *relational performance* (the difference between its performance with a focus partner vis-à-vis with its average partner base) with its *redeployable performance* (the performance levels trained suppliers can replicate across average customers), we attempt to integrate and advance the resource-based and relational views.

KNOWLEDGE TRANSFER AND PERFORMANCE

Referring to the model in Figure 1, we begin with the motivation from the resource-based logic (Hypothesis 1), which helps us review useful literature and explain sources of a particular supplier's redeployable performance. We then elaborate on factors involved in the relational view (Hypotheses 2, 3, and 4), which explain this supplier's relational performance.

Knowledge acquisition and redeployable performance

Management scholars assert that one's competitive advantage results from the possession of valuable, rare, and costly to imitate resources and capabilities (Barney, 1991; Dierickx and Cool, 1989; Peteraf, 1993). Teece, *et al*. (1997) extended this notion by proposing a dynamic capabilities approach to firm advantage; they propose that one's ability to continually acquire new knowledge

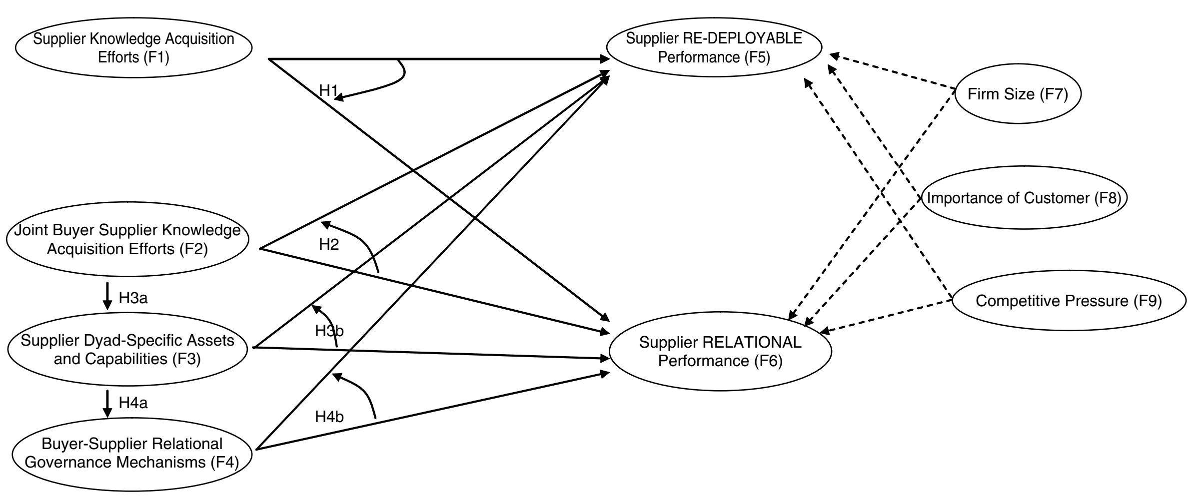

Figure 1. Model and hypotheses

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to adapt and upgrade a firm's capabilities is crucial to sustaining such advantages.

But not all knowledge translates into competitive advantages (Barney, 1991; Peteraf, 1993). It is only when the markets for knowledge are imperfect (e.g., this knowledge is 'sticky,' or the resources and capabilities based on such knowledge accumulate slowly over time, or the acquisition of this knowledge is subject to path dependence) that one is likely to see sustainable advantages (Barney, 1991; Dierickx and Cool, 1989). Based on the above market imperfection logic, scholars have proposed that advantages accrue mostly to those focusing on the acquisition of tacit and team-based (i.e., collective) as opposed to explicit and individually held knowledge (Spender, 1996; Zhao, Anand, and Mitchell, 2004).

Collective knowledge in buyer-supplier partnerships

Taking the RBV and dynamic capabilities framework above to the context of buyer-supplier partnerships, we have that suppliers who acquire collective production know-how out-compete those that do not. This acquisition of collective production know-how is defined as the implementation of a broader set of capabilities involving far-reaching organizational and technological adaptations inherent in advanced production systems (as opposed to the implementation of one or another specific technique). These include, for example, the abilities to perform large-scale plant changeovers and reductions of buffer inventories through just-in-time management, as well as various other multifaceted activities that lie across different layers of the firm's hierarchical ladder, such as the coordination of data gathering, the establishment of quality inspection responsibilities, and the integration of root cause analyses (Nishiguchi, 1994). Because this acquisition involves the understanding of socially complex nuances in these team-based capabilities (Hatch and Dyer, 2004), firms resort to multi-period learning efforts—what Ohno (1988) referred to as *kaizen*—and social interactions with training organizations (Dyer and Nobeoka, 2000; McEvily and Zaheer, 1999).[2]

The above described acquisition of collective know-how, in turn, enables trained suppliers to more speedily and more flexibly respond to changes in demand patterns of its customer base, thus observing improvements in its production and delivery abilities. For example, because of the temporal discrepancy between buyers' orders and goods production, suppliers often cushion against lost sales by stockpiling inventory (Hopp and Spearman, 2000). As they acquire the know-how above, suppliers are able to more flexibly and swiftly promote changes in plant setup so as to respond accordingly to changes in mix and volume. These capabilities enable suppliers to reduce the size of the temporal discrepancy and operate with smaller piles of buffer inventories (Dyer and Nobeoka, 2000; Lieberman and Asaba, 1997). Likewise, these suppliers are also likely to improve the efficiency with which they deliver goods to buyers. More specifically, with increased production flexibility (i.e., increased speed to respond) suppliers are less likely to delay delivery of particular orders, thus saving in costs such as 'expediting,' 'follow-up work,' and 'extra inventory,' all of which are recognized as some of the most expensive costs of product exchange (Dyer and Nobeoka, 2000; Ferdows *et al*., 1986; Kotabe *et al*., 2003; Ward *et al*., 1995).

Notably, the rationale above implies that once a supplier possesses valuable and costly to imitate resources, it will outperform rivals who do not own similar resources. At the same level, our theory implies that the possession of newly learned capabilities enables suppliers to improve performance in general, across different contexts. Specifically, the techniques it learns are not tailored to specific partners; therefore, such techniques can be redeployed regularly across partners, leading to redeployable as opposed to relational performance.

Hypothesis 1: A supplier's knowledge acquisition efforts associate more positively with its redeployable performance than with its relational performance.

Hypothesis 1 helps establish a basis for comparison with our central theses, presented below. Specifically, an exclusive focus on the RBV and

[2] Such training organizations may be large customers (e.g., Dyer and Nobeoka, 2000, describe how Toyota's suppliers rely on this automaker's successful knowledge transfer program), or even market available institutions (e.g., McEvily and Zaheer, 1999, describe how parts manufacturers acquire knowledge through extensive multi-period training efforts in publicly supported agencies, training centers, and universities).

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dynamic capabilities literature helps explain redeployable performance, but not relational performance. Below, we borrow theoretical elements from the relational view to explain that a supplier's relational performance is a function of its (a) acquiring knowledge in joint efforts with partners, as opposed to acquiring them from unrelated partners or even from publicly available agencies; (b) developing partnership-specific assets and capabilities; and (c) structuring buyer-supplier relational governance mechanisms to safeguard specific assets and coordinate the use of complementary assets. We explore each of these in turn.

Joint knowledge acquisition and relational performance

When suppliers develop knowledge acquisition efforts jointly with a given buyer, they are more likely to attain relational performance gains with that buyer. Joint buyer-supplier knowledge acquisition efforts are defined as the acquisition of collective or complex manufacturing know-how by suppliers where the focus buyer has direct participation in the process. Direct participation relates to buyers being involved in the supplier knowledge acquisition efforts either by 'teaching' and/or 'co-participating.' 'Teaching' involves hands-on instructing and consulting such as, for example, when buyers send their own employees into supplier plants for weeks or months to help implement *kaizen* routines, redesign work stations, reorganize process flow, modify equipment, and establish problem-solving groups (e.g., MacDuffie and Helper, 1997: 118). 'Co-participating,' in turn, involves buyers' and suppliers' staffs joining for training offered by third parties, such as when buyer and supplier firms each send engineers to learning programs at a given university or a government agency.

The effect of joint knowledge acquisition efforts on relational performance occurs in two ways. First, joint learning efforts lead to greater rates of learning, resulting in improvements that firms outside the dyad are unable to comprehend and unable to match. Where partners work in physical and social proximity, they are able to more serendipitously and swiftly cross-fertilize each other's systems with new ideas and suggestions for coadaptations (Kogut and Zander, 1996). For instance, Kogut and Zander (1996) explain that knowledge within an organization flows faster across its members than to outsiders because these members share an identity and are more socially integrated. We infer from this logic that the same knowledge flow effects can be observed in groups of buyer's and supplier's members integrated in joint purposes and efforts to share knowledge, even if they do not formally belong to the same organization (Zhao *et al.*, 2004). Moreover, scholars also believe there is a 'learning to learn' effect as well. For example, Anand and Khanna (2000) explain that alliance partners observe greater knowledge transfer effects over time, as their learning alliance becomes more efficient. Also, in such complex systems where partners hold separate but complementary sets of knowledge, the identification of forms of knowledge coadaptation is often knowable only to those physically and socially involved (Nelson and Winter, 1982).

Second, the frequent and serendipitous system improvements made over the course of several periods of interaction are more immediately apparent for those directly involved in the learning process and less apparent to outsiders. As Lane and Lubatkin (1998) explain, the social complexity of the interaction between two parties increases their 'relative absorptive capacity' and thus, although outsiders may eventually partner with either firm in the dyad, they are unable to grasp, assimilate, or take advantage of such changes. In sum, supplier performance gains associated with joint buyer-supplier knowledge acquisition efforts are more likely to be available to firms within that dyad than to outsiders.

Hypothesis 2: Joint buyer-supplier knowledge acquisition efforts more positively relate with a supplier's relational performance than with its redeployable performance.

Joint knowledge acquisition efforts and dyad-specific assets and capabilities

Joint buyer-supplier knowledge acquisition efforts not only have a direct effect on a supplier's relational performance, but also positively relate to a supplier's investments in dyad-specific assets and capabilities, which in turn further enhance supplier relational performance. The first step of this mediating effect relates to abilities of buyers to influence the supplier's decisions to invest in assets and capabilities that complement those of the buyer

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(von Hippel, 1988). In a way, a supplier's investments in dyad-specific capabilities must be guided by intimate interaction and decision making of both parties. Our logic is based on suggestions by organization and economics scholars that parties are more likely to build a tightly knit system when they more closely coordinate joint knowledge acquisition; this joint effort helps them work out the complex ways in which their capabilities will evolve symbiotically (March and Simon, 1958; Milgrom and Roberts, 1992; Simon, 2002).

As a case example, a large supplier firm we visited for this research had actively been involved with a supplier development program, sponsored by one of its largest customers, for the past two years. This buyer's consultants and engineers had been visiting this firm and working closely with its production and sales personnel to implement a more nimble just-in-time system. As this joint workforce redesigned routines, they made specific recommendations for the supplier's investments in assets and capabilities, such as the development of more appropriately designed storage bins, the separation of an exclusive loading dock, and the training and deployment of two exclusive account managers to more closely control the order flows for this customer. Thus, the buyer-supplier team was able to pinpoint detailed ways in which specific forms of investments and developments would benefit the greater complementarity of the two firms. Given the above:

Hypothesis 3a: Joint buyer-supplier knowledge acquisition efforts positively associate with the degree to which a supplier's investments in new assets and capabilities are dyad specific.

Supplier dyad-specific assets and capabilities, and relational performance

These dyad-specific assets and capabilities can have a further positive effect on relational performance. The rationale is three pronged. First, one's specific assets and capabilities are known to have better fit with assets owned by the relationship partner, and as a result enable the attainment of extra marginal performance that is unavailable to outsiders (Milgrom and Roberts, 1992: 108). Second, when suppliers' assets are tailored to fit their complementary buyer's resources, suppliers face a situation of small numbers bargaining (Williamson, 1985) whereby they are unable to easily find partners with capabilities that bear similar levels of complementarity in the market. Indeed, scholars from the economics and strategy fields have described how specific assets relate to performance gains unavailable in other partnerships (e.g., Asanuma, 1989; Dyer, 1996; Milgrom and Roberts, 1992). For example, the geographical proximity of immobile assets in successive production stages—what Williamson (1985) refers to as site specificity—leads to greater productivity because it enables reduced timing discrepancies in the interactions of information and product exchange (Dyer, 1996; Saxenian, 1994). Likewise, the degree to which partners tailor capital investments such as machinery, tooling, and dies to particular exchanges—what Williamson (1985) refers to as physical specificity—has been linked to greater interfirm process integrity and quality (e.g., Clark and Fujimoto, 1991; Nishiguchi, 1994). Further, the degree to which know-how and routines are partner specific—what Williamson (1985) refers to as human specificity—also enables alliance partners to coordinate communication and product exchange more effectively, thus helping reduce costs and speed access to market (Dyer, 1996; Kogut and Zander, 1992).

Third, specific resources and capabilities impose difficulties for a partnership outsider to comprehend how such specificity associates to superior performance. Simon (1947; 2002) explained that where partners' assets are specific, they are intricately tangled. Such intricacy is unique and important to the system's performance outcome; because of the intricate manner in which relationship-specific resources relate to one another, outsiders are less able to comprehend the fit and role of dyad-specific assets and capabilities within a system. As a result, they are less able to match the same complementary investments and obtain the same performance enhancements. In sum, the degree of specificity of a given resource or capability enhances the costs for redeployability (Dierickx and Cool, 1989), thus impeding suppliers from replicating equal performance levels with partners outside the focus dyad (Amit and Schoemaker, 1993; Dyer and Singh, 1998; Perry, 1989):

Hypothesis 3b: A supplier's dyad-specific assets and capabilities more positively associate with its relational performance than with its redeployable performance.

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Dyad-specific assets and capabilities and alliance governance mechanisms

Another set of effects in the model relates to alliance governance mechanisms. As suppliers increase their investments in dyad-specific assets, they are also likely to structure alliance governance mechanisms more carefully; such mechanisms, in turn, relate to supplier relational performance. We analyze each of these effects. First, the choice to structure given forms of alliance governance mechanisms is contingent upon previous choices of attributes present in the transactions, such as the levels of asset specificity (Masten, Meehan, and Snyder, 1991). This rationale stems from transaction cost scholars, who establish that specific assets trigger a threat of opportunism by unprincipled partners (Klein, Crawford, and Alchian, 1978); such threats may materialize in the form of holdup, as such assets can only be deployed in a second alternative use, at a substantial loss (Williamson, 1985). It is to counter such threats that parties resort to structuring alliance governance mechanisms.

Based on the above rationale, we conjecture that the more suppliers invest in dyad-specific assets and capabilities, the more they will rely on alliance relational governance mechanisms. Relational governance mechanisms are defined as 'informal agreements and unwritten codes of conduct that powerfully affect the behaviors of individuals within firms [and]... the behaviors of firms in their dealings with other firms' (Baker, Gibbons, and Murphy, 2002: 39–40). Our focus on relational governance mechanisms is not meant to deny the existence of other forms of agreements such as formal contracts or equity agreements, which are also often used in close buyer-supplier agreements (Dyer, 1997; Helper, 1991). We acknowledge such alliances may include several forms of contracting concomitantly.[3] Indeed, recent literature testing *discriminating alignment* (e.g., Leiblein, Reuer, and Dalsace, 2002; Mesquita and Brush, 2008; Silverman, Nickerson, and Freeman, 1997) suggest that different governance choices (e.g., make vs. buy, equity vs. non-equity) are also likely to enhance performance. However, given the greater complexities involved in the knowledge transfer process, it becomes costly for parties to establish *ex ante* what they will do *ex post* for all existing contingencies; as a consequence, such contracting mechanisms must also be self-enforced.[4] Thus, through tacit rules, buyers and suppliers rely mostly on *ex post* adaptive negotiations as opposed to trying to specify a complete set of terms and conditions for all future contingencies *ex ante* or even guarantee enforcement of *ex post* behavior by establishing equity partnerships *ex ante* (Helper, 1991: 783). Our focus is consistent with Dyer and Singh's (1998) relational view model, which focuses on relational governance. Our conjecture also parallels the thesis of Chung, Singh, and Lee (2000), in which resource complementarity serves as a basis for the formation of alliances.

In sum, as suppliers make greater investments in dyad-specific assets and capabilities, they are more likely to rely on alliance relational governance mechanisms.

> *Hypothesis 4a: The degree to which a supplier's assets and capabilities are dyad specific positively associates with the relational content of their buyer-supplier alliance.*

The alliance relational content identified above, in turn, positively relates to higher relational performance. This effect can be explained by both the 'coordination' and the 'transaction costs' logics. The former explains that relational alliance mechanisms affect the efficiency with which parties mutually coordinate their interdependent systems (Gulati and Singh, 1998; Lorenzoni and Lipparini, 1999; Thompson, 1967; Mesquita and Brush, 2008). The second logic explains that through relational governance, parties also observe a lower likelihood that one will opportunistically hold up the other (Masten, 1996; Williamson, 1985), for example by cutting back on product deliveries (Noordewier, John, and Nevin, 1990).

Three particular forms of relational governance mechanisms help suppliers achieve greater levels of relational performance. First, based on

[3] Whether relational governance 'substitutes' or 'complements' other forms of alliance mechanisms (e.g., formal contracts or equity agreements) is a topic reviewed in Poppo and Zenger (2002).

[4] Theories of contractual self-enforcement posit that parties may honor unwritten agreements in order to preserve their reputation and avoid the termination of valuable, long-term relationships (Axelrod, 1984: 124; Heide and Miner, 1992: 267). As parties continue transacting over time, social norms and trust will also tend to emerge and further support a collaborative orientation (Fichman and Levinthal, 1991).

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commitments for extensive information exchange, especially on market demand conditions, parties are able to more accurately track the expectations of each other (Van de Ven and Walker, 1984). As a result, they can size up the need for inventory provisions against demand contingencies the two agree are more likely to happen, thus helping parties reduce the costs of coordination. Moreover, as parties voice their concerns over the problems that arise, they are more likely to resolve their differences and avoid *ex post* negotiation hazards (Helper, 1991). Second, based on commitments for mutual assistance, parties prevent unwanted supply interruptions or even react quicker to avert major losses when disruptions inadvertently occur (e.g., production line breakdowns). Thus, such commitments help firms enhance the reliability of each part of the system (Milgrom and Roberts, 1992). Moreover, the attitude of assistance also creates an environment that is more conducive to future cooperation (Kale *et al*., 2000). Third, based on commitments for reciprocity, partners more effectively coordinate when and how to draw on each other's resources, contribute resources to the relationship (Asanuma, 1989; Kotabe *et al*., 2003), and leverage their complementary capability sets according to shared expectations of industry conditions (Dyer and Nobeoka, 2000: 360). As with specific assets, relational governance is partnership specific, and thus is more likely to associate with relational performance than with redeployable performance. Therefore:

Hypothesis 4b: Buyer-supplier relational governance more positively associates with a supplier's relational performance than with its r-deployable performance.

DATA AND METHODS

We tested our hypotheses on a sample of vendors supplying recurrently purchased parts to equipment manufacturers (i.e., makers of farm, construction, and industrial tractors). This industry has been subject to a special set of common trends and pressures that make firms adopt advanced production systems and invest in learning partnerships. These trends include higher competition and cost pressures due to industry overcapacity (Bossong Martinez, 2000) and customer inclinations to buy less on impulse and more on cost-benefit trade-offs (Menes, 2000). We also have evidence of increasing investments in supplier development programs, as demonstrated by public statements of large buyers (e.g., Stundza, 2001; Siekman, 1999) or even by research conducted in the automotive industry, known to also invest in supplier development efforts and rely on the same supplier base (e.g., Dyer and Nobeoka, 2000). Moreover, our preliminary fieldwork confirmed that several of the suppliers to be surveyed aggressively boasted of their constant investment in capabilities upgrading.

Research design and data collection

Data on interorganizational processes and knowledge acquisition are often difficult to obtain. While some scholars have been able to gauge knowledge transfer through explicit measures, such as counts of cross-patent citations (e.g., Mowery *et al*., 1996; 1998), our study requires measures and data collection processes that allow us to handle the team-based and hard-to-identify nature of the knowledge involved. As such, we follow the lead of Dyer and Chu (2003) and McEvily and Zaheer (1999), who developed research work that is more akin to ours, and collect data with a survey instrument. In our survey, we mostly followed prescriptions by Dillman (2000). We first developed a questionnaire by identifying construct items used in previous literature. We then obtained the help of other academics and managers to develop items where the literature was missing, to refine survey wording and to check overall validity of questions vis-à-vis the industry environment.

We compiled a mailing list of approximately 900 suppliers from the largest equipment manufacturers in the United States. Following advice from operations management scholars whom we consulted, we selected a sample of supplier firms with like production activities in order to ensure comparability of performance. Specifically, we selected approximately 500 firms producing goods that involve machining, stamping, or cutting of basic material (e.g., sheet metal), and assembly of a component. Our response rate was just above 50 percent, yielding 253 responses.

To minimize key-informant bias, we surveyed the *most knowledgeable informant* (Kumar, Stern, and Anderson, 1993). Here, we contacted each supplier by phone prior to sending the survey, and identified the manager who, according to indications, would be the most knowledgeable about

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relationships with the customer in this industry group, as well as production-related information. One may query the use of single informants as to whether they have sufficient knowledge and ability to assess the collective orientation of the supplier toward the buyer. Though responses from multiple informants may have been preferred (at a cost of a much smaller sample), we believe that our informants are well positioned to make the assessment asked of them for the following reasons. First, key informants have been employed at their respective organizations for an average of 12 years; they also had a long history of working in their current position. These individuals had primary responsibility for managing the day-to-day relationship with the customer, and were well aware of the history of interactions between their and their buyer's employees. Further, for 40 suppliers, we surveyed a second top executive separately from the key informant, to evaluate interrater reliability (see Dyer and Chu, 2003, for similar treatment). The degree of similarity among the responses was remarkable. Rarely did responses vary by more than one point. Thus, we believe the key informant responses do represent the overall orientation of supplier firms in a reliable way.

We performed Harman's single factor test (Harman, 1967); here, if a significant amount of common method bias (CMB) exists in the data, then a factor analysis of all the variables in the model will generate a single factor that accounts for most of the variance. Unrotated factor analysis using the eigenvalue-greater-than-one criterion revealed that the first factor explains 17.1 percent of the variance in the data. We thus conclude our data is not subject to CMB.

In the survey, we asked respondents to qualify the past three years of their relationship to avoid biased responses due to abnormal experiences (see Artz and Brush, 2000 for similar treatment). We also assessed nonrespondent bias by t-test comparing early with late respondents (Armstrong and Overton, 1977). We found no significant differences. Lastly, we asked respondents to assess relationship and performance characteristics related to 'this' customer, defined as 'a customer the respondent was most knowledgeable about.' In case the supplier serviced multiple facilities of 'this' customer and/or serviced 'this' customer with multiple products, the respondent was to answer the questions relative to the facility and product family that were most representative for her business. If the respondent's company had multiple divisions, we asked her to refer to the division of which she was a manager. We also asked respondents to indicate performances of her firm with another 'average' customer, defined as 'a customer that is representative of the supplier's average performance.'

Measures

Multi-item constructs below were measured through a five-point Likert scale, where 1 represents 'not at all,' and 5 'to a large degree.' The Appendix lists our survey questions.

Supplier knowledge acquisition efforts

Our multi-item scale measures the degree to which suppliers had 'invested' or 'participated' in any of a series of knowledge acquisition programs listed. Based on literature searches (e.g., Liker, 1997; Ohno, 1988) and interviews with managers, we inventoried several programs associated with the acquisition of team-based capabilities, such as *kaizen* (i.e., constant improvement techniques), lot-size optimization, machinery and plant set-up techniques, as well as total quality management.

Joint buyer-supplier knowledge acquisition efforts

We measured the degree to which suppliers had 'invested' or 'participated' in any of the above-listed knowledge acquisition programs where 'this' buyer had 'direct participation.' We defined 'direct participation' as this buyer having taught, or consulted (e.g., buyer's personnel teach supplier's personnel), or co-participated (e.g., teams from both companies join efforts in a given training program).

Supplier dyad-specific assets and capabilities

Our multi-item scale identifies the degree to which the supplier has *invested in new* or *modified existing* capabilities (e.g., order taking, production processes) and physical assets (e.g., production equipment, new facilities) primarily to serve the unique needs of *this* customer. We based these construct items on previous work by Artz and Brush (2000), who captured dimensions related not only to physical assets, but also to personnel and routines that were specialized to the focal partner.

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Buyer-supplier relational governance

We measure the degree to which partners rely on social commitments of collaboration as gauged by their efforts to share information, assist each other, and promote fair sharing of cost savings and benefits arising out of joint efforts. The first two survey items were adapted from Heide and John (1992), Noordewier, *et al*. (1990) and Artz and Brush (2000). The third was adapted from Ring and Van de Ven (1992).

Supplier performance

As we model the production efficiencies arising from the acquisition of complex production know-how, we turn to research done by scholars working closely with the implementation of such production systems for measures (Boyer *et al*., 1997; De Meyer and Ferdows, 1985; Ferdows *et al*., 1986; Miller and Vollmann, 1984; Ward *et al*., 1995). According to these scholars, measures of inventory turn over and effectiveness in delivering goods on a timely manner can capture such performance dimensions. Thus, we measure 'the number of inventory turns to support 12 months of sales' and 'the percentage of goods delivered on time.' The choice of these measures is consistent with those by other strategy scholars working with buyer-supplier relations (e.g., Dyer and Nobeoka, 2000; Kotabe *et al*., 2003). For *redeployable performance* (the performance suppliers are usually able to replicate across customers) we used the respondents input for performance they achieved with an 'average' customer. For *relational performance* we subtracted the performance a supplier obtained with an 'average' customer from that it obtained with 'this' customer. This conceptualization is consistent with our definition of relational performance presented earlier as well as with the concept of 'relational rent' as presented in Dyer and Singh's (1998) relational view. For example, where respondents indicated that the inventory necessary to support sales to 'this' customer turned 18 times a year and the inventory for average customers turned 11, then relational inventory performance was 7 turns (i.e., 18 minus 11). We did the same for timely delivery (e.g., 99% of goods delivered on time for a given customer, versus 92% of goods delivered on time for another average customer resulted in a 7% relational performance in timely delivery). Our analysis of construct validity suggests that the two performance dimensions (i.e., inventory turns and timely delivery) measure the same underlying construct, that is, production performance, and we therefore factored them together.

Control variables

While we are interested in developing a parsimonious model, we are also aware that other alternative factors may influence supplier performance. Thus, we include control variables to ensure results are not unjustifiably influenced by these factors. First we control for supplier firm size. Because larger firms have larger resource pools and the consequent ability to compete more effectively, the performance gains we observe may be explained by such asset endowment, as opposed to the mechanisms we model. We measure firm size as the log of three-year average yearly revenue. A second possible confounding effect relates to the importance the business of the specified customer has for the supplier. The more relevant the customer is for the supplier, the more likely the supplier may be eager to hold on to relationship loyalty by being more responsive to one customer vis-à-vis others; thus we believe relational performance could arise out of necessity. We measure importance of customer as a ratio of the three-year average supplier sales to the specified customer to total sales. Another variable that could explain preferred treatment by suppliers to a given buyer relates to the competitive pressure of the marketplace. If a supplier faces stiff competition in selling to a given customer but not in selling to others, it could establish internal decisions that would lead to preferred performance enhancements regardless of it developing dyad-specific capabilities. Thus, we control for the log number of 'direct competitors,' defined as suppliers selling the same products to the same original equipment manufacturer customer.

Structural equation method

We performed a structural equation analysis (SEM), which, by definition, is a hybrid of factor and path analysis. Our preference for SEM as opposed to other methods, such as multiple regression, results from three specific traits of our research design. First, most of our measures are multi-item; because SEM integrates factor analysis in the computations, the measurement error of these multi-item constructs are incorporated in the

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model, enabling one to obtain unbiased parameter estimates (Anderson and Gerbing, 1988; Bentler, 1990). Second, SEM simultaneously tests the fit of an integrated set of dependence links, as opposed to testing coefficients in individual equations. This allows us to test the fit of alternative model configurations. Third, SEM allows for the testing of the reciprocal (causality) structure of covariances (Berry, 1984; Frone, Russell, and Cook, 1994; Wong and Law, 1999), as we do below.

To implement our SEM, we followed Anderson and Gerbing's (1988) two-step approach. In the first stage—the measurement model—we used confirmatory factor analysis. The goal here is to obtain an acceptable fit to the data (Anderson and Gerbing, 1988; Bentler, 1990; Joreskog and Sorbom, 1989). For convergent (i.e., whether items are fairly correlated with one another) and discriminant (i.e., whether items across constructs clearly measure different constructs) validities, we examined values from the correlation matrix in Table 1. Here, we observe that all values greater than 0.56 involve intrafactor correlations, while interfactor correlations do not surpass the 0.36 level. We thus believe we have initial evidence of good convergent and discriminant validities. Additionally, for convergent validity, we computed t-tests for factor loadings (Anderson and Gerbing, 1988); we kept indicators for which loadings were greater than twice their standard errors (see Table 2). Also, for discriminant validity, we performed chi-square difference tests for constrained and unconstrained models. The constrained model sets the correlation between two constructs equal to one; a significantly lower chi-square for the unconstrained model supports the discriminant validity criterion. As shown in Table 3, all constructs exhibit satisfactory discriminant validity.

In the second stage of SEM, we compute the structural model based on the measurement model found in the first stage. Here, interfactor correlations are estimated for all factors, making this an oblique, rather than an orthogonal, analysis. As such, we specified given associations between constructs, as hypothesized in our theoretical model, and assessed the overall goodness of fit. To test the hypotheses, we used the maximum likelihood estimation procedure, often preferred in management and social sciences studies (Ping, 1996).

Most of our hypotheses represent a comparison between the coefficients for two separate paths (i.e., Hypotheses 1, 2, 3a, 3b, and 4b). Thus, our testing required constraining each pair of paths noted in the hypothesis statement to be equal (Bentler, 1990) and comparing each model with the theoretical model (Satorra, 1989). In such a test (Table 6), a significant increase in chi-square implies the constraint is invalid and the path coefficients are significantly different. Comparing the signs and magnitudes of coefficients in which the chi-square increased significantly, then, indicates support or lack of support for these hypotheses.

RESULTS

In Table 5, we look at various fit indices to test our measurement model (Model 1). The first index, chi-square statistic (χ^2), tests the correspondence between the model and the underlying data. Though a nonsignificant χ^2 value is desirable to indicate the model is not significantly different from the underlying data, we observe that our chi-square is significant ($\chi^2 = 233.947$; $p < 0.002$). Following Joreskog and Sorbom (1989), we treat this chi-square simply as a general goodness of fit index, but not a statistical test in the strictest sense. Instead, we supplement the chi-square analysis with 5 other goodness of fit indices: GFI, NFI, NNFI, CFI, and RMSEA.[5] A commonly accepted rule of thumb is that the first four fit indices should be greater than 0.90, whereas RMSEA should be below 0.05 (Hatcher, 1998). As seen in Table 5, all fit indices are within the expected range. Thus, we accept Model 1.

With respect to our theoretical model (Model 2), our chi-square difference test indicated no significant differences vis-à-vis the measurement model ($\Delta\chi^2 = 22.44$, $\Delta df = 8$, $p > 0.1$). We hence accepted the theoretical model as the most parsimonious (Anderson and Gerbing, 1988). All other

[5] The GFI indicates the relative amount of variance and covariance jointly explained by the model. The NFI and NNFI (Bentler and Bonnett, 1980) are defined as 'the percentage of observed-measure covariation explained by a given measurement or structural model ... that solely accounts for the observed-measure variances' (Anderson and Gerbing, 1988: 421). The NNFI is often viewed as a superior variation of the Bentler and Bonnett (1980) normed fit index (NFI) since it has been shown to be more robust in reflecting model fit regardless of sample size (Anderson and Gerbing, 1988; Bentler, 1990). The last index, Bentler's (1990) CFI, is similar to the NNFI in that it provides an accurate assessment of fit regardless of sample size. The CFI tends to be more precise than the NNIF however in describing comparative model fit as it corrects for small sample size by subtracting the degrees of freedom from their corresponding χ^2 values (Bentler, 1990).

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Table 1. Pearson correlation matrix

		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
Relational governance–information exchange on production plans, schedules	1	1.000																					
Relational governance–technical support and mutual assistance	2	0.836***	1.000																				
Relational governance–fair sharing of benefits from joint efforts	3	0.826***	0.692***	1.000																			
Generic knowledge acquisition–total quality management	4	−0.057	−0.074	−0.084	1.000																		
Generic knowledge-acquisition–new machine set up techniques	5	−0.012	−0.061	−0.028	0.874***	1.000																	
Generic knowledge acquisition–*kaizen* techniques	6	−0.076	−0.094	−0.077	0.855***	0.779***	1.000																
Generic knowledge acquisition–lot size optimization techniques	7	0.023	−0.004	−0.024	0.857***	0.734***	0.734***	1.000															
Joint knowledge acquisition–total quality management	8	−0.020	−0.051	−0.040	−0.017	0.003	−0.027	−0.030	1.000														
Joint knowledge acquisition–new machine set up techniques	9	−0.034	−0.081	−0.034	−0.042	0.016	−0.018	−0.033	0.841***	1.000													

Joint knowledge acquisition–kaizen techniques	10	−0.030	−0.057	−0.034	−0.007	−0.009	0.026	0.007	0.848***	0.712***	1.000												
Joint knowledge acquisition–lot size optimization techniques	11	−0.012	−0.045	−0.020	0.021	0.04	0.013	−0.008	0.846***	0.736***	0.724***	1.000											
Specific assets–order taking and order processing routines	12	0.159**	0.140*	0.195**	−0.045	0.002	−0.001	−0.021	0.186**	0.178**	0.166**	0.163**	1.000										
Specific assets–production processes	13	0.210***	0.210***	0.216***	−0.064	−0.021	−0.019	−0.015	0.193**	0.188**	0.142*	0.164**	0.861***	1.000									
Specific assets–new tooling and manufacturing or R&D equipment	14	0.163**	0.038*	0.216***	−0.093	−0.047	−0.047	−0.074	0.167**	0.144*	0.185**	0.160*	0.869***	0.763***	1.000								
Specific assets–new facilities	15	0.190***	0.186**	0.240***	−0.055	−0.033	−0.017	−0.033	0.185**	0.171**	0.150*	0.182**	0.841***	0.731***	0.752***	1.000							
Re deployable performance–on time delivery	16	−0.049	−0.072	−0.046	0.211***	0.226***	0.176**	0.196**	0.016	0.034	−0.045	0.031	−0.041	0.005	−0.067	−0.031	1.000						
Re deployable performance–inventory turns	17	−0.072	−0.034	−0.037	0.182**	0.196**	0.164**	0.0195**	−0.005	0.033	−0.042	−0.015	−0.068	−0.051	−0.083	−0.076	0.563***	1.000					
Relational performance–on time delivery	18	0.257***	0.206***	0.196**	−0.11†	−0.137*	−0.047	−0.096	0.130*	0.095	0.175**	0.140*	0.311***	0.269***	0.302***	0.287***	0.085	0.026	1.000				
Relational performance–inventory turns	19	0.223***	0.124*	0.199**	0.035	0.016	0.061	0.013	0.162**	0.133*	0.188**	0.157*	0.306***	0.255***	0.247***	0.261***	0.016	0.025	0.600***	1.000			
Supplier size	20	0.069	0.012	0.088	0.11†	0.077	0.067	0.102†	0.096	0.079	0.074	0.072	0.056	0.039	0.028	0.063	0.087	0.200***	0.117†	0.110†	1.000		
Importance of customer	21	0.101	0.087	0.038	−0.033	−0.019	−0.014	−0.017	−0.046	−0.011	−0.058	−0.073	0.028	−0.008	0.000	0.031	−0.031	−0.072	0.110†	0.135*	−0.056	1.000	
Competitive Pressure	22	−0.010	0.035	−0.059	−0.001	−0.008	0.006	−0.026	−0.115†	−0.106†	−0.112†	−0.053	−0.112†	−0.106†	−0.100	−0.074	0.140*	0.206***	−0.146*	−0.166	−0.036	0.177**	1.000

Table 2. Comparison of measurement model to theoretical model

Parameter	Path Description	Best Model	Measurement Model
LF1KAO1	Supplier knowledge acquisition ← total quality management training	1.000	1.000
LF1KAO2	Supplier knowledge acquisition ← new machine set up training	0.932(27.066)***	0.930(27.049)***
LF1KAO3	Supplier knowledge acquisition ← Kaizen training	0.886(25.029)***	0.884(25.012)***
LF1KAO4	Supplier knowledge acquisition ← lot size optimization training	0.874(25.058)***	0.873(25.067)***
LF2KAOSP1	Joint buyer supplier knowledge acquisition ← total quality management training	1.000	1.000
LF2KAOSP2	Joint buyer supplier knowledge acquisition ← new machine set up training	1.040(23.394)***	1.041(23.405)***
LF2KAOSP3	Joint buyer supplier knowledge acquisition ← Kaizen training	1.058(23.992)***	1.058(23.993)***
LF2KAOSP4	Joint buyer supplier knowledge acquisition ← lot size optimization training	1.042(23.901)***	1.042(23.903)***
LF3SPASS1	Supplier dyad-specific assets & capabilities ← order taking & processing	1.000	1.000
LF3SPASS2	Supplier dyad-specific assets & capabilities ← production processes	0.929(25.551)***	0.930(25.568)***
LF3SPASS3	Supplier dyad-specific assets & capabilities ← new tools, manufacturing, or R&D equipment	0.909(26.518)***	0.909(26.532)***
LF3SPASS4	Supplier dyad-specific assets & capabilities ← new facilities	0.858(23.724)***	0.858(23.728)***
LF5dployDEL	Supplier REDEPLOYABLE performance ← percentage goods delivered on time	1.000	1.000
LF5dployINV	Supplier REDEPLOYABLE performance ← inventory turns	1.806(4.617)***	1.871(8.716)***
LF6relatDEL	Supplier RELATIONAL performance ← percentage goods delivered on time	1.000	1.000
LF6relatINV	Supplier RELATIONAL performance ← inventory turns	2.020(7.137)***	1.714(10.104)***
LF4rell	Buyer-supplier relational governance ← information exchange on production plans & schedules	1.000	1.000
LF4rel2	Buyer-supplier relational governance ← mutual assistance	0.981 (21.042)***	0.966 (20.320)***
LF4rel3	Buyer-supplier relational governance ← share benefits from joint efforts	0.899 (20.046)***	0.971 (19.903)***

† $p < 0.1$; * $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$

goodness-of-fit indices indicate Model 2 is indeed acceptable (Table 5).

Results of hypotheses tests

Our findings, shown in Column D of Table 4, and in Figure 2, are as follows. Hypothesis 1 (i.e., suppliers' knowledge acquisition efforts positively associate with their redeployable performance more than with their relational performance), is strongly supported. The path coefficient between knowledge acquisition and redeployable performance is positive and statistically significant (PF1F5 = 0.185, t = 3.528, $p < 0.001$), whereas the one between knowledge acquisition and relational performance is negative and statistically not significant (PF1F6 = −0.041; t = −0.748; $p > 0.1$). As shown in Table 6, the significant increase in chi-square ($\Delta\chi^2 = 18.972$, $\Delta df = 1$, $p < 0.001$) indicates that the path coefficients are significantly different, whereas the signs and magnitudes of the respective coefficients indicate that suppliers' knowledge acquisition efforts more positively associate with redeployable performance.

Hypothesis 2 (i.e., joint knowledge acquisition efforts positively associate with relational performance more than with redeployable performance), is *not* supported. The path between joint knowledge acquisition and redeployable performance is

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Table 3. Chi-square difference test

Covariance	Latent variables		Chi-square statistics: Constrained model (d.f. = 81)	Chi-square statistics: Unconstrained model (d.f. = 80)	Difference (d.f. = 1)–significant if chi-square >3.85
CF1F2	Supplier knowledge acquisition efforts	Joint buyer supplier knowledge acquisition efforts	289.4	233.9	55.5
CF1F3	Supplier knowledge acquisition efforts	Supplier dyadic-specific assets & capabilities	290.8	233.9	56.9
CF1F4	Supplier knowledge acquisition efforts	Buyer-supplier relational governance	297.5	233.9	63.6
CF1F5	Supplier knowledge acquisition efforts	Redeployable performance	238.6	233.9	4.7
CF1F6	Supplier knowledge acquisition efforts	Relational performance	242.1	233.9	8.2
CF2F3	Joint buyer supplier knowledge acquisition efforts	Supplier dyadic-specific assets & capabilities	259.3	233.9	25.4
CF2F4	Joint buyer supplier knowledge acquisition efforts	Buyer-supplier relational Governance	297.5	233.9	63.6
CF2F5	Joint buyer supplier knowledge acquisition efforts	Redeployable performance	240.4	233.9	6.5
CF2F6	Joint buyer supplier knowledge acquisition efforts	Relational performance	244.2	233.9	10.3
CF3F4	Supplier dyadic-specific assets & capabilities	Buyer-supplier relational governance	262.8	233.9	28.9
CF3F5	Supplier dyadic-specific assets & capabilities	Redeployable performance	245.7	233.9	11.8
CF3F6	Supplier dyadic-specific assets & capabilities	Relational performance	247.3	233.9	13.4
CF4F5	Buyer-supplier relational governance	Redeployable performance	247.4	233.9	13.5
CF4F6	Buyer-supplier relational governance	Relational performance	239.1	233.9	5.2
CF5F6	Redeployable performance	Relational performance	252.9	233.9	19

positive but statistically not significant (PF2F5 = 0.0.028, t = 0.545, p > 0.1), while the link between joint knowledge acquisition and relational performance is positive and statistically significant (PF2F6 = 0.110; t = 2.218; p < 0.001). Though the magnitudes of these coefficients are as expected and would seem to indicate a support for Hypothesis 2, results from Table 6 indicate the

Table 4. Parameter estimates for structural equation model

Column A	Column B	Column C	Column D	Column E	Column F
Hypothesis/Covariance	Parameter	Path Description	Theoretical Model	Best Model	Alternative Model
H1 (supported)	PF1F5	Supplier Knowledge Acquisition Efforts → Re-deployable Performance	0.185(3.528)***	0.167(3.686)***	0.165(3.568)***
	PF1F6	Supplier Knowledge Acquisition Efforts → Relational Performance	−0.041(−0.748)		
H2 (NOT supported)	PF2F5	Joint buyer supplier knowledge acquisition efforts → Re-deployable performance	0.028(0.545)		
	PF2F6	Joint buyer supplier knowledge acquisition efforts → Relational Performance	0.110(2.128)*	0.115(2.343)*	0.169(1.918)†
H3a (supported)	PF1F3	Supplier Knowledge Acquisition Efforts → Supplier Dyad Specific Assets & Capabilities	−0.046(−0.737)		
	PF2F3	Joint buyer supplier knowledge acquisition efforts → Supplier Dyad Specific Assets & Capabilities	0.194(3.092)**	0.193(3.084)**	
H3b (supported)	PF3F5	Supplier Dyad Specific Assets & Capabilities → Supplier RE-DEPLOYABLE performance	−0.022(−0.412)		
	PF3F6	Supplier Dyad Specific Assets & Capabilities → Supplier RELATIONAL Performance	0.262(4.498)***	0.250(4.983)***	0.233(4.845)***
H4a (supported)	PF3F4	Supplier Dyad Specific Assets & Capabilities → Buyer Supplier Relational Governance Mechanisms	0.177(2.859)**	0.177(2.864)**	
H4b (supported)	PF4F5	Buyer Supplier Relational Governance Mechanisms → Supplier RE-DEPLOYABLE Performance	−0.035(−0.645)		
	PF4F6	Buyer Supplier Relational Governance Mechanisms → Supplier RELATIONAL Performance	0.209(3.499)***	0.190(3.699)***	0.244(4.836)***

Moderating Effect (NOT supported)	P(F3×F2)F6	Interaction (Joint Buyer Supplier knowledge acquisition × Supplier Dyad Specific Assets) → relational performance			0.000(0.307)
Moderating Effect (NOT supported)	P(F4×F2)F6	Interaction (Joint Buyer Supplier knowledge acquisition × Buyer supplier relational governance) → relational performance			−0.001(0.−1.245)
CONTROL (NOT supported)	PF7F5	Firm Size → Supplier RE-DEPLOYABLE Performance	0.038(0.747)	0.036(.723)	0.036(0.683)
CONTROL (NOT supported)	PF7F6	Firm Size → Supplier RELATIONAL Performance	0.044(0.804)	0.046(.851)	0.046(0.850)
CONTROL (NOT supported)	PF8F5	Importance of Buyer → Supplier RE-DEPLOYABLE Performance	−0.077(−1.369)	−0.083(−1.488)	−0.083(−1.497)
CONTROL (supported)	PF8F6	Importance of Buyer → Supplier RELATIONAL Performance	0.143(2.361)**	.149(2.462)**	0.165(2.678)**
CONTROL (supported)	PF9F5	Competitive Pressure → Supplier RE-DEPLOYABLE Performance	0.176(3.469)***	.175(3.493)***	0.174(3.492)***
CONTROL (NOT supported)	PF9F6	Competitive Pressure → Supplier RELATIONAL Performance	−0.135(−2.524)*	−0.134(−2.550)*	−0.149(−2.758)**

†$p < 0.1$; * $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$
As far as variable nomenclature is concerned, we follow the Bentler (1990) EQS convention of identifying latent (i.e. unobserved) variables with the letter "F" (for Factor), and labeling manifest (i.e. observed) variables with the letter "V" (for Variable). We use the notation "P" (for Path) followed by the identification of variables linked by such path (e.g. PF3F2 indicates a causal path from the factor F3 to factor F2). The sign and statistical significance of the "P" path coefficients serve as a test of the hypothesized relationships.

Table 5. Model statistics and testing sequence across models

Model	Model Name	Chi-Sq	Df	Probability	GFI	NFI	NNFI	CFI	RMSEA	AIC	BCC	BIC
1	Measurement	233.947	176	<0.002	0.926	0.945	0.951	0.986	0.036	387.947	403.414	660.018
2	Theoretical	256.389	184	<0.000	0.920	0.939	0.941	0.978	0.039	392.389	406.048	632.659
3	Best Model	257.867	188	<0.001	0.919	0.939	0.942	0.983	0.038	385.867	398.723	612.004
4	Alternative model	1120.089	76	<0.000	0.818	0.795	0.796	0.828	0.126	1272.089	1288.829	1616.627
	Δ from 3 to 4									886.222	890.106	1004.623

path coefficients are, just at the margin, not statistically different ($\Delta\chi^2 = 1.586$, $\Delta df = 1$, $p > 0.1$).

Hypothesis 3a (i.e., joint buyer-supplier knowledge acquisition efforts more positively associate with supplier dyad-specific assets and capabilities than do suppliers' knowledge acquisition efforts) is supported. The path coefficient between suppliers' knowledge acquisition and dyad-specific assets and capabilities is negative and statistically not significant (PF1F3 = −0.0022, t = −0.412, $p > 0.1$), whereas the association between joint buyer-supplier knowledge acquisition and specific assets and capabilities is positive and statistically significant (PF2F3 = 0.194; t = 3.092; $p < 0.001$). The signs and magnitudes of these coefficients indicate a support for Hypothesis 3a, whereas the significant increase in chi-square, shown in Table 6 ($\Delta\chi^2 = 14.228$, $\Delta df = 1$, $p < 0.001$) confirms our claim.

Hypothesis 3b (i.e., a supplier's dyad-specific assets and capabilities associate more positively with its relational performance than with its redeployable performance), is strongly supported. The path coefficient between specific assets and capabilities and redeployable performance is negative and statistically not significant (PF3F5 = −0.022, t = −0.412, $p > 0.1$), whereas that with relational performance is positive and statistically significant (PF3F6 = 0.262; t = 4.498; $p < 0.001$). The signs and magnitudes of these coefficients indicate a support for Hypothesis 3b, whereas the significant increase in chi-square, shown in Table 6 ($\Delta\chi^2 = 24.221$, $\Delta df = 1$, $p < 0.001$) confirms our claim.

Hypothesis 4a (i.e., supplier's dyad-specific assets and capabilities associates positively with buyer-supplier relational governance mechanisms), is strongly supported. The path coefficient is positive and statistically significant (PF3F4 = 0.177, t = 2.859, $p < 0.001$).

Hypothesis 4b (i.e., buyer-supplier relational governance associate more positively with relational performance than with redeployable performance), is strongly supported. The path coefficient between relational governance and redeployable performance is negative and statistically not significant (PF4F5 = −0.035, t = −0.645, $p > 0.1$), whereas the association between relational governance and relational performance is positive and statistically significant (PF4F6 = 0.209; t = 3.499; $p < 0.001$). The signs and magnitudes

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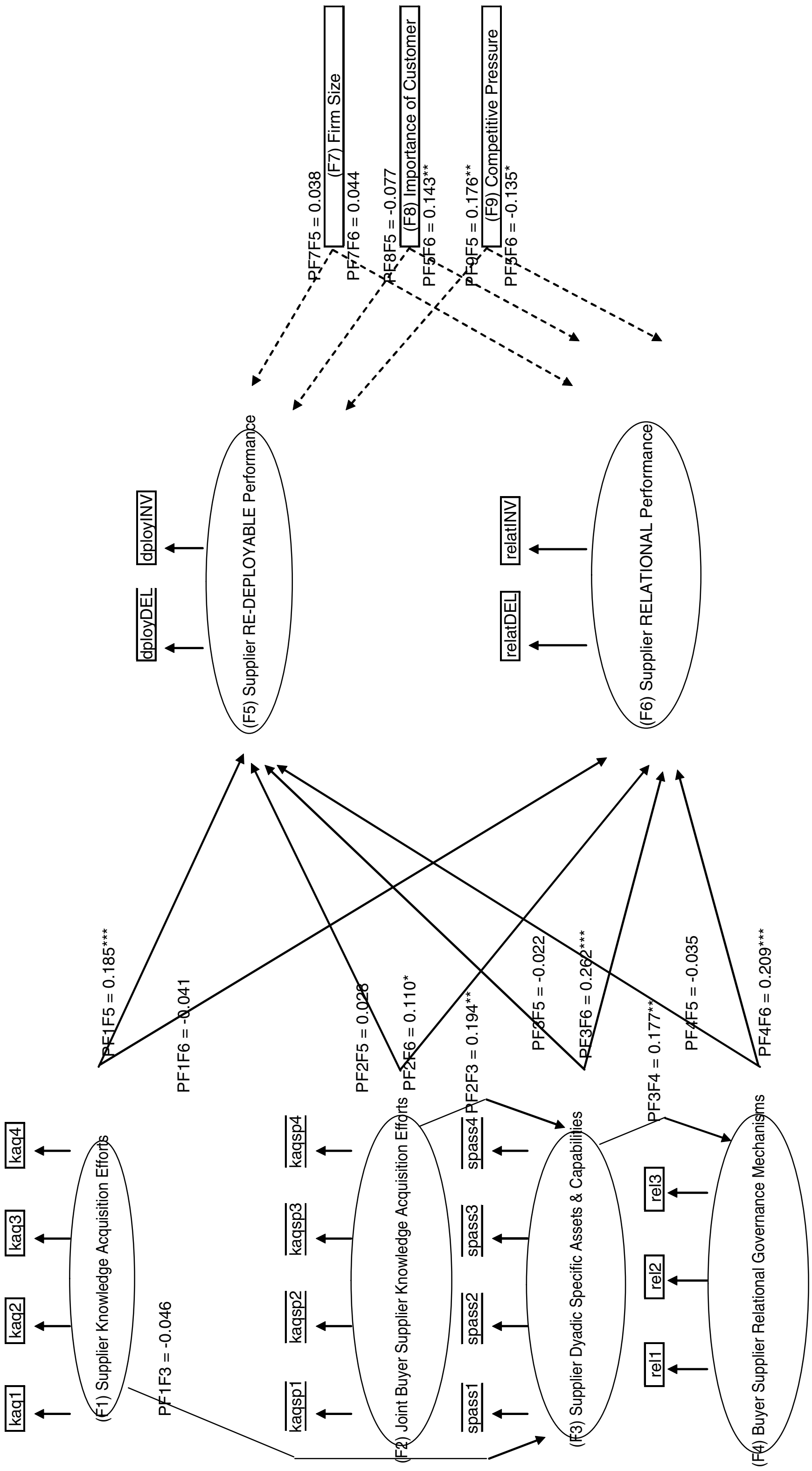

Note: Figures 1 and 2 are simplified versions of the actual models. They exclude error terms, covariances, disturbance terms, or correlations between exogenous factors. Full line and dotted lines represent hypothesized and control effects, respectively.

Figure 2. Theoretical model, with parameter estimates (Column D of Table 4)

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Table 6. Results of tests for differences in parameter estimates for theoretical model

COMPARATIVE HYPOTHESES	PARAMETER ESTIMATES		χ^2	$\Delta\chi^2$ (compare model 2)– significant if $\Delta\chi^2 > 3.85$	Δ df	p-value
H1 (supported)	PF1F5 = 0.185	PF1F6 = −0.041	275.361	18.972	1	<0.001
H2 (NOT supported)	PF2F6 = 0.098	PF2F5 = 0.028	257.975	1.586	1	>0.100
H3a (supported)	PF2F3 = 0.194	PF1F3 = −0.046	270.617	14.228	1	<0.001
H3b (supported)	PF3F6 = 0.262	PF3F5 = −0.022	278.654	22.265	1	<0.005
H4b (supported)	PF4F6 = 0.209	PF4F5 = −0.035	272.351	15.962	1	<0.001

of these coefficients indicate a support for Hypothesis 3b, whereas the significant increase in chi-square, shown in Table 6 ($\Delta\chi^2 = 18.07$, $\Delta df = 1$, $p < 0.001$) confirms our claim.

Lastly, we found only partial support for the predicted relationships with control variables. As indicated in Table 5, firm size—though it seems to have marginal correlations with both redeployable and relational performances (see Table 1)—does not help explain any form of performance in the structural equation model (PF7F5 = 0.038, $p > 0.10$; and PF7F6 = 0.044, $p > 0.10$). Importance of customer, on the other hand, does seem to play a significant role in explaining relational performance (PF8F6 = 0.143, $p < 0.01$). Here, the larger the proportion of total sales going to 'this' customer, the more the supplier does seem to confer preferred treatment to this particular customer. Importance of customer, however, has no association with redeployable performance (PF8F5 = −0.077, $p > 0.10$). As far as competitive pressure is concerned, it has a positive and significant impact on redeployable performance, as expected (PF9F5 = 0.176, $p < 0.001$). However, unexpectedly it has a negative and significant effect on relational performance (PF9F6 = −0.135, $p < 0.01$). It appears that the larger the competitive pressure, the greater a supplier's redeployable performance; this higher competitive pressure however also seems to deteriorate relational performance.

From the theoretical to the best model

As a last step in developing our model, we follow Anderson and Gerbing (1988) and trim off insignificant parameter estimates to obtain a most constrained version of the theoretical model. We refer to this model as our *best* model. Based on the marginal significance cutoff of $p < 0.10$, and z-statistic of 1.645, we dropped several paths, as shown in Column E of Table 4. We however retain paths involving control variables even if their coefficients were insignificant. In Table 5, we see that our best model gains four degrees of freedom vis-à-vis the theoretical model, while the increase in chi-square is insignificant.

Testing reciprocal relations

SEM has become a common technique to test the reciprocal (i.e., causal) relations between two constructs using cross-sectional data in management research (Wong and Law, 1999: 69). On the one hand, using longitudinal models is often argued to be more appropriate to test reciprocal relations since 'causes antecede effects' (Cook and Campbell, 1979: 10; Organ and Bateman, 1991: 43). However, from a pragmatic point of view, using SEM analysis with cross-sectional data is preferable in circumstances where one has difficulties in determining cause-effect time lags, or even finding true time-lagged data (Frone *et al*., 1994; Wong and Law, 1999: 69–71).

With the availability of SEM, one can test if two constructs are reciprocally related by analyzing the observed covariance structure against a prespecified, nonrecursive causal model, using cross-sectional data (Berry, 1984; Frone *et al*., 1994; Wong and Law, 1999; James and Singh, 1978). Wong and Law (1999) studied the reliability of this methodology, that is, they empirically analyzed the chances of one erroneously identifying relationships among constructs to be either unidirectional, reverse, or reciprocal, when they are not. By comparing a SEM cross-sectional model with a true time-lagged model, Wong and Law (1999) showed that the above methodology results in parameter estimates that are a good proxy for the true time-lagged effects with a reliability of $p < 0.05$. They identified three conditions for such nonrecursive SEM models to be reliable proxies for true time-lagged models. First, the time lag

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between the occurrences of the two effects should be short. With longer effect delay, SEM cross-sectional models will be less effective in computing reciprocal relations. Second, the model has to be identified; specifically, reciprocal relations can only be computed for endogenous variables, which are themselves affected by two different instrumental variables. In this case, an independent variable for one of the reciprocal constructs cannot simultaneously explain the other reciprocal construct. If such is not the case, parameters have no unique solutions, and their interpretation becomes meaningless (Wong and Law, 1999: 71; Berry, 1984). Third, to reduce the possibility that instrumental variables affect the relative size of disturbance terms of reciprocal constructs, a covariance path between such disturbance terms is to be included (Wong and Law, 1999: 71; Frone *et al*., 1994).

We applied the above methodology to our study to test the directionality proposed in our theory. To ensure we had endogenous variables in each of our reciprocal analyses, we switched the place of *firm size* across the model. Because this variable was already included in all models tested previously, our reciprocal analyses were based on nested models.

In Table 7, the relation between *knowledge acquisition efforts* (F1) and *redeployable performance* (F5) is significant from F1 to F5, but not significant from F5 to F1. Thus, we conclude that the relationship is unidirectional, from F1 (*knowledge acquisition efforts*) to F5 (*redeployable performance*). Applying the same logic to the other relationships in Table 7, we find that almost all relationships are unidirectional, with the causality as theorized in our hypotheses. The exception here involves the association between *supplier dyad-specific assets and capabilities* (F3) and *relational performance* (F6), as well as the association between *supplier dyad-specific assets and capabilities* (F3) and *relational governance* (F4). These relationships seem to be reciprocal, in that F3 causes F6 and in return F6 causes F3, while F3 causes F4 and in return F4 causes F3.

Table 7. Testing of reciprocal relations between main constructs for best model

Causal paths	Point estimates	Standard deviation
F1 → F5	0.128*	0.061
F5 → F1	0.125	0.136
F2 → F6	0.137*	0.068
F6 → F2	−0.065	0.131
F2 → F3	0.428*	0.191
F2 → F3	0.155	0.196
F3 → F6	0.750*	0.32
F6 → F3	0.455†	0.257
F3 → F4	0.357*	0.061
F4 → F3	0.173†	0.109
F4 → F6	0.710**	0.135
F6 → F4	0.099	0.277

† $p < 0.1$; * $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$

Testing and interpreting an alternative model

Because SEM provides information regarding the fit of a proposed model but cannot determine if that model is the 'correct' one, we examine an alternative model. Specifically, we explore the *moderating*, as opposed to the *mediating*, effects of (a) *supplier dyad-specific assets and capabilities* and (b) *buyer-supplier relational governance mechanisms*, on the association between *joint buyer-supplier knowledge acquisition efforts* and *relational performance*.[6] Though our logic above clearly implies a *mediating* effect, we refer to the work of Baron and Kenny (1986) to inquire whether these could be in fact *moderating* effect. Specifically, using the terminology of Baron and Kenny (1986: 1173), it is possible that the factors above partition *relational performance* into subgroups that establish its domains of maximal effectiveness. If such is the case, then the effect from *joint buyer-supplier knowledge acquisition efforts* to *relational governance* would become stronger the more suppliers invest in *specific assets and capabilities* and structure *relational governance*.

[6] Analyses of latent variable interactions are not common in strategy studies and only recently have they been adopted in marketing and psychology (see Bollen and Curran, 2005 for a review). Here, we use Ping's (1995; 1996) techniques for interaction terms with a single indicant. The single indicant for two factors X and Y, with respective indicants as x_1, x_2 and y_1, y_2, is computed as $X:Y = (x_1 + x_2)(y_1 + y_2)$. In such case, Ping proposes that the loadings and errors for X : Y be given respectively by $\lambda x : y = (\lambda_{x1} + \lambda_{x2})(\lambda_{y1} + \lambda_{y2})$ and $\theta_{\varepsilon x:y} = (\lambda_{x1} + \lambda_{x2})^2 \mathrm{Var}(X)(\theta_{\varepsilon y1} + \theta_{\varepsilon y2}) + (\lambda_{z1} + \lambda_{z2})^2 \mathrm{Var}(Y)(\theta_{\varepsilon x1} + \theta_{\varepsilon x2}) + (\theta_{\varepsilon x1} + \theta_{\varepsilon x2})(\theta_{\varepsilon y1} + \theta_{\varepsilon y2})$. As far as specification of the measurement model is concerned, based on Anderson and Gerbing (1988: 418), Ping (1995: 339) indicates that the unidimensionality of X and Y enables the omission of the nonlinear latent variables from the linear-terms-only measurement model. Because X and Y are each unidimensional, their indicants are unaffected by the presence or absence of other latent variables in a measurement or structural model. Stated differently, this provides similar measurement parameter estimates between measurement and structural models.

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To contrast the *moderating* and *mediating* theoretical models we use the Akaike Information Criteria (AIC), the Browne-Cudeck Criteria (BCC) and the Bayes Information Criteria (BIC). Lower indices are preferred.[7] In Table 5 the alternative (i.e., *moderating*) model is inferior to the best (i.e., *mediating*) model across all three indices. Specifically, ΔAIC, ΔBCC, and ΔBIC from the best to the alternative model are all positive (886.2; 890.1; 114.6 respectively); these results indicate that the *mediating* model is the best representation of the phenomenon under study. The alternative *moderating* model's fit indices also support our conclusion for its inferiority; all fit indices (GFI, NFI, NNFI, and CFI) are below our 0.90 threshold, whereas RMSEA is well above 0.05. Lastly, in Column F of Table 4, the parameters of moderating effects are statistically not significant.

What the results mean

Our results highlight important aspects of buyer-supplier knowledge transfer interfaces. First, from Hypothesis 1, we know that trained suppliers outperform untrained ones. As this comparison contrasts average performances, we conclude that a significant portion of the knowledge transferred permeates to the supplier's average performance. This implies that average customers outside of the learning dyad benefit, to some extent, from partnerships with learning suppliers. We can thus infer that *cream-off* approaches do add value. Buyers who do not invest in supplier training can free ride on supplier knowledge acquired from other sources.

Second, from Hypothesis 2, we find that *joint* buyer-supplier knowledge acquisition efforts *per se* do not seem to improve a supplier's relational performance more than they improve that supplier's redeployable performance. However, as we integrate a full analysis of other factors (Hypotheses 3a, 3b, 4a, and 4b), as well as an analysis of moderating vis-à-vis mediating effects, we can see that not all knowledge transferred to suppliers permeates to average buyers following cream-off approaches. Instead, some of this knowledge yields performance gains that are exclusive to the learning partnership. Specifically, based on our analyses of Hypotheses 3b and 4b, it appears that (a) *supplier dyad-specific assets and capabilities* and (b) *buyer-supplier relational governance mechanisms* have a significant effect in generating performance gains that are exclusive to the learning alliance, that is, relational performance. Moreover, based on analyses of Hypotheses 3a and 4a, it is also clear that *joint knowledge acquisition efforts* affect these two generators of relational performance.

The system of hypotheses above implies a mediation effect of (a) *specific assets* and (b) *relational governance* on the association between *joint knowledge acquisition* and *relational performance*. Our testing the alternative *moderating* model allows us to ascertain the appropriateness of our *mediating* framework. Specifically, our analysis of the alternative model shows that the factors (a) and (b) above really *mediate* the association between *joint knowledge acquisition* and *relational performance*. This representation of how the constructs interact to produce relational performance can be interpreted using Baron and Kenny's terminology (1986: 1173). Specifically, in vertical alliance knowledge transfer contexts, it seems that both (a) supplier dyad-specific assets and capabilities and (b) buyer-supplier relational governance mechanisms function *less* as mechanisms that partition the effect of *joint buyer-supplier knowledge acquisition* onto *relational performance* into subgroups of higher and lower outcomes; instead, they function *more* as *direct generative mechanisms* of relational performance changes. In sum, maximizing *relational performance* from *joint buyer-supplier knowledge acquisition efforts* seems to involve the mediation effects of relationship-specific assets and capabilities, and relational governance mechanisms

DISCUSSION AND CONCLUSION

In this article we investigate the extent to which knowledge acquisition processes enable a firm's *relational* (i.e., learning-partnership exclusive) and

[7] The AIC can be said to represent an operational way of trading off the complexity of an estimated model against how well the model fits the data (Akaike, 1987). Another measure with a similar intent, the BCC is known to impose a slightly greater penalty for model complexity than does the AIC (Browne and Cudeck, 1993). In comparison to AIC and BCC, the BIC assigns a greater penalty to model complexity, and so has a greater tendency to pick parsimonious models (see Raftery, 1995; Schwartz, 1978 for reviews). In our computations, we avoid comparisons through chi-square statistics since our alternative model is *non-nested*. The *non-nested* nature of our model arises from our implementing Ping's interaction term procedure (1995, 1996), which, as explained above, creates a new single-indicant variable from two other factors.

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redeployable (i.e., replicable with other average customers) performance enhancements. By integrating theoretical elements from the RBV and relational views, our model formulates propositions in the context of vertical learning alliances. Beginning with the RBV, we argue that suppliers acquiring tacit, team-based capabilities attain competitive advantages vis-à-vis rivals that do not acquire those capabilities. We also argue that these acquired capabilities are redeployable, rendering improvements on a supplier's overall average performance. Then, following with the relational view, we explain that suppliers can further attain *relational performance*, that is, performance gains that are above their average performance levels, and which are learning-partnership exclusive. We theorize that relational performance is a function of the mediating effects of (a) suppliers' dyad-specific assets and capabilities and (b) alliance relational governance mechanisms, on the association between joint buyer-supplier knowledge acquisition efforts and relational performance. Our empirical tests confirm the effects of our constructs on both redeployable and relational performances.

Theoretically and empirically, our approach represents a significant departure from previous literature. First, our research illustrates the usefulness of the RBV and relational views for strategy research. Though controversy remains as to whether the relational view is a different theory or just an extension vis-à-vis the RBV (e.g., Dyer and Singh, 1998; Molina, 1999; Dyer and Singh, 1999; Lavie, 2006), we believe that both the RBV and relational view perspectives offer distinct, yet complementary contributions, and where combined, allow for richer analysis of competitive advantages than it first appears. Specifically, the RBV helps us trace firm performance advantages back to firm-level tacit, team-based capabilities, as confirmed by empirical analysis of Hypothesis 1. However, an exclusive focus on the RBV keeps us from understanding performance gains that materialize exclusively within the learning alliance. By modeling learning alliances through the relational view, our research identifies and empirically confirms that three factors associate with partnership-exclusive performance enhancements: (1) joint knowledge acquisition, (2) suppliers' investments in dyad-specific assets and capabilities, and (3) buyer-supplier alliance relational governance. In sum, our model highlights that while the RBV helps establish the fundamental link between a supplier's advantages from its valuable yet costly to imitate assets and capabilities, the relational view suggests how portions of those advantages are interlocked within a particular symbiotic relationship with a focus customer.

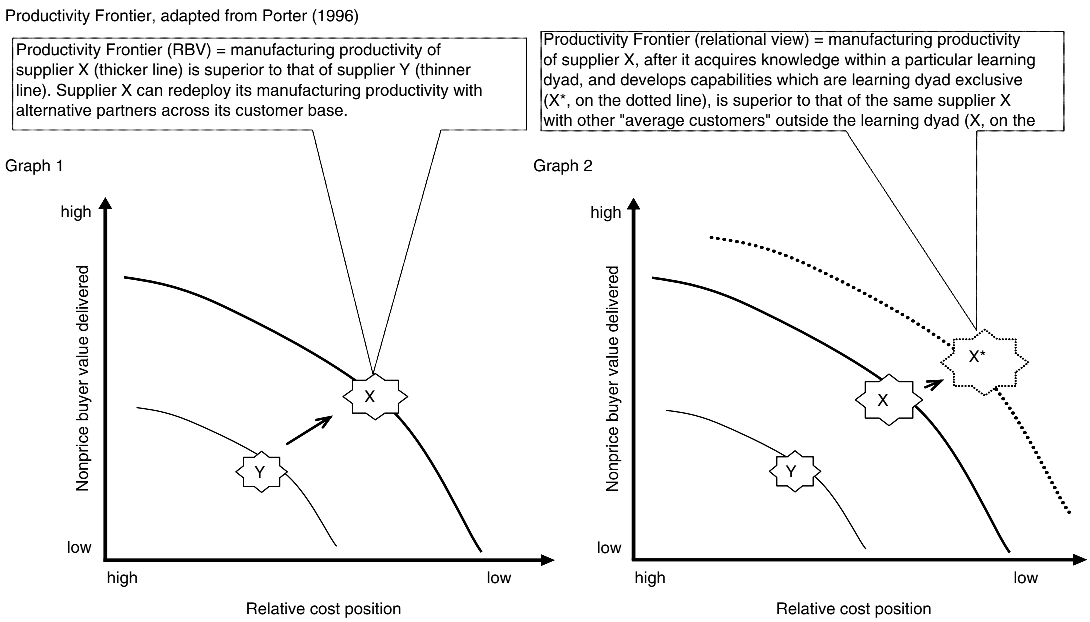
Further, we also believe our research informs the knowledge management literature. While much of the scholarly debate thus far has focused on *knowledge* spillover prevention factors (e.g., firms should focus on acquiring 'tacit,' as opposed to 'explicit' knowledge), little has been investigated about *performance* spillover (i.e., redeployability) prevention factors. The tension between knowledge and performance spillover is an important one, and can be traced back to previous alliance knowledge transfer literature (e.g., Hamel, 1991 and more recently, Dyer and Nobeoka, 2000; Kale *et al*., 2000). Redeployability is at the heart of performance spillover. Redeployability helps erode appropriability advantages for training buyers, and thus must be considered with the same degree of importance as tacitness. We acknowledge the contribution of current literature that outlines mechanisms and factors related to transferring tacit knowledge in faster and more efficient ways to avoid undesired spillover that can benefit competitors.

Here, we add to this literature to explain the factors involved in locking in the knowledge acquired and resulting performance gains within the learning alliance. The factors that help prevent redeployability have in part been explored in previous research. For example Lorenzoni and Lipparini (1999) explain that a firm's relational capabilities—that is, its ability to interact with other firms—accelerates a firm's knowledge access and transfer with relevant effects on company growth and innovativeness. Moreover, Dyer (1996) explored the link between dyad-specific assets and capabilities and superior performance. Our work integrates both firm and interfirm perspectives on these factors to explain the mediating effects within the context of joint interfirm knowledge acquisition efforts. As such, we identify circumstances when dyad partners are more likely to develop partnership-exclusive capabilities and advantages. Our findings corroborate some of Dyer & Hatch's (2006) findings, while also adding to their work. Specifically, our theoretical model integrates both resource-based and relational views, therefore helping establish a clear contrast between the two. Moreover, our study also highlights the importance of 'joint learning' activities in vertical alliances. As such, our study helps contrast, both theoretically and empirically, the extent to which knowledge transfer programs result in performance gains that spill over vis-a-vis performance gains that get retained within the learning dyad.

Our research also represents an empirical supplement to previous research on knowledge transfer alliances. Specifically, previous scholars have established a primary focus on linking various factors that antecede knowledge transfer (such as knowledge ambiguity, as in Simonin, 1999; tacitness and knowledge complexity, as in Khanna *et al*., 1998; Kotabe *et al*., 2003; Mowery *et al*., 1996; partner relational capital, as in Kale *et al*., 2000). Thus, these studies have often relied on dependent variables that highlight the effectiveness of the learning processes (e.g., Simonin, 1999) or performance improvements of trained suppliers (e.g., Kotabe *et al*., 2003). We acknowledge the importance of these studies, and supplement this literature by also investigating performance advantages that are exclusive to learning partnerships. Specifically, by explicitly measuring performance gains while controlling for the portion of such gains that firms can redeploy across an 'average' partner base, our findings illustrate the circumstances under which learning alliances create advantages not only for trained firms, but also for their training partners. Moreover, we hope our application of SEM techniques for testing *moderating* and *reciprocal relations* will help other strategy scholars understand the usefulness of such techniques and leverage them in future research.

As far as managerial practice is concerned, we believe our model and empirical results offer a useful picture about the strength of alternative approaches to handling supplier networks. Referring back to our Deere example, it appears that, both 'cream-off' and 'supplier development' approaches seem to have different, yet complementary forms of payoff. Initially, cream-off approaches enable buyers to access performance gains from suppliers that redeploy improvements arising out of knowledge acquisition from other sources; this approach relies on the resource-based view conjectures that once suppliers acquire valuable knowledge they are able to outperform untrained competitors. This approach also assumes this superior performance is redeployable across partners. However, at a higher level, supplier development approaches enable buyers to access supplier performance that is superior to that supplier's redeployable performance and that are learning partnership exclusive. This approach relies on the relational view; it conjectures that portions of the acquired knowledge that lie at the learning dyad intersection are only deployable within the learning partnership. It is clear the effects are not substitutes. To better illustrate the nonsubstitutable, yet complementary and superior value of relational over redeployable performance, we offer the logic below, based on Figure 3.

In Figure 3, we adapt the concept of the productivity frontier from Porter (1996). Here, the productivity frontier represents the maximum value a supplier delivers in the form of product or service, at a given cost, using the best technologies, skills and managerial techniques (Porter, 1996: 62). As suppliers acquire valuable resources, they move toward the frontier, and even help push such frontier outward, as new technologies and managerial techniques are invented. This move outward is depicted in Graph 1 of Figure 3, where supplier X (thick line) outperforms Y (thin line). This rationale, elucidated by the RBV, explains average performance improvements arising from knowledge acquisition. However, this rationale hides an additional 'learning partnership exclusive' supplier performance edge. Managers must be aware of the possibility of this additional edge, as well as of the mechanisms that lead to it, as per our model presented in this research. As depicted in Graph 2 of Figure 3, when supplier X acquires knowledge within a learning partnership and develops alliance exclusive capabilities (complemented by the appropriate safeguarding/coordinating governance mechanisms explained above), this supplier is able to outperform even its own average output levels, albeit this performance above one's own average is exclusive to the learning partnership (compare X^*, on the outer dotted line with X, on the inner thick line). Note that where competing buyers (as depicted in our introductory example of Deere's competitor) partner with a trained supplier, in attempts to *cream off* the investments by training buyers, this competitor will only attain performance X, by this supplier. This performance X is clearly superior to that of an untrained supplier (Y), but clearly inferior to the relational performance this supplier X delivers within the learning partnership (X^*). From here, we conclude that cream-off approaches do work, albeit only limitedly. Supplier development approaches, on



Graphs 1 and 2 above serve as illustrations for our theoretical argument, based on the Resource-Based and Relational Views:

Graph 1: Suppliers Y and X, positioned relative to productivity frontier, according to resource-based view. As supplier X acquires costly to imitate capabilities ahead of Y, it out-performs supplier Y

Graph 2: Suppliers Y and X, positioned relative to productivity frontier, according to resource-based and relational views. As supplier X acquires knowledge within a learning dyad, and develops capabilities which are dyad exclusive, it attains *relational performance* (X*, on the dotted line), which is even superior to the performance this same supplier X attains with partners outside the learning dyad (X, on the full line). Note that the productivity frontier represented by the dotted line is partnership exclusive; supplier X can only deliver at this level within the dyad. Note that supplier X still out-performs Y on an average basis, while it can addititionally out-perform itself within exclusive *relational* / *learning* partnerships.

Figure 3. Productivity frontier through the lenses of the resource-based and relational views

the other hand, enable training partners to attain a far superior and exclusive supply productivity advantage that cream-off competitors cannot attain.

Our findings also bring implications for public policy. Specifically, in the competitive race to benchmark the latest capabilities, competitors are at least likely to try and free ride a more knowledgeable supplier base without paying for its development costs (Sako, 1999: 115). Because knowledge transfers are known to be costly for both source and recipient firms (Szulanski, 1996), 'redeployability' can actually become a potent drain of resources, as opposed to a source of competitive advantages. Thus, where training firms are unable to attain advantages from their knowledge transfer programs, the spread of production capabilities across industries may suffer from a problem of market failure (Sako, 1999); this failure occurs as the incentives for individual firms to provide such knowledge transfer would tend to zero, as knowledge becomes a free good. As Teece (1986) and Sako (1999) indicate, where such zero incentive exists, government agencies may be required to provide such basic training. Both government and firms have separate yet complementary roles in industrial development as they spread valuable management and production skills across industries.

Limitations and directions for future research

Despite our contributions, our work raises further questions. First, our study is limited to an analysis of suppliers' asset investments and relational mechanisms; it thus may have missed the effects of buyers' complementary asset investments. Moreover, though relational performance implies a positive outcome for buyers' knowledge transfer programs, it is unclear whether financial investments in such programs receive their due capital return. If the relational performance earned by training firms is less than their capital investment justifies, all buyers would be better off simply creaming off supplier markets, treating knowledge as a public good, and expecting government agencies to invest in spreading best practices.

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Thus, future research needs to better integrate these dyad and financial perspectives.

Our analysis of reciprocal relations assumes that cause and effect occur close to one another in time. Because this assumption is easier to make and harder to prove (Wong and Law, 1999), the probability we incurred in error Type I (i.e., concluded for the unidirectional causality, when we in fact have a reciprocal association), may be greater than $p < 0.05$. Future research has to confirm our causal predictions with panel data.

Despite the growing attention scholars have given to understanding alliance knowledge transfer processes, research has devoted little attention to the tension between knowledge transfer, knowledge appropriation, redeployable performance, and relational performance. We believe our current study is one step toward integrating these perspectives and shining some light on the phenomenon of (vertical) alliance competitive advantages.

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APPENDIX: CONSTRUCT ITEMS AND RELATED SURVEY QUESTIONS

F1—Supplier Redeployable performance: performance dimensions are:

a. percentage of goods delivered on time
b. number of inventory turns necessary to support 12 month sales

F2—Supplier relational performance: difference between performance of supplier with ‘this’ buyer vis-à-vis its performance with average buyer. Performance dimensions are:

a. percentage of goods delivered on time
b. number of inventory turns necessary to support 12 month sales

F3—Supplier knowledge acquisition efforts: degree to which supplier has invested in or participated in (i.e., been involved with) programs to acquire any of the following improvement packages

a. total quality management programs
b. new machine set up techniques programs
c. *kaizen* programs
d. lot size optimization techniques programs

F4—Joint buyer-supplier knowledge acquisition efforts: degree to which supplier has invested in or participated in (i.e., been involved with) programs to acquire any of the following improvement packages with ‘co-participation’ of ‘this’ buyer, that is, where this buyer participated in these knowledge acquisition efforts either by ‘teaching,’ ‘consulting,’ or ‘joint-participating’ (e.g., this buyer’s and supplier’s employees jointly participated in someone else’s programs)

a. total quality management programs
b. new machine set up techniques programs
c. *kaizen* programs
d. lot size optimization techniques programs

F5—Supplier dyadic specific assets and capabilities: degree to which investments within past three years in assets and capabilities listed below were primarily made to serve the unique and exclusive needs of ‘this’ buyer

a. order taking and order processing
b. production processes
c. new tooling and new manufacturing or R&D equipment
d. new facilities

F6—Buyer-supplier relational governance mechanisms between supplier and ‘this’ buyer: degree to which supplier and ‘this’ buyer

a. keep each other informed relative to production plans, schedules and demand forecasts
b. extend technical support during emergencies and breakdown and/or on site support for implementation of improvements
c. promote ‘fair sharing’ of cost savings and benefits arising out of joint efforts

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