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Supplier Performance in Vertical Alliances: The Effects of Self-Enforcing Agreements and Enforceable Contracts

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The paper examines the significance of enforceability and adaptability in governing vertical alliances and their performance ramifications for suppliers. Literature on supplier relations suggests that suppliers are skeptical of close ties with their buyers (Helper 1991, Helper and Sako 1995). Such skepticism persists in spite of the fact that buyers are writing longer (enforceable) contracts with fewer suppliers. In this context, the paper develops a transaction cost economics (TCE)-based model that distinguishes between the verifiable and nonverifiable aspects of governance attributes (of safeguards, incentive intensity, and adaptability) in explaining supplier performance variations. The paper argues that the following factors prove valuable for suppliers: (1) the adaptive and collaborative orientation fostered by the original equipment manufacturer's (OEM's) credible commitment to the exchange and by information sharing on the part of the supplier, (2) the presence of certain nonverifiable safeguards, and (3) the incentives inherent in target pricing. These assertions have been tested using data from the home appliance industry. Results indicate that information sharing together with (1) OEM dependence and (2) target pricing does indeed enhance supplier performance. Also, results suggest that while nonverifiable safeguards can help, verifiable safeguards do not have a positive association with supplier interests. Under certain conditions then, suppliers can venture into closer relationships with buyers and benefit.

Key words: governance of supplier relations; vertical relations; adaptability in vertical relations; supplier interests in vertical relations; self-enforcing agreements; supplier cooperation

The emergence of global markets, shortened product life cycles, and the rapid pace of new product introduction have all contributed to the growing strategic significance of supplier-relationship (vertical market) organization and management. Supplier activities gain competitive significance in the downstream market through their effect on product quality, new product or process innovations, and manufacturing costs (Clark et al. 1987). In fact, evidence from several industries suggests that the Japanese original equipment manufacturer (OEM)-supplier relationships (a specific form of which is the just-in-time (JIT) exchange) underscore their significant advantage pertaining to cost, quality, and innovation in global markets (Richardson 1993, Nishiguchi 1994).

Explicit benefits of JIT exchange to the buyer include reduced uncertainty in supplies, supplier investment in buyer-specific assets, better quality of parts, lower manufacturing overheads (such as inventory carrying cost, cost of rework), and lower product-development time and costs. Delivery of necessary quantity, with perfect quality, per a precise timetable to the OEM is a crucial element of JIT (Frazier et al. 1988). Of course, such a relationship also entails being more dependent on fewer suppliers, and ensuring that these suppliers undertake innovative and cost-reducing efforts. Regarding the seller, potential benefits include reduced (volume) uncertainty because of the long-term focus, negotiations on nonprice features, better planning of R&D activity, etc. (Lyons et al. 1990). Such relational exchange is, thus, a potential source of competitive advantage, as seen in the case of the Japanese *keiretsu* system and the global drive for long-term contracts (LTCs) that it has brought with it.

Conflict resolution and mutual adaptation are crucial to reap the above-mentioned benefits in long-term buyer-supplier relationships. Longevity implies greater interdependence among the parties, and could lead to conflicts on account of opportunistic behavior, misaligned incentives, etc.—as all future contingencies cannot be foreseen and provided for in the contracts (Salanie 1998, Bernheim and Whinston 1998). There is friction between buyers and suppliers over the management of JIT exchange, and this study investigates ways of resolving this conflict from the suppliers' perspective. In particular, the study addresses the performance implications of governance choices that accompany vertical relationships, wherein the relationships tend to be (1) long-lived and (2) characterized by specialized investments and interdependence between the parties. Anecdotal and descriptive evidence from both popular press and academic works suggests that buyers are potentially gaining at the expense of their suppliers (Womack et al. 1990, Lyons et al. 1990, Helper 1991, Helper and Sako 1995, Mudambi and Helper 1998). Although suppliers have been meeting JIT requirements of quality, timely delivery, R&D participation, etc., they fear that buyers have not reciprocated with a commitment to long-term association. For example, suppliers fear that buyers continue to judge them on short-term, lowest price bid basis, despite the buyers having increased contract durations (Lyons et al. 1990, Helper 1991, Helper and Sako 1995, Dyer 1994). Because the source of friction rests in the manner in which these bilateral relationships are governed, the study focuses on the governance choices made in such alliances to explain variations in supplier performance.

Theory Development

The study draws on two related theoretical perspectives—transaction cost economics (TCE) and theory of contracts—to address the effects of governance choices on supplier profitability. TCE provides a discriminating match between transactions and alternate governance modes so as to economize on the (transaction) costs of writing, monitoring, and enforcing contracts (Williamson 1985). TCE identifies *asset specificity* as a defining attribute of transactions, and *incentive intensity* and *adaptability* as the characterizing attributes of governance modes chosen to govern the transactions (Williamson 1985, 1996a). The term incentive intensity refers to the incentive that parties enjoy to perform their obligations, undertake continuous improvements, etc.

Williamson (1985) emphasizes the efficiency-enhancing role played by ex post support institutions in governing bilateral exchanges characterized by specialized investments. Although continuity is highly valued because of the nontrivial investments made in the relationship, futuristic uncertainty, complexity, and bounded rationality can cause parties' interests to drift out of alignment over time. In this context, TCE disputes the efficiency of third-party arbitration in resolving conflicts (Williamson 1985, p. 29). It argues that parties, instead, need to focus on ongoing, mutual adjustment processes (bilateral negotiation). The objective is not merely to resolve conflicts in progress, but also to recognize potential conflicts and devise suitable support mechanisms to forestall them.

In the context of LTCs, contracting theory recognizes that comprehensive contracting between parties is prohibitively expensive and may not even be feasible in the face of uncertainty, complexity, and bounded rationality (Bernheim and Whinston 1998). Given that contingent claims contracts are prohibitively expensive to be written and enforced, LTCs, would necessarily be incomplete and imperfect governance mechanisms (Hart 1988, Klein 1988). Joskow (1988b) explains:

> The more costly it is to contract on all contingencies and the greater the ex ante incentive effects of potential ex post hold up threats, the more imperfect long-term contracts are likely to be. (p. 101)

Which means, the LTC's adaptive ability as events unfold will drive its success potential—in terms of contributing to an efficient outcome, i.e., contributing to either party's profitability.

The study distinguishes between self-enforcing and enforceable contracts to highlight a crucial determinant of the parties' ability or inability to adapt. In pursuing long-term relations, parties face difficulty in writing a contract that is sufficiently clear and unambiguous so that the terms can be verified and, therefore enforced by a third party. The need to incorporate verifiable terms, in turn, is a significant source of contractual incompleteness and governance costs (Hart and Holmstrom 1987). We define *self-enforcing* or implicit contracts as those that rely on mutual adjustment processes (and not on third-party intervention) to adapt to changing circumstances, to resolve conflicts, to provide incentives, and to enforce an agreement. On the other hand, *enforceable* or explicit contracts incorporate performance incentives and adaptability features in a manner that is verifiable (and hence enforceable) by a third party. Parties adapt to unfolding events with these contractual provisions and resort to third-party arbitration to resolve conflicts.

Imposing the condition of verifiability would drastically limit the scope for flexibility in an LTC. In the case of verifiable contracts, parties incorporate flexibility provisions only with respect to verifiable variables such as quantity, price, etc. Even in the case of verifiable variables, such provisions can cause severe ex post rigidities because of the inability of the contract to accommodate all possible contingencies. These rigidities, in turn, lead to inefficient results (in terms of performance of at least one party), litigation, and in some cases, breakdown of the contractual relationship (Klein 1988, Joskow 1990).

What is self-enforcing about implicit contracts? In contrast to explicit, enforceable contracts, contractual flexibility is maintained through bilateral adjustment processes. Besides the vertical nature of exchange that contributes to the externality between the parties, exchange partners (may) voluntarily engage in activities that enhance this mutual reliance. An essential attribute of these reciprocal activities is that they have little value outside the relationship, and hence signify credible commitment to the alliance (Williamson 1985, 1996a). Self-interest of the parties—as they recognize the nontrivial value of their commitment to the exchange and the accompanying mutual interdependence—motivates them to adjust to and accommodate each other's priorities and behave reasonably. The ability of nontrivial mutual commitments or hostage exchange to engender cooperative behavior in a repeated context is also called a subgame perfect outcome (Fudenberg and Tirole 1991). The symbiotic dependence and collaborative orientation, in turn, allow the parties to mutually agree on nonverifiable aspects of trade as well, thereby vastly enhancing their ability to adapt to changing circumstances.

Reciprocal commitments thus handle incompleteness by deterring opportunistic behavior and allowing for self-enforcement through mutual adaptation. Furthermore, reciprocal commitments, while being nonverifiable supports, enhance the value of exchange for the two parties by neutralizing the costs associated with maladaptation, and by providing the cost, quality, and innovation benefits that accompany their investments.

Asset Specificity, Adaptability, and Performance. The study's emphasis on the profitability implications of governance choices in an asset-specific context warrants some attention here. Specialized assets help produce higher quality products, processes, improved products, better customer service, etc. The specialized asset may also dramatically reduce inventory costs, costs of product rework, assembly overheads, etc. Both of the above-mentioned benefits have direct profitability implications (either through the ability to charge a premium price or by reducing costs). Williamson's (1985, 1996a) repeated reference to *discriminating match* suggests that the benefits of asset specificity may potentially be lost through higher costs of governing such specialized assets. Therefore, where appropriate governance choices address the adaptability needs of specialized assets, efficiency gains are reaped (Williamson 1985, 1996a, 1999; Saussier 2000). To quote Williamson (1996b) here:

> Because transactions differ in the degree to which they require coordinated adaptation, the alignment of governance structures with transactions in a discriminating way has economizing consequences. Specifically… transactions where the parties bear a strong bilateral dependency relation to each other are ones for which *coordinated adaptation yields real gains*. The bureaucratic costs of internal organization notwithstanding, *the* (*coordination*) *benefits of hierarchy here may well exceed the added* (*bureaucratic*) *costs.* (p. 51)

Williamson (1999) further adds:

> And *governance* is an economizing response to the Commons triple, in that governance is a means by which to infuse *order* in a relation where potential *conflict* threatens to undo or upset opportunities to realize *mutual* gains. (p. 1090)

In fact, Williamson (1985, pp. 17, 28–29) grounds his reasoning firmly in serving efficiency purposes of the contracting parties. Regarding the ability of credible commitments to generate cooperative behavior, cooperation yields more efficient outcomes than noncooperation (Fudenberg and Tirole 1991). More generally, the term *efficiency* refers to net gains rather than mere minimization of costs.

To sum up, the study combines two disparate contributions of TCE and contracting theory to suggest that the verifiability requirement of contractual terms embodies the lack of adaptability among contracting parties. The next section examines whether nonverifiable features—of incentive and adaptability attributes—matched with mutual enforcement can add value in an asset-specific context. The role of verifiable incentives and safeguards in an asset-specific context is also discussed.

Model Development and Hypotheses Formulation

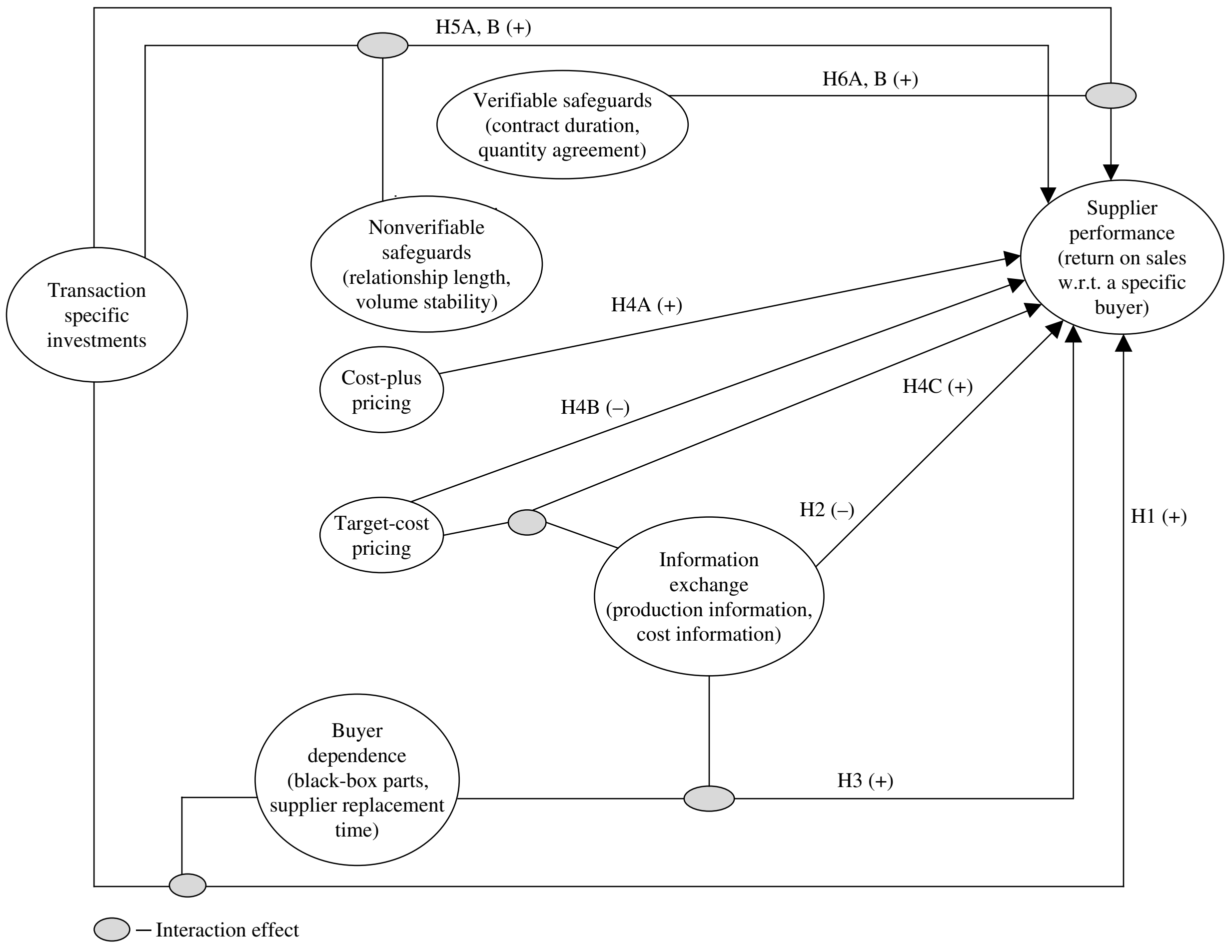
This paper proposes that enforceable and self-enforcing agreements vary systematically in terms of their adaptability, incentive, and safeguard features, and, in turn, affect supplier performance differently. By supplier performance, we refer to the supplier's returns from conducting business with a specific OEM customer, and therefore the explanatory (governance) variables are also specific to the chosen customer. We first focus on (1) buyer's credible commitment to the exchange and (2) supplier information sharing to assess the adaptability of the parties and the performance effects of such adaptability on the supplier (H1–H3 in Figure 1). Subsequently, we assess the supplier-performance implications of verifiable and nonverifiable incentives that take the form of cost-plus pricing and target-pricing practices, respectively (H4A–H4C in Figure 1). The last set of hypotheses (H5A–H5B, H6A–H6B) test for the performance effects of nonverifiable and verifiable safeguards in an asset-specific context. Detailed development of the hypotheses ensues in the following paragraphs.

Adaptability and Its Value to Suppliers

Buyer Dependence. Some works on supplier relations recognize the significance of OEM commitment (Dyer and Ouchi 1993; Nishiguchi 1994; Dyer 1994, 1996b), but many others ignore the need for reciprocity on the part of OEM buyers (Noordewier et al. 1990, Heide and John 1992, Artz 1995, Buvik and John 2000). The supplier practice of black-box designing illustrates OEM customers' credible and reciprocal commitment to the exchange. Some manufacturers engage in the enduring practice of procuring entire assemblies or subsystems from particular suppliers (Asanuma 1988). Such suppliers are said to undertake black-box designing, because the customers merely specify the performance requirements of the component or subsystem, and the subcontractors use their technical expertise to perform the detailed design, engineering, and manufacturing tasks. Although black-box designing reduces the complexity of a buyer's product-development tasks, it also simultaneously makes the buyer quite dependent on specific suppliers.

From a supplier-performance viewpoint, the customer's dependence on technological or product design,

Figure 1 Asset Specificity, Governance Attributes, and Supplier Performance



or both, serves as a credible hostage (Nishiguchi 1994, p. 118) because it guarantees steady demand realizations. Credibility is also rooted in the inability of the OEM customer to switch suppliers easily. The ability of such buyer dependence to enhance ongoing adaptive ability (through mutual enforcement), support exchange, and create a collaborative orientation contributes to improving supplier performance. Therefore the following hypothesis is made:

HYPOTHESIS 1 (H1). *Buyer's dependence,* (*operating as its credible commitment to the exchange*) *in the form of black-box parts design, together with supplier's specialized investments, would relate positively with supplier performance* (*with respect to the buyer's business*).

The *buyer dependence* variable illustrates the hypothesis in Figure 1.

Information Exchange. Suppliers need to share their process and cost information for the success of JIT exchange, and yet getting the suppliers to share the information has proved elusive to OEMs (Helper 1991, Womack et al. 1990, Helper and Sako 1995). In the Japanese context, what makes the "target-cost" method of new product development and outsourcing operate as sources of advantage is the ability of the manufacturers to rigorously apply supplier process information in their value analysis (VA) and value engineering (VE) endeavors (Nishiguchi 1994). VA refers to improvement of existing components, while VE refers to component and cost planning of new models.

Supplier's reticence to share production information is rooted in their skepticism of JIT requirements. JIT exchange requires the supplier to make OEM-specific investments to achieve zero-defect, JIT delivery of parts and to participate in product-development tasks. However, customers continue to treat such suppliers as being equally replaceable, and indulge in periodic, short-term price bidding, which proves harmful to supplier interests. The term *JIT delivery* has come to mean increased inventory burden for suppliers, with the customers not reciprocating by way of technical or financial support. Low level of OEM commitment and high degree of information exchange is an untenable combination (Helper 1991). Therefore the following hypothesis is made:

HYPOTHESIS 2 (H2). *Production-information exchange on the part of the supplier* (*without buyer's credible* *commitment*) *would associate negatively with supplier performance—with respect to the buyer's business.*

The term *information exchange* illustrates this hypothesis in Figure 1.

Information Exchange Together with Buyer Dependence. In direct contrast to the above-mentioned adversarial negotiations, Japanese buyers and suppliers jointly focus on total manufacturing costs when implementing VA or VE techniques or both. Important factors that provide the subcontractors with an incentive to share production information include (1) implementation of profit-sharing rules, (2) concentration of orders among few direct (first tier) suppliers, (3) significant dependence on specific subcontractors on account of black-box design methods, and (4) the gradual development of bilateral decision making regarding price determination (Nishiguchi 1994). This sets the stage for joint profit maximization. Truthful revelation of cost or demand parameters or both is essential for maximizing joint profits. It is important to note here that, provided ex ante incentives (as mentioned above) exist for the supplier, it is very much in the interest of the supplier to reveal true cost parameters. If the supplier fails to share and distorts information, double marginalization (adversarial bargaining) comes into play, which yields lower levels of individual firm profits (Scherer and Ross 1990).

In a static, one-shot context, either firm could do better by not cooperating (Hill 1990). The buyer will not have to make reciprocal commitments, share profits, or retain a supplier for a long period of time, while the supplier will not be constrained to meet target cost. However, in the context of repeated exchange, reputation effects and competition, the downstream buyer needs to solicit the cooperation of the supplier so that revenue and profit levels can be increased (Scherer and Ross 1990). In other words, a see-through value chain and open information exchange is essential to minimize total manufacturing costs and create sustainable, significant economic value (Dyer and Ouchi 1993). Therefore the following hypothesis is made:

Hypothesis 3 (H3). *When there exists credible commitment on the part of the buyer, sharing of production information would associate positively with supplier performance* (*with respect to the buyer's business*).

The interaction between *buyer dependence* and *information exchange* variables represents H3 in Figure 1.

Incentive Intensity and Supplier Performance

One reason why suppliers retain their distinct identity (and not vertically integrate) is because they get to become residual claimants of profits from their operations. The ability to retain residual profits, in turn, provides them the incentive to continuously seek efficiency, quality, and technological improvements. The pricing terms between the buyer and the supplier determine not only the supplier's rewards (and punishment) for performance (or nonperformance), but also its share of the residual profits. We therefore discuss incentives here in terms of their incorporation in verifiable and nonverifiable pricing mechanisms.

Cost-Plus Pricing. The use of rate of return or cost-plus pricing arrangements between buyers and suppliers is pervasive in many industries. The high incidence of cost-plus pricing (or a variant of it; namely, base price plus escalation (BPE)) provisions in LTCs protects supplier interests in that it guarantees a specific rate of return on investment. As the profit component is built into the pricing formula, it is subject to legal or third-party remedy (because price is a verifiable variable). Empirical evidence on cost-plus contracts in the coal industry reveals that cost-plus prices track market-price changes quite closely, so long as the changes are linked to increases in cost of production (Joskow 1988a). On the other hand, Joskow (1990) finds suppliers reluctant to allow decreases in prices, when changes in the technological environment warrant such price reductions. The absence of upward price rigidity and the presence of downward rigidity clearly protect supplier interests and are not unique to regulated industries. The following hypothesis is therefore made:

Hypothesis 4A (H4A). *The incidence of cost-plus pricing would relate positively with supplier performance* (*with respect to the buyer's business*).

Target Pricing. Japanese industrial buyers routinely employ *target pricing* in their dealings with suppliers. Buyers commonly set a target sales price for a new model and arrive at the targeted price for each part in a "market-price minus" manner using VA results (Nishiguchi 1994). Market-price minus, in principle, is the antithesis of cost-plus pricing and the pricing formula is rarely written in the contract.

Under the target-pricing regime, buyers typically expect the suppliers to achieve gradual cost reductions through investments in cost-reducing equipment, processes, and through experience curve effects (Cusumano and Takeishi 1991, Dyer and Ouchi 1993). Although the suppliers do not commit to a specific percentage decline in costs and prices of the components, prices are brought up for rectification every six months (Nishiguchi 1994). To this end, buyers employ forced competition between the few chosen suppliers by following a two-vendor policy (Dyer and Ouchi 1993). The system rarely allows for increases in material or fuel costs to be passed on to the buyer (Helper and Sako 1995). The constant pressure to cut prices without considering the individual supplier's ability (in terms of current costs) to provide price cuts could prove quite harmful to supplier margins. Therefore the following hypothesis is made:

Hypothesis 4B (H4B). *The incidence of target-pricing practices* (*absent information exchange*) *would relate negatively to supplier performance* (*with respect to the buyer's business*).

Target Pricing and Information Exchange. The discussion on information exchange warrants a second look at target-pricing effects. Two vendor policies of OEM customers together with a perennial expectation of cost savings exert substantial pressure on supplier margins (Helper and Sako 1995, Dyer and Ouchi 1993). It is important to note though that the target price is arrived at only after extensive VA and VE exercises that provide for normal returns to the supplier. Any future reductions in the targeted price are based on cost savings achieved by the supplier, and not on reduced supplier margins.

The end-product target price arrived at this way tends to be very competitive, yielding substantial volume advantage to both the OEM and the supplier. This trend has been repeatedly seen in the case of Toyota, Fuji Electric, and Matsushita to name a few (Nishiguchi 1994). The increased volume, in turn, allows them to climb further down on the cost curve. Therefore the following hypothesis is made:

Hypothesis 4C (H4C). *The incidence of target pricing together with production-information exchange* (*on the part of the supplier*) *would relate positively with supplier performance* (*with respect to the buyer's business*).

Asset Specificity and the Need for Safeguards

Transacting parties undertake customized, durable investments because of the efficiency and product improvements that accompany such assets (Williamson 1985, Clark and Fujimoto 1991, Dyer and Ouchi 1993). However, once the specialized investment is made, the investing party is exposed to postcontractual opportunistic behavior on the part of the noninvesting party (Klein et al. 1978). Given that the fear of postcontractual opportunistic behavior can lead to inefficient ex ante investment decisions (thereby denying both buyer and supplier firms of sources of advantage), safeguards emerge in support of these investments. Here, we distinguish between nonverifiable, implicit safeguards and verifiable but explicit ones.

Nonverifiable (*Implicit*) *Safeguards.* An inherent feature of JIT exchange is the longevity of association between suppliers and buyers (Cusumano and Takeishi 1991). For example, where Japanese suppliers meet target requirements, their relationships with the OEMs have lasted more than 20 years (Nishiguchi 1994, Helper and Sako 1995). Longevity of association serves as an implicit safeguard because the parties do not contractually bind themselves for a long time period. Instead, the parties sign flexible annual contracts that (1) provide the "general constitution" of the relationship and (2) are constantly adjusted and renegotiated (Dyer and Ouchi 1993, Nishiguchi 1994, Helper and Sako 1995).

Helper (1991) contrasts the implicit longevity of business relations (not tied to a specific product or contract) with legally enforceable duration of a contract. Despite the fact that the average contract duration had increased from 1.2 years in 1984 to 2.3 years in 1989 (Helper 1991), less than 5% of the American suppliers in Helper and Sako's (1995) survey have supplied the (same) customer for more than 20 years. On the other hand, an informal commitment to a long-lived business relation has encouraged Japanese suppliers to continue making transaction-specific, efficient investments. Longevity provides sufficient time horizon and accumulated volume for the suppliers to climb down the cost curve and recover their investment (Dyer and Ouchi 1993). We therefore hypothesize the following:

Hypothesis 5A (H5A). *Where suppliers have made transaction-specific investments* (*TSI*), *their expectation of the relationship's future length* (*unaccompanied by verifiable safeguards*) *would have a positive association with supplier performance* (*with respect to the buyer's business*).

It is relevant to point out here that longevity in itself does *not* guarantee positive performance effects for the supplier in theory, for cooperation is only one of several possible outcomes in a repeated context (Fudenberg and Tirole 1991). H5A therefore remains an interesting empirical question in supplier relations.

Volume Stability. Another much focused upon aspect of JIT exchange (in fact, the term JIT owes its origin to this practice) is the ability of the supplier to make JIT delivery to its customer. A persistent mismatch between supplier production and delivery lot sizes results in the supplier delivering *just in time* out of its own buffer inventory, thereby shifting the inventory burden from the buyer to the supplier (Womack et al. 1990, Helper 1991). The difference between the average production and delivery lot sizes in the United States averages at three days' needs, while that in Japan averages at eight hours' requirement (Helper and Sako 1995). Also, the average stockholding of a Japanese supplier is 1.5 days' production, while that of an American supplier is 8.1 days' (Nishiguchi 1994, p. 204). Consequently, it is not surprising that American suppliers have been skeptical of the JIT system.

From a supplier performance perspective, for the requirement of frequent delivery in small lot sizes to not unreasonably increase the inventory holding of the supplier, it is imperative that the suppliers also produce in small lot sizes. For the supplier to reduce its lot size, customer-delivery schedules must be stable at least for the duration of the supplier's lead time. To this end, the customer must first be willing to share its production schedules and then make little or no alteration to them.[1] Production *and* delivery in small lot sizes lead to lower stock covers and higher inventory turnovers for the suppliers; this is clearly beneficial to their bottom line. The following hypothesis is therefore made:

Hypothesis 5B (H5B). *Where suppliers have made durable investments, volume stability in the form of production-schedule sharing and minimal schedule alterations would relate positively to supplier performance* (*with respect to the buyer's business*).

Both H5A and H5B are shown in Figure 1 by the interaction between TSI and nonverifiable safeguards.

Verifiable (*Explicit*) *Safeguards.* Empirical works on LTCs have long attempted to explain the coexistence of TSI and protective provisions in several industrial contexts (Joskow 1988b). In a thorough empirical analysis of coal supply contracts to electric utilities, Joskow (1985, 1987) finds that the average duration of mine-mouth contracts is 35 years, while the all-sample average is 12.75 years. On account of the large minimum-efficient scale and high-capital intensity of Western coal mines, agreements with longer duration allow the coal mine owner to employ least cost technologies and reap beneficial returns. Joskow's (1985, 1987) results therefore suggest that extended contract duration, as a safeguard for asset specificity, would associate favorably with supplier performance. Mulhern (1986) finds that the length of the contract significantly increases the probability of natural gas producers securing a most-favored-nation status with gas pipelines (the buyers). This, in turn, allows the producers to earn higher revenues and returns. Consequently, the following hypothesis is made:

Hypothesis 6A (H6A). *Supplier's specialized investments, together with extended contract duration, would associate positively with supplier performance* (*with respect to the buyer's business*).

Along with contract duration, it is not uncommon to find ex ante purchase quantity provisions in supply contracts (Saussier 2000). In the case of coal supply contracts to mine-mouth power plants, requirements contracts are extensively used to ensure continued business for the coal mine. Requirements contracts specify that the contract should be written to meet buyer-plant requirements over a specific period of time. Threats by the buyer to switch to alternate suppliers then become less credible. In the case of natural gas supply contracts to pipelines, both Mulhern (1986) and Masten and Crocker's (1985) studies show that supplier's interests are served by take-or-pay provisions that specify the minimum daily quantity for which the pipeline is obliged to take or pay. Hence the following hypothesis is made:

Hypothesis 6B (H6B). *TSIs of the supplier, in the presence of ex ante quantity provisions, would have a positive association with supplier performance* (*with respect to the buyer's business*).

Both H6A and H6B are represented by the interaction between TSI and verifiable safeguards in Figure 1.

The Model

The model developed in this section can be formulated as follows:

$$\begin{aligned}
&[\text{supplier profitability}]_i \\
&\quad = \text{intercept}_i + [\text{TSI} \cdot \text{buyer dependence}]_i \\
&\qquad + [\text{TSI} \cdot \text{information sharing by supplier}]_i \\
&\qquad + [\text{buyer dependence} \cdot \text{information sharing}]_i \\
&\qquad + [\text{target-cost pricing}]_i + [\text{cost-plus pricing}]_i \\
&\qquad + [\text{target-cost pricing} \cdot \text{information sharing}]_i \\
&\qquad + [\text{TSI}]_i + [\text{TSI}_i \cdot \text{relationship length}_i] \\
&\qquad + [\text{TSI}_i \cdot \text{volume stability}_i] \\
&\qquad + [\text{TSI}_i \cdot \text{contract duration}_i] \\
&\qquad + [\text{TSI}_i \cdot \text{quantity requirements}_i] \\
&\qquad + [\text{product category control}]_i \\
&\qquad + [\text{supplier size control}]_i + [\text{structural control}]_i + \varepsilon_i.
\end{aligned}$$

The term TSI stands for transaction-specific investments made by the supplier. Also, the model includes control variables not discussed in the preceding paragraphs. The product category variable controls for any product specific (materials versus component suppliers) influence on supplier profits. The second control variable captures any size-related influence on supplier profits. The last two controls check for the effect of industry structure on supplier performance. In particular, they control for the power exerted by the buyers in the industry in the form of (1) buyer concentration and (2) the number of firms currently supplying the same product to the buyer (Cool and Henderson 1998). Figure 1 depicts the model in its entirety.

Research Methodology

The unit of analysis chosen for the study is the buyer-supplier association in its entirety. The study attempts to explain variations in supplier performance in terms of differences in transactional attributes and contracting or governance arrangements between suppliers and their OEM customers. Regarding the dependent variable (supplier performance), feedback from industry experts and respondents reveals that suppliers do indeed keep track of earnings *at the client level* in terms of gross margin, return on sales, etc. More conventional earnings measures such as ROI and return on equity are, however, hard to obtain (because most suppliers are private firms) and may not even be available at the client (OEM) level.

Variable Definition

Supplier Performance (*Return on Sales with Respect to the OEM's Business*). Supplier performance is measured in terms of the supplier's average return on sales (profit before taxes/sales) regarding the OEM's business during 1993–1996: OEMROSA. The return on sales data are gathered at the postinterest, pretax stage to capture the benefits that suppliers may reap because of any cheap loans or equity investment made by the OEM.

TSI (*Asset Specificity*). The term TSI refers to durable investments undertaken by the supplier to support the unique transaction with an OEM customer, wherein such assets have little alternate use. The study measures TSI in terms of supplier's investment in durable equipment, machinery, advanced design systems, operating procedures, R&D, etc. to meet the specialized needs of the OEM customer (SC_ASP). Suppliers responded to a multi-item construct measured on a Likert scale (1–5); the measure has a coefficient alpha of 0.74—indicating a high degree of internal consistency among the items. Also, exploratory factor analysis reveals only one eigenvalue in excess of 1.

Verifiable Safeguards (*Contract Duration, Quantity Provisions*). Verifiable safeguards are specified in terms of contract duration and ex ante quantity-take provisions in the contract. Contract duration (CONT_DUR) is measured in terms of the number of months for which the parties (supplier and OEM) write a contract. Based on the feedback from industry experts at the pretesting stage of the survey, quantity agreement has been measured as the percentage of customer's requirements to be met by the contract (SPQPRC).

Nonverifiable Safeguards (*Expectation of the Relationship's Length, Volume Stability*). Nonverifiable safeguards have been measured in this study in terms of the supplier's expectation of the length of the relationship with the OEM customer and production stability experienced by the supplier. Expectation of the duration of the relationship is measured by a ranked categorial variable with four categories: (1) less than a year, (2) between one and four years, (3) between five and ten years, and (4) more than ten years (REL_LN) (Helper 1991). Volume stability has been measured in terms of the percentage of production schedules that remain *unaltered* (VOL_STB) (Helper 1991, Womack et al. 1990).

Incentive Intensity (*Cost-Plus or Target Pricing*). The study measures verifiable incentives in the form of cost-plus pricing or BPE clauses in supply contracts. The incidence of cost-plus arrangements is captured both when the cost base is fixed and varying over time. The variable is binary in nature, coded 1 if cost-plus pricing is practiced and 0 otherwise (COSTPR). On the other hand, nonverifiable performance incentive is captured in the form of target pricing, again where the targeted time horizon could be fixed or varying. The incidence of target pricing is measured as a binary variable, coded 1 if the supplier pursues target pricing and 0 otherwise (TGTPR). Because the two pricing variables are categorized from a common set of questions, the base-pricing category is the incidence of market pricing.

Buyer Dependence (*Technological Dependence, Supplier Replacement Time*). Two variables have been used to measure buyer dependence in this study. One variable is based on the degree to which suppliers undertake detailed engineering and design activities, with OEM design of the component at the lower end of the scale and supplier's proprietary technology on the higher end (BBOX). The second variable measures the time (in months) it takes the OEM to replace this supplier successfully with an equally competent one (SUPREPTM) (Dyer and Ouchi 1993, Nishiguchi 1994). While the former captures the OEM's technological dependence on the supplier, the latter measures the OEM's overall (managerial) dependence on the supplier.

Information Exchange (*Production Information and Cost-Information Exchange*). Information sharing by the supplier is measured by two variables. The first measures the extent to which the supplier provides details of its production process to the OEM customer. The response is measured on a Likert scale ranging from 1 to 5—PRDINF (Helper 1991, Helper and Sako 1995). The second measures any cost information shared by the supplier, and is binary in nature (PRDCOST). It takes the value 1 if the supplier shares cost information and 0 otherwise.

Data Collection and Analysis

The hypotheses developed in the model are tested in the context of the home appliance industry. Regarding the choice of industry, it is imperative that two conditions be satisfied for the research model to have meaningful implications. First is that the OEM's end product must be a configuration of multiple, interdependent parts that work in unison; and second, that the OEMs compete on new product and process developments, so that differentiation and innovation at the supplier's stage become critical to the OEM. The major home appliance industry satisfies these two criteria. Typical products included in the industry are cooking ranges and ovens, refrigerators, laundry equipment, vacuum cleaners, microwave ovens, and electrical kitchen appliances (SIC codes 3631–3635). Recent new product introductions include *smart* appliances both in the traditional and microwave oven categories, smart toasters, bagless and hand-held vacuum cleaners, room-air and water filters to name a few (Reimich 1999, 2000). Also, new process innovations are essential to keep the products energy efficient and cost effective.

Data collection was done through a two-stage questionnaire survey of suppliers to OEMs in the industry (specific questions can be obtained from the authors). The target sample consisted of two primary groups:

materials suppliers and component suppliers. The survey instruments were designed and pretested with the help of the supplier division of the Association of Home Appliance Manufacturers (AHAM) and local suppliers to the industry. The first survey was designed to capture the independent variables; it was mailed to more than 1,000 suppliers in the target sample. Responses were received from 300 firms, with a response rate of 29%. The second phase followup survey was mailed to these 300 respondents. The questions measured performance of the supplier firm in relation to the OEM account. Of the 300 surveys mailed out, 153 responses were received—resulting in a response rate of 51%.

Data Analysis. As the supplier performance measure (OEMROSA) is a continuous variable, this study uses ordinary least squares (OLS) estimation for testing the model. Regression diagnostics reveal that OEMROSA is skewed a little to the left, however, there seems to be no major deviation from normality. The residual and normal probability plots reveal that the normality and constant variance assumptions of OLS regression are satisfied. Also, the data have been checked for nonresponse bias. Mean tests of early and late respondents reveal no significant difference in the two groups.

The independent variables have also been examined for multicollinearity problems, given the high incidence of interaction terms in the model. Most of the variance inflation factor (VIF) estimates have values below 10, thereby providing no evidence of multicollinearity effects. However, because three terms have VIFs ranging from 13 to 16 each, ridge regression coefficients have also been estimated. In performing the ridge regression, a small constant (bias) is added to the unbiased OLS estimates to reduce the multicollinearity effects (Neter et al. 1990). The ridge and the OLS estimates have been presented in Table 3. It is clear that neither the signs nor the significance of the explanatory variables are altered much under ridge estimation. Consequently, the original OLS estimates are retained for analysis and discussion purposes.

Test for Sample Selection Bias. OLS estimation requires that all of the explanatory variables be "random" so that the error terms remain independent. Some recent works, however, argue that governance choices can be determined by the transactional (asset specificity) variable, which would then make the governance variables endogenous to the system (Masten 1993). The sample may therefore not be random, but one with a selection bias. The randomness of the explanatory variables needs to be established before interpreting the results. To this end, a two-stage estimation with endogenous switching has been conducted using the Heckman correction (Maddala 1983, p. 223; Masten et al. 1991). Results of the switching regressions are tabulated in the appendix, and the statistical *insignificance* of the inverse Mill's ratio (LAMBDA in the appendix) suggests that the study's sample is indeed a random one.

Discussion of Results

Both descriptive statistics (Table 1) and formal testing reveal that supplier management in this industry is not as evolved as that in the automobile industry. The average contract duration between OEMs and suppliers is 10 months, while that in the automobile industry is more than two years (Helper and Sako 1995). However, the industry as a whole is trying to emulate the more successful attributes of JIT supply chain management. Component suppliers (more than 55% of the sample) work in tandem with the OEMs on new product design and development, wherein supplier innovations contribute to higher-quality, energy-efficient, easy-to-manufacture, and lower-cost products. They further average 3.5 deliveries per week to the OEM plants, and pursue target-pricing techniques.

Regarding the literature on managing vertical relations, the study's hypotheses encapsulate a TCE-based model that tests the performance implications of asset specificity and the accompanying governance choices—albeit from the supplier's perspective (David and Han 2004, Silverman et al. 1997, Zaheer and Venkatraman 1995). Specifically, results reveal that asset specificity, when accompanied by buyer's credible commitment to the exchange proves valuable to the supplier. Furthermore, sharing of production information on the part of the supplier proves valuable when accompanied by buyer's commitment in the form of black-box parts (BBOX) dependence. The study also empirically illustrates that target pricing, together with information sharing—on the part of the supplier—preserves supplier interests. Regarding the TCE literature, the study uniquely finds that implicit, nonverifiable safeguards prove valuable to suppliers in an asset-specific context. On the other hand, contractual safeguards do not contribute to supplier performance in an asset-specific context. Detailed analysis of results pertaining to individual hypotheses ensues.

Buyer Dependence and Supplier Performance

Regarding formal testing of the model, results from reduced and full models are tabulated in Tables 2 and 3, respectively. H1 postulates that buyer dependence in the context of supplier's specialized investments would associate favorably with supplier performance (with respect to the specific buyer). We test the hypothesis by interacting the buyer dependence variables (BBOX and supplier replacement time (SUPREPTME)) with the variable measuring TSIs (asset specificity (SC_ASP)). The coefficient of supplier replacement time $*$ asset specificity (SUPREPTME $*$ SC_ASP) is positive and significant at the 5% and 1% levels in the reduced and full

Table 1 Variable Definition and Descriptive Statistics

Variables: Measure	Range of values	Mean values	Standard deviation	Comments
OEMROSA (%) Past three-year average (PBT/Sales) supplier has earned from the OEM's business (percentage)	−10 to 90	13.46	11.25	Continuous variable
SC_ASP Physical asset specificity	0 to 20	10.48	5.09	Four item Likert scale: Range (1–5) each
CONT_DUR Contract duration (in months)	0 to 144	10.28	17.95	Continuous variable
SPQPRC Quantity—take requirement (percentage)	0 to 100	15.61	33.84	Continuous variable
REL_LN Duration of relationship *in future*	1 to 4	3.47	0.709	Ranked data: Ascending order of scale
VOLSTB Percentage of schedules *unaltered*	0 to 100	71.65	29.36	Continuous variable
COSTPR Incidence of cost pricing (*base option*: *Market price*)	0 or 1	0.59	0.49	Binary variable: Based on use of "fixed cost/ base plus escalation" provisions
TGTPR Incidence of target pricing	0 or 1	0.275	0.447	Binary variable: Based on use of "fixed or moving target prices over time"
BBOX Black-box nature of the part	0 to 4	2.19	1.07	Ranked data: Ascending order of scale
SUPREPTME Supplier replacement time for the buyer (in months)	0 to 60	7.19	8.04	Continuous variable
PRDINF Extent to which supplier provides process information to the OEM	0 to 5	1.75	1.76	Ranked data: Ascending order of scale
PRDCOST Whether supplier provides cost information or not	0 or 1	0.23	0.42	Binary variable
SIZE_1 LN (number of employees)	2 to 18	7.94	2.62	Continuous variable
P_ASP Component supplier or not	0 or 1	0.682	0.47	Binary variable
STKINVST Number of days' stockholding by the supplier in WIP and finished goods	0 to 300	30.06	36.57	Continuous variable

models, respectively, thereby providing strong support for H1. It is important to interpret the dependence captured by supplier replacement time from a credible commitment perspective (Koss and Eaton 1997). It is true that most suppliers in the appliance industry receive no financial support from their OEM customers. A board member of the AHAM supplier division reveals that suppliers fund a great deal of working capital in the pipeline. However, the longer it takes the OEM customer to replace a specific supplier, the more real and enduring is its commitment to that supplier, and the higher is the supplier's share of surplus from the specialized asset (Asanuma 1988). The beta coefficient of the second term testing H1 (BBOX $*$ SC_ASP) is negative and not significant.

Information Exchange and Supplier Performance

H2 postulates that any production-related information that the supplier shares with the buyer (unaccompanied by buyer commitment) does not bode well for its profitability—with respect to the specific buyer's business. In the context of the appliance industry, 18% of the respondents provide *detailed* process information to their OEMs, while 44% provide *some* information on their processes to the OEMs. We test the hypothesis using two measures of information exchange: Production-information sharing (PRDINF) and cost-information sharing (PRDCOST). Regression results presented in Table 3 indicate that sharing of production information (PRDINF) indeed has a significant negative coefficient as hypothesized, while the cost sharing variable (PRDCOST) is not significant at all.

The negative and significant result of production-process information sharing provides formal support to conventional wisdom on the issue of information sharing with OEMs. In an adversarial context, the more knowledge the OEM has on supplier operations, the more likely the OEM will use this knowledge to bring prices

Table 2 Standardized OLS Regression Estimates of Reduced Models

Dependent variable: Supplier's return on sales from the OEM's business					
Variable	Hypothesized direction	Estimates: (*t*-values)	Ridge estimates[1]	Estimates: (*t*-values)	Estimates: (*t*-values)
SC_ASP Physical asset specificity		−0.178 (−0.75)	−0.187 (−0.988)	0.10 (1.02)	−0.326 (−1.12)
BBOX Black-box nature of the part		0.106 (0.58)	0.073 (0.481)		
SUPREPTME Supplier replacement time		−0.064 (−0.17)	0.088 (0.338)		
(SC_ASP * BBOX) H1	(+)	−0.184 (−0.54)	−0.108 (−0.421)		
(SC_ASP * SUPREPTME) H1	(+)	**0.894**** (2.15)	**0.708***** (2.429)		
PRDINF—H2 Extent to which supplier shares production information	**(−)**	−0.203 (−0.84)	−0.162 (−0.81)	−**0.373***** (−3.15)	
PRDCOST—H2 Whether supplier shares cost information or not	(−)	0.222 (0.93)	0.186 (0.884)	−0.028 (−0.24)	
(BBOX * PRDINF) H3	(+)	**0.403*** (1.48)	**0.33*** (1.477)		
(SUPREPTME * PRDINF) H3	(+)	−**0.591** (−3.40)	−**0.54** (−3.365)		
(BBOX1 * PRDCOST) H3	(+)	−0.067 (−0.31)	−0.035 (−0.18)		
(SUPREPTME * PRDCOST) H3	(+)	−0.114 (−0.73)	−0.125 (−0.85)		
COSTPR—H4A Use of cost-plus pricing	(+)			0.083 (0.64)	
TGTPR—H4B Use of target pricing	(−)			−**0.343**** (−2.07)	
(PRDINF * TGTPR) H4C	**(+)**			**0.407***** (2.58)	
(PRDCOST * TGTPR) H4C	(+)			0.079 (0.62)	
CONT_DUR Duration of contract					−0.127 (−0.53)
SPQPRC Percentage OEM agrees to take contractually					−0.094 (−0.33)
REL_LN Duration of relationship *in future*					0.042 (0.42)
VOLSTB Percentage of schedules unaltered by the OEM					−0.051 (−0.21)
(SC_ASP * CONT_DUR) H6A	(+)				0.215 (0.81)
(SC_ASP * SPQPRC) H6B	**(+)**				0.044 (0.14)
(SC_ASP * REL_LN) H5A	**(+)**				−**0.172** (−1.43)
(SC_ASP * VOLSTB) H5B	**(+)**				**0.486*** (1.41)
SIZE_1 LN (number of employees)		−0.065 (−0.78)	−0.072 (−0.88)	−0.115 (−1.29)*	−0.151 (−1.58)*
P_ASP Component supplier or not		−0.093 (−1.13)	−0.097 (−1.20)	−0.01 (−0.11)	−0.007 (−0.08)
Adjusted *R*-squared		0.29		0.07	0.0435

**p*-values < 0.10, ***p*-values < 0.05, ****p*-values < 0.01.
[1]Because the distributional property of ridge estimates is unknown, the *t*-values are only approximate.

Table 3 Standardized OLS Estimates for Full Models

Dependent variable: Supplier return on sales from the OEM's business				
Variable	Hypothesized direction	Estimates (*t*-values)	Ridge estimates[1]	OLS estimates with more controls
SC_ASP		−0.323	**−0.298**	−0.311
Physical asset specificity		(−1.01)	(−1.26)	(−0.95)
BBOX		0.132	0.077	0.119
Black-box nature of the part		(0.74)	(0.53)	(0.64)
SUPREPTME		−0.141	0.047	−0.141
Supplier replacement time		(−0.040)	(0.20)	(−0.39)
(SC_ASP ∗ BBOX) H1	(+)	−0.412	−0.26	−0.373
		(−1.19)	(−1.03)	(−1.03)
(SC_ASP ∗ SUPREPTME) H1	(+)	**0.951***	**0.72***	**0.956***
		(2.37)	(2.67)	(2.33)
PRDINF: Extent to which supplier shares production information—H2	**(−)**	**−0.389**	**−0.30*	**−0.376*
		(−1.65)	(−1.58)	(−1.55)
PRDCOST: Whether supplier shares cost information or not—H2	(−)	0.272	0.22	0.271
		(1.20)	(1.11)	(1.12)
(BBOX ∗ PRDINF) H3	(+)	**0.55**	**0.42**	**0.525**
		(2.02)	(1.93)	(1.86)
(SUPREPTME ∗ PRDINF) H3	(+)	**−0.62***	**−0.56***	**−0.625***
		(−3.72)	(−3.63)	(−3.60)
(BBOX ∗ PRDCOST) H3	(+)	−0.124	−0.085	−0.097
		(−0.58)	(−0.45)	(−0.41)
(SUPREPTME ∗ PRDCOST) H3	(+)	−0.139	−0.152	−0.152
		(−0.94)	(−1.09)	(−1.00)
COSTPR—H4A	(+)	0.068	0.063	0.069
Use of cost-plus pricing		(0.58)	(0.56)	(0.58)
TGTPR—H4B	(−)	**−0.364***	**−0.355***	**−0.368***
Use of target pricing		(−2.55)	(−2.61)	(−2.52)
(PRDINF ∗ TGTPR) H4C	**(+)**	**0.361***	**0.347***	**0.370***
		(2.51)	(2.53)	(2.51)
(PRDCOST ∗ TGTPR) H4C	(+)	**0.168*	**0.165*	0.159
		(1.45)	(1.47)	(1.24)
CONT_DUR		**−0.274**	**−0.224**	−0.267
Duration of contract		(−1.34)	(−1.27)	(−1.25)
SPQPRC		−0.248	−0.209	−0.244
Percentage OEM agrees to take contractually		(−1.03)	(−1.04)	(−0.98)
REL_LN		0.004	0.008	0.004
Duration of relationship *in future*		(0.05)	(0.09)	(0.04)
VOLSTB		−0.058	−0.010	−0.05
Percentage of schedules unaltered by the OEM		(−0.28)	(−0.06)	(−0.23)
(SC_ASP ∗ CONT_DUR) H6A	(+)	0.206	0.174	0.201
		(0.92)	(0.90)	(0.87)
(SC_ASP ∗ SPQPRC) H6B	**(+)**	0.312	0.249	0.30
		(1.16)	(1.13)	(1.08)
(SC_ASP ∗ REL_LN) H5A	**(+)**	**−0.247**	**−0.237**	**−0.247**
		(−2.36)	(−2.42)	(−2.28)
(VOLSTB ∗ SC_ASP) H5B	**(+)**	**0.483**	**0.402**	**0.461*
		(1.62)	(1.71)	(1.51)
SIZE_1		−0.015	−0.026	−0.015
LN (number of employees)		(−0.18)	(−0.32)	(−0.18)
P_ASP		−0.08	−0.081	−0.077
Component supplier or not		(−1.01)	(−1.04)	(−0.94)
OTSSCU				−0.018
Number of other suppliers to the OEM				(−0.21)
TOP3PRC				−0.01
Percentage of business from top three customers				(−0.11)
Adjusted *R*-squared		0.39	0.39	0.376

*p-values < 0.10, **p-values < 0.05, ***p-values < 0.01.
[1]Because the distributional property of ridge estimates is unknown, the *t*-values are only approximate.

down or play suppliers off against each other—both of which prove detrimental to supplier profits (Helper 1991, Lyons et al. 1990).

Information Exchange Together with Buyer Dependence

We next assess the profit implications (with respect to the specific buyer) of information sharing in the presence of reciprocal buyer commitment—as stated in H3. To test the hypothesis, we interact buyer dependence with information exchange. The variables measuring buyer dependence, black-box parts (BBOX) and supplier replacement time (SUPREPTM), have been interacted with information exchange variables, sharing of production information (PRDINF) and sharing of cost information (PRDCOST) to test H3. Results for these tests are presented in Tables 2 and 3 in terms of the reduced model and full model, respectively. The interaction terms incorporating cost information sharing (PRDCOST) are not significant at all, and we therefore discuss only the interaction terms with production information sharing (PRDINF).

Regarding the first interaction term, black-box parts ∗ sharing of production information (BBOX ∗ PRDINF), the coefficient is positive and significant, thereby providing convincing support for H3. As the supplier increasingly undertakes product/part design, engineering, and research activities, the OEM gets further distanced from the product and part architecture, making its dependence on the supplier very credible. Any production-process information that the supplier shares with the OEM for value analysis purposes does not dissipate such dependence on the supplier, and hence the positive relationship to supplier performance.

Regarding the second interaction term; namely, supplier replacement time ∗ sharing of production information (SUPREPTM ∗ PRDINF), the coefficient is significant and negative, thereby negating the hypothesis. Where the supplier shares its production process details, the OEM customer is in a position to share the details with other suppliers. In fact, OEMs regularly play suppliers off against each other through the two-vendor policy both in Japan and in the United States (Nishiguchi 1994, Helper and Sako 1995). An essential aspect of the two-vendor policy is to bring the weaker vendor on par with the stronger vendor through sharing of know-how. It is therefore possible that sharing of process details attenuates buyer's dependence on the supplier, thereby hurting supplier margins as well. The two results suggest that while information sharing combined with black-box part (BBOX) dependence benefits the supplier, information sharing combined with supplier-replacement time reduces supplier performance. The strategic benefit accruing from the supplier's competence in product or part architecture is more durable than the benefits coming from its production process (Mudambi and Helper 1998).

Incentive Intensity and Supplier Performance

Hypothesis 4 tests for the association between alternate pricing policies (and the incentives they incorporate) and supplier performance—with respect to a specific buyer. Results for cost-plus pricing do not support H4A, that cost-plus pricing favors supplier performance. Regarding H4B, both the reduced and full models (Tables 2 and 3) indicate a significant, negative association between target pricing and supplier performance (see Figure 1). Results clearly support H4B's reasoning that a persistent pressure to reduce prices (unaccompanied by VA endeavors) hurts supplier margins. Evidence from the Japanese and American auto industries indicates that suppliers do indeed periodically take margin cuts with respect to the OEMs' businesses (Helper and Sako 1995).

To fully understand the profit impact of target pricing, H4C tests for the joint effect of target pricing and information exchange on supplier performance (see Figure 1). Results clearly support the hypothesis, with the coefficients of target pricing ∗ sharing of production information (TGTPR ∗ PRDINF) and target pricing ∗ sharing of cost information (TGTPR ∗ PRDCOST) being positive and significant at the 1% and 10% levels, respectively, in the full model (see Table 3). Also, the magnitudes of the two coefficients (0.36 and 0.17, respectively—Table 3) together exceed the negative effect (−0.36) of target pricing, unaccompanied by information sharing. As a result, the net effect of target pricing is one of unequivocally increasing supplier profits, where profits climb with higher levels of information sharing. Taken together, the results of H4A–H4C clearly indicate that it is very much in the supplier's interest to share production and cost information with the OEMs for VA and VE exercises.

The overall significance of information sharing (on the part of the supplier) is complex in the study. Where the supplier enjoys credible buyer dependence (in the form of black-box part dependence), sharing of production-process information proves beneficial. Also, a supplier's willingness to share both production-process and cost information for target-pricing purposes proves valuable for its profitability. However, the total effect of information exchange in the study suggests that the suppliers exercise some caution in sharing information—given the overwhelming negative effects of production-information exchange (main effect) and its interaction term with supplier replacement time.

Nonverifiable Safeguards and Supplier Performance

Hypothesis 5 of the model deals with the relationship between nonverifiable safeguards and supplier performance—with respect to a specific buyer, under conditions of asset specificity. The study measures nonverifiable safeguards in two ways: (1) supplier expectation of relationship length (REL_LN) and (2) volume stability (VOLSTB). H5A is tested by interacting asset specificity (SC_ASP) with expectation of relationship length (REL_LN), while retaining the main effects of asset specificity and expected relationship length (SC_ASP and REL_LN) in the regression. The coefficient of the interaction term is negative and statistically significant, while the main effect of expected relationship length (REL_LN) is not significant.

Contrary to expectations rooted in literature (Buvik and John 2000, Nishiguchi 1994, Dyer and Ouchi 1993, Heide and John 1992, Artz and Brush 2000), results suggest that a potentially long-lived association would harm the supplier, under conditions of asset specificity. It is relevant to recall here that repetition alone is not sufficient to guarantee efficient or cooperative outcomes (McMillan 1990, Fudenberg and Tirole 1991). In fact, anecdotal and descriptive evidence does suggest that relationship age has no association with supplier performance or customer adaptation (Brennan and Turnbull 1999, Corbett et al. 1999).

Regarding H5B, empirical results show that volume stability plays a very critical role in boosting supplier performance. As in the previous case, we test the hypothesis by interacting asset specificity (SC_ASP) with volume stability (VOLSTB), while retaining the main effects of asset specificity and volume stability in the model. The coefficient of the interaction term is positive and statistically significant in both the reduced and full models.[2] Results clearly suggest that the presence of volume stability makes investing in OEM-specific assets a more valuable proposition to the supplier than not investing in them at all.

In return for making specialized investments for the benefit of the OEM, suppliers not only need reduced demand uncertainty but also require smooth production flows to translate JIT delivery to JIT production on their shop floors. Absent production stability, JIT delivery implies increased inventory burden for the suppliers, which, in turn, harms their margins and makes them distrust a closer relationship with the OEM customer (Helper 1991). The importance of volume stability in this study should not be surprising, given that the average stock levels of suppliers is 30 days' production, which is nearly 3.76 times the stock that auto part suppliers carry.

Verifiable Safeguards and Supplier Performance

Hypothesis 6 of the model states that when verifiable safeguards accompany specialized assets of the supplier, such assets would have a positive association with supplier performance—with respect to a specific buyer. Furthermore, it identifies two kinds of safeguards commonly used in buyer-supplier contracts; namely, contract duration (CONT_DUR) and ex ante quantity agreements (SPQPRC). We test the hypothesis by interacting asset specificity (SC_ASP) with contract duration (CONT_DUR) and quantity agreement (SPQPRC), respectively. The regression continues to retain the main effects of asset specificity, contract duration, and quantity-take agreement in the model.

Results from Table 4 indicate positive and significant correlations between asset specificity on the one hand, and contract duration and quantity-take agreement on the other. However, regression results for the full model (Table 3) suggest that contract duration, together with asset specificity, has a positive but not significant estimate. Ex ante quantity agreement, together with asset specificity, also has a positive and statistically insignificant coefficient. Therefore, neither H6A nor H6B receives any support. These results imply that even though contractual safeguards tend to accompany specialized assets, they do not in any way increase supplier profits. At least, this seems to be the case in the home appliance industry. It could very well be that their

Table 4 Correlation Matrix of Independent Variables

Variables	1	2	3	4	5	6	7	8	9	10	11	12	13
1. SC_ASP	1.00												
2. CONT_DUR	0.216[a]	1.00											
3. SPQPRC	0.154[b]	0.355[a]	1.00										
4. REL_LN	0.034	0.065	0.094	1.00									
5. VOLSTB	−0.124[b]	−0.097	−0.026	0.030	1.00								
6. COSTPR	−0.228[a]	0.004	0.034	−0.013	−0.062	1.00							
7. TGTPR	0.275[a]	−0.014	−0.02	0.049	0.068	−0.741[a]	1.00						
8. BBOX	−0.038	0.083	0.074	−0.001	0.012	0.014	−0.012	1.00					
9. CUSTOM	−0.20[a]	0.002	−0.013	0.047	0.077	−0.008	−0.034	0.218[a]	1.00				
10. SUPREPTME	0.244[a]	0.217[a]	0.134[b]	0.095	0.016	−0.063	0.145[b]	0.066	−0.057	1.00			
11. PRDINF	0.385[a]	0.091	0.057	0.020	−0.122[b]	−0.091	0.134[b]	−0.079	−0.157[a]	0.035	1.00		
12. PRDCOST	0.15[b]	0.017	−0.083	0.026	−0.096	0.017	0.104	−0.129[b]	−0.135[b]	0.128[b]	0.263[a]	1.00	
13. SIZE_1	0.308[a]	0.179[a]	0.157[a]	0.205[a]	−0.006	−0.117	0.127[b]	0.022	−0.014	0.156[b]	0.123[b]	0.057	1.00

[a] p-values < 0.001, [b] p-values < 0.05.

absence might deter suppliers from even making such investments.

Conclusion

In pursuing closer vertical ties, both the buyers (OEMs) and the suppliers are attempting to reap the benefits of vertical integration without having to incur any of the accompanying bureaucratic costs (Hill 1990). For the buyer to enjoy the advantages of vertical integration regarding cost, quality, and differentiation, it is essential that the supplier (1) shares information regarding its production parameters and (2) undertakes innovative efforts and specialized investments for the benefit of the buyer (Scherer and Ross 1990, Williamson 1985). However, suppliers have been unwilling to share production parameters with their OEM customers for VA purposes (Lyons et al. 1990, Womack et al. 1990, Helper 1991, Helper and Sako 1995, Mudambi and Helper 1998). Comprehending what sustains the JIT exchange from the supplier's perspective is essential for *both* parties to make better use of it.

In modeling supplier interests in JIT relations, the study contends that the verifiability requirement in contractual attributes limits the degree of adaptability that the parties can achieve, and hence limits the value that the supplier can reap from a vertical alliance with its OEM customer. Under conditions of asset specificity and longevity, enforceable contracts have the potential to suffer from high governance costs on account of maladaptation, conflict resolution, and incompleteness (Hart and Holmstrom 1987). On the other hand, self-enforcing contracts—on account of being characterized by reciprocal or credible commitment among the parties—rely on mutual enforcement to facilitate adaptability among the parties. Though not verifiable, the study argues (and empirically illustrates) that reciprocal commitment together with information sharing and target pricing significantly enhances supplier performance.

Empirically, the fundamental hypothesis of the study is that self-enforcing agreements prove more valuable for suppliers than enforceable contracts in pursuing close ties with buyers. Regarding adaptability features incorporated in self-enforcing agreements, strong empirical support is found where buyer commitment takes the form of black-box part dependence on the supplier. Where the buyer exhibits credible commitment to the exchange, information sharing strengthens supplier performance—with respect to the specific buyer. Regarding the incentive features of self-enforcing agreements; namely, target pricing, a unique contribution of the study is to show that where a supplier shares production information with the OEM customer, target pricing actually enhances supplier performance with respect to that specific customer. The study also reveals that, in return for investing in OEM-specific assets, suppliers require nonverifiable supports such as volume stability to protect their interests. With volume stability absent, JIT merely increases the inventory burden of the suppliers, making them weary of close ties with buyers (Helper 1991, Liker and Wu 2000).

This study primarily focuses on the sources of governance efficiencies in vertical alliances. A limitation is that there are other relevant variables such as production efficiencies (economies of scope) and industry volatility that can explain variations in supplier profitability, with respect to a specific customer (Harrigan 1983). The study is a single-industry study, and generalization of results is restricted to similar industry contexts, where relative value added by suppliers is sufficiently high to warrant such governance structures.

In conclusion, while OEMs have implemented some aspects of JIT management, they have not fully considered some of the governance choices that accompany JIT exchange. As Teece et al. (1997) state: "Put differently, partial imitation or replication of a successful model may yield zero benefits" (p. 519).

It is in the OEM's interest to pay attention to supplier needs; it is this attention that transforms cooperative alliances into sources of advantage for the OEMs. However, interfirm differences in supplier-management skills persist (Dyer 1996a). And hence to date, collaborative vertical-exchange practices continue to be strategic capabilities, aiding firms like Toyota (and its suppliers) to earn sustained above-normal returns.

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Endnotes

[1]Smoothing the supplier's production process is quite different from agreeing to take certain quantity ex ante. While the former does guarantee a minimum volume, the actual schedules can vary substantially in terms of volume, mix, and timetable. This difference gains particular cost significance if the buyers expect JIT supplies. Although it could be argued that schedule alterations can be contracted upon (thereby questioning its nonverifiability), rarely does the OEM know in advance the exact demand realization of its products. The JIT regime specifically serves the purpose of operating in tandem with market realities. The fact that some OEMs choose to smooth their supplier's schedules reflects their *informal* choice to do so; such a choice depends on the history of the relationship (Mudambi and Helper 1998).

[2]Also, where asset specificity is significant and negative (ridge estimates in Table 3), the ridge coefficient for (asset specificity $*$ volume stability) (0.402) exceeds the ridge estimate of asset specificity (-0.298).

Appendix. Sample Selectivity Bias Results

Governance choice probit model

Variable	Probit coefficients T_GOV = 0 or 1 (t-statistic)	Probit coefficients TRIGOV = 0 or 1@ (t-statistic)	Measurement of variables
Constant	0.214	0.959	T_GOV = 1 if OEM contractually agrees to take specific quantity; T_GOV = 0 if OEM makes no contractual undertaking but regularly shares production schedules
Main effect of TSI			
PLDIST	0.001**	−0.0004	Log (distance in miles between supplier and customer plants)
Plant distance	(1.65)	(−0.698)	
SC_ASP	0.07	−0.175***	Four items ranked on a Likert scale ranging from 1 to 5
Physical asset specificity	(0.88)	(−2.33)	
TECHAS_N	0.29***	−0.15*	Number of supplier's technical personnel assigned to the specific OEM's business
Human asset specificity	(2.31)	(−1.40)	
PRDDED	−0.02	−0.03*	Percentage of supplier's production capacity dedicated for the OEM in 1995
Dedicated assets	(−0.82)	(−1.53)	
N	199	188	
U-squared	0.05	0.08	
Chi-squared goodness of fit	**	**	@TRIGOV = 1 if cost-plus pricing TRIGOV = 0 if target pricing

Sample Selection Model: Second Stage Regression of Subsamples

Dependent variable: OEMROSA

Variable	T_GOV = 1 (t-statistic)	T_GOV = 0 (t-statistic)	TRIGOV = 1 (t-statistic)	TRIGOV = 0 (t-statistic)
Constant	8.83	17.65	14.52	15.46
Main effect of TSI				
PLDIST	0.02	−0.02	−0.0004	−0.007
	(0.236)	(−0.037)	(0)	(0)
SC_ASP	−0.14	−0.37	−0.27	−0.30
	(−0.02)	(−0.023)	(−0.002)	(−0.001)
TECHAS_N	1.22	1.13	1.49	0.17
	(0.15)	(0.013)	(0.007)	(0)
LAMBDA	0.01	0.05	0.013	0.005
	(0.003)	(0.003)	(0)	(0)
N	44	68	80	44
R-squared	0.26	0.03	0.09	0.03
Goodness of fit based on *F*-values	*	—	—	—

*$p < 0.1$, **$p < 0.05$, ***$p < 0.01$.

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