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When Does Vertical Coordination Improve Industrial Purchasing Relationships?

Vertically coordinated ties are purportedly effective responses to the uncertainties of fast-changing purchasing environments. Building on transaction costs arguments and related work in marketing, the authors analyze vertical coordination as a response to external uncertainty and show that its effectiveness is highly contingent on the magnitude of the safeguarding problem present. Indeed, its beneficial effects can be overwhelmed by the consequential increase in trading hazards. The authors use survey data from a sample of 161 industrial buyers to test the hypotheses. When specific investments are modest, greater vertical coordination diminishes transaction difficulties in adapting to high environmental uncertainty. Conversely, vertical coordination increases transaction difficulties when firms adapt to high environmental uncertainty and specific investments are substantial. The authors discuss the importance of these results for transaction cost theory and develop the results into a managerial decision framework for designing purchasing ties that balances safeguarding and adaptation.

The productivity of purchasing ties is particularly significant to a buyer, because gains from purchasing drop straight to the buyer's bottom line. Not surprisingly, sophisticated industrial and commercial buyers have advocated contemporary initiatives such as supply chain management, early supplier involvement, and purchasing alliances. Although the particulars of these initiatives differ, they coalesce around the idea of greater vertical coordination of action between buyer and seller. In this situation, buyers and sellers engage each other in ways that are more intense than simple exchanges of products for payments.[1] The motivation is to create additional economic value through interaction patterns that take into account the trading partners' requirements and circumstances. This is in direct contrast to Porter's (1980) advice about buyers acquiring power over suppliers.

Although March and Simon (1958) provide the initial theoretical models of coordination, much of our insight into vertical coordination comes from recent work in the transaction cost analysis (TCA) tradition (Heide 1994). Although developed initially with reference to choices between markets and hierarchies, its analysis of hybrid modes has been particularly germane to understanding vertical coordination.

Hybrid modes are similar to markets in that the partners remain independent in an ownership sense, but there are two crucial differences. First, the interaction patterns within hybrid modes extend well beyond contractually mandated actions. Second, hybrid modes maintain these desired interaction patterns through private rather than legal ordering.[2]

The ramifications of these aspects of hybrid modes have attracted scholarly work in several disciplines. Sociologists have argued that interactions embedded within close ties will yield economic gains (e.g., Granovetter 1985). In marketing, Noordewier, John, and Nevin (1990) argue that coordinated interaction patterns facilitate adaptation, and the authors develop data showing that closer (relational) ties improve purchasing performance when external uncertainty is high. The message from these studies is that greater vertical coordination is at least always benign. Nevertheless, empirical studies have found null effects (e.g., Lusch and Brown 1996) and even detrimental effects (e.g., Uzzi 1996) of closer ties on performance. We believe that certain aspects of the extant studies have turned attention away from exploring the implications of these unexpected findings.

To begin, the research is very thin on testing performance predictions directly. Instead, virtually all the studies test descriptive implications.[3] Expected governance modes arising from specific investments and uncertainty are compared with observed modes. Insights about performance are

[1]Several related constructs have been described in other literature. For example, information technology researchers (Clemons, Reddy, and Row 1993) describe a trend toward greater outsourcing in conjunction with a shift toward fewer (but closer) suppliers, which they dub the "move to the middle." The similarity to vertically coordinated ties is obvious.

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[2]Private ordering does not rely on appeal to courts or other legal entities to enforce obligations. Instead, the focal parties to the exchange deal with it bilaterally (privately, as it were).

[3]Notable exceptions include Buchanan (1986), Noordewier, John, and Nevin (1990), and Kalwani and Narayandas (1995).

Journal of Marketing
Vol. 64 (October 2000), 52–64

based on extrapolating from these descriptive results. Unfortunately, such extrapolation is suspect in this case because of a fundamental tension between safeguarding and adaptation processes.

Masten (1996) summarizes this tension compactly. Safeguarding investments requires that the parties tie their hands, whereas adaptation requires that options exist to revise anticipated courses of action. Ceteris paribus, more complete contracts safeguard better but adapt more poorly, and vice versa.

This tension is illustrated in the case of an automobile component manufacturer that we have studied in some detail. This firm won a contract to supply an under-hood component to an original equipment manufacturer (OEM). A one-year, sole-source contract safeguarded this supplier's OEM-specific investments in a dedicated production line. However, the supplier was also obliged (noncontractually) to work as a partner with the OEM's internal engineering staff, using linked computing facilities to exchange detailed engineering information and coordinate frequent design and manufacturing changes over the term of the contract. Such interactions could reduce costs and/or increase quality by improving the firm's responsiveness to marketplace changes. However, this supplier believed that such interactions also magnified the threat posed to its intellectual property. It had used proprietary software and equipment to design sound-deadening covers for the component in question. This tension between safeguarding and adaptation creates a dilemma, and it is the core issue addressed in our article.

Our core postulate is that vertical coordination assists buyer–seller ties to adapt better but simultaneously increases the hazard posed to the supplier's exposed specific investments. Therefore, we expect that vertical coordination could have positive or negative effects depending on the levels of exposed assets.

The remainder of the article is structured in the following manner: After presenting the conceptual background, we elaborate specific hypotheses. Next, we describe our empirical study. We close by discussing implications for theory and practice, including a new managerial decision framework that incorporates our results.

Conceptual Framework

Adaptation as an Exchange Problem

Adaptation can be traced back to the view of organizations as open systems that depend on input and output resources to fulfill their goals. Uncertainty, or unanticipated changes in the task environment,[4] gives firms an incentive to create negotiated environments. As Cyert and March (1963) argue, such environments economize on their limited information processing capabilities (bounded rationality). In TCA and the closely related incomplete-contracting literature (e.g., Grossman and Hart 1986), this notion is expanded on in several ways.

First, these perspectives note that exchanges facing unforeseen contingencies cannot be addressed by writing more complex, contingent (complete) contracts, because bounded rationality makes such contracts increasingly difficult to write. Second, complete contracts lock the parties into positions that might otherwise be revised profitably. Deliberately designed-in incompleteness permits profitable revisions; however, incomplete contracts can work only within supportive governance structures.

The supportive governance structure initially studied in TCA is vertical integration. This was extended to studies of various nonintegrated governance modes that might play a supportive role. As noted previously, the core aspects of these various nonintegrated modes are the vertically coordinated interaction patterns.

Defining Vertical Coordination

Vertical coordination was first elaborated in marketing by Stern and Reve (1980) in their political economy framework and later operationalized in empirical work by John and Reve (1982) and Reve and Stern (1986). Following this stream, we define vertical coordination as the purposive organization of activities and information flows between independent firms. These activity patterns and information flows possess two related features. First, they are not enforced through legal ordering. Second, profits from these patterns and flows are split up through ongoing adjustments and bargaining rather than contractually specified ex ante. Both the activity patterns and information flow aspects of vertical coordination have been studied in extant work.

Heide and John's (1990) work on joint action and Lusch and Brown's (1996) work on relational behavior both show that coordinated interaction patterns permit better adaptation. Activity sets can be revised or shifted without formal reassignment of roles, and tightly coupled activities can be accomplished more smoothly because of the reduced likelihood of the parties stepping on each other's toes inadvertently.

As for the impact of information flows, Farrell and Gibbons's (1995) model of "cheap talk" captures the essential theoretical point. Cheap talk is the authors' term for information whose quality (and/or quantity) is neither verifiable by third parties nor enforceable through contract terms. Nevertheless, cheap talk can be valuable because it can enable the receiver to change its activities to accommodate changes occurring on the sender's side. Pilling, Crosby, and Jackson (1994) offer empirical evidence that supports this viewpoint.

Ex post transaction costs as a performance metric. Carson and colleagues (1999) note that the principal roadblock to revising existing activity sets in favor of more profitable new sets is the requirement that own-firm profit increases are aligned with dyadic (joint) profit increases. Such alignment is trivial in a zero transaction cost world according to Coase's (1960) theorem. In the real world, however, trans-

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[4]This definition of external uncertainty is narrow but quite consistent with the definitions offered in previous work (e.g., Achrol and Stern 1988).

action costs measure the height of the roadblock and thus the opportunity loss. Because we are particularly concerned with the revision of initially agreed-on activity sets, ex post transaction costs measure the size of the relevant roadblocks. These include the costs of haggling, documentation, renegotiating margins, and so forth associated with the new activities being contemplated.

Vertical coordination is an effort to reduce the problems of making product design changes, production planning, and the like (Dowst 1988; Drozdowski 1986; Frazier, Spekman, and O'Neal 1988; Spekman 1988). These are precisely the components of ex post transaction costs. In other words, if vertical coordination is to be beneficial, we should observe that ex post transaction costs decline with greater vertical coordination, and vice versa. Thus, to answer the question of when vertical coordination improves exchange, ex post transaction costs are the relevant dependent variable.

Hypotheses

Effects on OEMs' ex post transaction costs. Two extant studies show that the beneficial effects of vertical coordination on ex post transaction costs are more pronounced under high environmental uncertainty. Notice that these effects describe slopes of the coordination–cost relationship, not levels of costs per se. Noordewier, John, and Nevin (1990) conclude that firms purchasing standardized maintenance, repair, and operating items show lower transaction costs with increases in relational contracting under high external uncertainty conditions. In contrast, such increases have no effect in low uncertainty conditions. Supportive evidence also comes from Pilling, Crosby, and Jackson's (1994) experiment. More uncertainty led their subjects to anticipate more transaction costs of developing an exchange relationship.

It is crucial to note that Noordewier, John, and Nevin (1990) offer a prediction about the coordination–cost slope only for low levels of specific investments. Therefore, they conducted their test in a sample of dyads selected purposely for low specific investment levels (standardized ball bearings). What would be expected if specific investments were present at a more substantial level? To examine this, we consider the context of vertically coordinated ties more closely.

Because our context involves independent firms, neither de jure nor de facto hierarchy is relevant. Complete, contingent contracts are also of little relevance, because the relevant contingencies cannot be specified. Under these circumstances, obligating parties to more vertically coordinated exchange patterns carries costs and benefits.

The upside is that better adaptation results. The downside is that additional opportunities are now available to distort, obfuscate, or otherwise manipulate the proposed activity sets for each firm's own purposes. This is particularly problematic when each party can profit from such manipulation by appropriating the other party's exposed assets. For example, fast-changing demand conditions and rapid technological changes provide greater opportunities for appropriating exposed assets.

The prospects of such behavior will set off efforts by the aggrieved party to uncover and correct it. In short, attempts to improve adaptation through vertical coordination may paradoxically result in increased haggling and other ex post transaction costs rather than the reverse. Bakos and Brynjolfsson (1993) offer an illustration. Using "high-bandwidth" information technology with suppliers permits faster and better identification of new activity sets that are more profitable, but it also opens up new possibilities for reorganizing the terms of trade in ways that are detrimental to the more vulnerable partner.

The standard TCA response to safeguarding problems is either to implement stronger contractual safeguards or to impose vertical integration. Recall, however, that these two safeguards were not relevant in our context. What would constitute a middle-range extension to the standard TCA model in such circumstances? To develop such a model, we adapt Williamson's (1991, p. 21, emphasis added) conjecture that the private ordering process is quite fragile:

> [T]he effects of more frequent disturbances are especially pertinent for those disturbances for which mainly coordinated or strictly coordinated responses are required. Although the efficacy of all forms of governance may deteriorate in the face of more frequent disturbances, the hybrid mode is arguably the *most susceptible*.

Baker, Gibbons, and Murphy (1997) derive the same conclusion from a formal model of incomplete contracts in which private-ordering safeguards are shown to be less potent than the protection afforded by either complete contracts or hierarchy. Large disturbances can simply overwhelm private ordering.

These arguments aptly describe our situation. Recall that vertical coordination is the process by which parties within hybrid forms adapt to external disturbances. Crucially, private ordering was the basis of the coordinated action. We recast these observations about the vulnerability of hybrid modes into specific refutable hypotheses. Although economic work in the TCA tradition tends to imply symmetry between the parties' views and underplays the distinctions between a fully dyadic level and an individual firm within a dyad, we know from the prior empirical work that an individual party's viewpoint matters greatly. Thus, we specify hypotheses from one partner's viewpoint.

Following the tradition of work in industrial purchasing (e.g., Noordewier, John, and Nevin 1990; Pilling, Crosby, and Jackson 1994; Sriram, Krapfel, and Spekman 1992), we consider the buyer the more significant actor in creating and maintaining these ties. Thus, in specifying our hypotheses, we take the viewpoint of an industrial manufacturer (OEM) that buys a component from an independent supplier.

Suppliers with minimal OEM-specific investments will find it beneficial to engage in greater vertical coordination to cope with changing circumstances. It makes the revision of current activity sets easier and quicker. In contrast, suppliers with larger OEM-specific investments will find it more hazardous to engage in greater vertical coordination, because the OEM can exploit the suggested revisions to its own advantage. The supplier will react to the threat of such exploitation by being more cautious and suspicious about implementing proposed revisions. In summary, these OEMs will report higher ex post transaction costs. Formally, there are two hypotheses about the slope of the coordination–transaction cost relationship:

H_1: Increased vertical coordination in the face of greater environmental uncertainty will have (a) a beneficial effect (decrease) on ex post transaction costs reported by the

OEM under conditions of minimal levels of OEM-specific investments made by an independent supplier and (b) a deleterious effect (increase) on ex post transaction costs reported by the OEM under conditions of substantial levels of OEM-specific investments made by an independent supplier.

We do not imply that effects are symmetric across the dyad. An OEM faces fewer hazards from vertical coordination than a similarly exposed supplier because of its direct access to the end user. Because the proposed revisions are intended to deliver greater value downstream, exposed buyers can better filter out potentially hazardous information and actions arising from the revisions. The less informed supplier is at greater risk.

Controlling for reciprocal investments. Previous work (e.g., Anderson and Weitz 1992) shows that one party's investments serve as a hostage to safeguard the other party's investments. Again, consider the vantage point of our OEM. To the extent that the supplier-specific investments safeguard the supplier's OEM-specific investments, the supplier's exposure is lowered, and parties can proceed to engage in more vertical coordination. Thus, we expect such OEMs to report lower transaction costs. Formally,

> H_2: Original equipment manufacturers with larger supplier-specific investments will report lower ex post transaction costs when their suppliers also make correspondingly large OEM-specific investments.

Controlling for OEM size. We know from previous work (e.g., Buchanan 1986) that cooperation and coordination is more readily accomplished between equals. However, purchasing relationships are typically neither balanced nor symmetric. Suppliers facing large, powerful OEMs are more vulnerable and suspicious. Stalling the implementation of proposed revisions to current activity sets is a natural reaction of such suppliers, but it must be balanced against the larger prospective gains available from trading with a large OEM. In addition, the visibility of larger OEMs creates a stronger reputational safeguard on untoward behavior, so their suppliers might be more confident about realigning activities and agreements. It is difficult to assess the net outcome of these conflicting effects. As a result, we do not posit a directional hypothesis for OEM size.

Instead, we control for these effects by including two size measures. First, the OEM's overall revenues capture the business attractiveness and reputation that accrue to a large OEM. Second, we use the OEM's annual dollar purchases from this supplier to capture the magnitude and importance of the relationship itself. Formally,

> H_3: The overall size of OEMs and large purchase volumes within a relationship will affect ex post transaction costs reported by the OEMs.

Controlling for long-term ties. Hakansson (1982) and his associates identify elapsed time as the primary enabler of relationship development. We tie their work to ours by observing that relationship development effectively reduces the threat of opportunism in long-term ties (Ring and Van de Ven 1992), which in turn reduces ex post transaction costs. In summary, performance should be higher in long-term ties. Kalwani and Narayandas (1995) offer evidence consistent with this view. They find that suppliers with long-term ties to their buyers have lower inventory costs. Formally,

> H_4: Original equipment manufacturers with a longer history of buying from a supplier should report lower ex post transaction costs.

Empirical Study

Research Context

We conducted a search of the academic literature and the trade press to capture adequately the domain of each construct in the model. Next, we conducted an exploratory study to verify that our constructs materialized as intended within the proposed empirical context. In this study, we presented a list of items for each construct to a convenience sample of purchasing managers and consultants. Their open-ended reactions appear to support our expectation that the constructs are relevant to OEM–component supplier ties. Furthermore, the items used did not appear to provoke hypothesis guessing.

After this initial effort, we examined the contents of actual purchasing contracts and related documents obtained from 24 manufacturers. These documents support our expectation that purchasing contracts were materially incomplete within these settings. For example, they often were based on standard-form contracts and were of a rather short duration (18 months or less). Strikingly, these buyers and suppliers use these contracts to deal with each other over extended periods of time: Eight-to-ten-year-old relationships were quite common. We conclude that these firms rely on private ordering as the dominant basis of their interaction.

Following the contract document study, we administered a draft questionnaire to 14 buyers at a trade association conference. On the basis of their responses and follow-up interviews, we modified the questionnaire. In particular, we simplified the specific investments construct. Initially, we had an elaborate typology of human assets, physical assets, site-specific assets, and so forth but found that these subscales were difficult for the respondents to distinguish. Consequently, we pruned them back to a single dimension. We also changed from a –3 to +3 response format to a 1–7 format for all the Likert-type items.

Finally, we conducted mail and personal interviews with eight people from the sampling frame that would be used for the final data collection. This questionnaire was a revised version of the one used in the previous pretest. No significant problems were found with any of the revised measures or scale formats.

Mail Survey

Our sampling frame consisted of the membership list of a professional association of purchasing personnel. We selected 684 manufacturers in nine two-digit Standard Industrial Classification groups from this frame. Of this initial selection, 114 fell outside the scope of the study because their firms had gone out of business or were no longer engaged in manufacturing. Of the remainder, 182 responded to our questionnaire after two callbacks. These response rates are similar to those reported for channels and purchasing studies in the marketing literature.

After elimination of missing data, 161 observations remained in our database. This sample includes OEMs from a wide range of industries. The formal contracts lasted less than 18 months on average. However, the OEMs continue to buy from the suppliers over long periods of time (almost ten years on average).

Nonresponse Bias

Because we lacked population statistics, we tested for nonresponse bias by comparing early respondents with late respondents (Armstrong and Overton 1977). Firms that responded before our callback efforts (64%) were placed into the early category, and the other firms constituted the late group. We found no significant differences on demographic variables, such as elapsed length of the relationship, firm size, and purchasing volume, or the focal construct measures. Likewise, our key informants' self-reported knowledge and involvement were not different across the two groups. We concluded that these data were sufficiently free of nonresponse bias to permit further analysis.

Reliability of Scales

Multi-item scales. We estimated the correlation matrix of the items for each construct. We inspected the item-total correlations to check for ill-fitting items that we then dropped. We then fitted a congeneric model of each item set to assess unidimensionality.[5] When an adequate fit was achieved, we used the estimated loadings to calculate construct reliability.[6] In Table 1, we report these results.

Ex post transaction costs (TRANSCOST) are the bargaining and monitoring costs incurred by the parties as they attempt to realign the terms of trade over time. Previous studies by Noordewier, John, and Nevin (1990), Walker and Poppo (1991), and Dahlstrom and Nygaard (1999) provided items for our scale. On the basis of item-total correlations, we deleted two of the original items. Confirmatory factor analysis showed an acceptable one-factor solution. The final four-item scale's reliability estimate is .78.

Vertical coordination (VERT) is the purposive organization of the flow of activities and information between the transacting parties. Previous empirical studies (Heide and John 1990; Reve and Stern 1986) provided some of the items for our scale. After item-total correlations were inspected, the confirmatory factor analysis showed a single factor fitting the data. The final five-item scale's reliability is .78.

Uncertainty (UNCT) is the unpredictability of the task environment. Previous empirical studies provided eight possible items for our use (Anderson 1985; Heide and John 1990; Noordewier, John, and Nevin 1990). After inspecting item-total correlations and fitting a single-factor model to the data, we were left with only four of the original eight items. The four-item scale's reliability is estimated at .54. This is somewhat low and prompted additional analysis. Because multifactor representations of uncertainty have been used in previous studies (e.g., Klein, Frazier, and Roth 1990), we estimated a two-factor solution to compare with our single-factor scale. On the basis of the comparative fit index (CFI), the single-factor model describes the data better than the two-factor model (CFIs are .93 and .83, respectively).

Supplier asset specificity (SUPPINV) is the investments made by the supplier in physical assets, production processes, tools, and knowledge that are tailored to the focal OEM. Previous works that provided items for our scale include Anderson and Weitz (1992) and Heide and John (1990). Item-total correlations showed no problematic items, and the confirmatory factor analysis showed an acceptable one-factor solution. The four-item scale shows a reliability of .82.

We refer to the investment made by the OEM in physical assets, production processes, tools, and knowledge tailored to the focal supplier as OEM asset specificity (OEMINV). Studies by Anderson and Weitz (1992) and Heide and John (1990) provided items for our scale. After an item-total correlation check and an acceptable single-factor solution, the reliability of the four-item scale is estimated at .76.

Single-item measures. We measured some of the variables using single-item grounded measures. As such, the variables cannot be subjected to the unidimensionality and reliability assessment procedures described previously. These measures are described next.

Size of the OEM is represented by two different measures. The gross annual sales of the manufacturer (OEMSALES) is one measure, and the annual volume purchased from the supplier (OEMPURCH) is the other measure of size. Notice that these are not reflective indicators of a single construct but instead represent different facets of a multiplex construct.

Long-term ties (LNLENGTH) are represented by elapsed time. This is not the contractual length of the supply arrangement. Rather, it is the cumulative length of time that has elapsed. Following Heide and Miner's (1992) study, we use the natural logarithm of the elapsed length in years as our measure to capture the decreasing returns argument in their conceptualization.

Discriminant Validity

We factor analyzed all the items in the five multi-item scales: SUPPINV, OEMINV, VERT, UNCT, and TRANSCOST. Common factor analysis revealed a five-factor solution based on eigenvalue cutoffs and scree tests. We present the varimax rotated factor loading matrix in Table 2.

The own-construct loadings are quite large and are all above the .30 rule of thumb. The cross-construct loadings are all smaller than the corresponding own loadings. Together, these point to the discriminant validity of our multi-item scales.

We followed up with a LISREL-based confirmatory factor analysis of the same matrix. However, the five-factor model would not yield admissible solutions on account of a Heywood problem (negative variance estimates for some of the error terms). As a fallback, we reorganized the items into two subsets for analysis. The first subset consisted of the items from the OEMINV, SUPPINV, and UNCT scales. The second subset consisted of the items from the VERT and the TRANSCOST scales.

In Table 3, we show the results of the three-factor LISREL model specified for the first subset. All the loadings are

[5]The fitted LISREL model is $y_i = \lambda_i\xi + \varepsilon_i$, where y_i is the ith item in the item pool for that construct; λ_i is the loading of item i on the unobserved trait, ξ; and ε_i is the random error in item i.

[6]The formula for reliability is $(\Sigma\lambda)^2/[(\Sigma\lambda)^2 + \Sigma\sigma^2]$.

TABLE 1
Scale Items and Reliability Estimates

Scale Confirmatory Fit Statistics	Item
SUPPINV $\chi^2(2) = 1.1$ $p > .05$ CFI = .99 Reliability $\alpha = .82$	1. Our supplier has invested in production equipment to a great extent in order to adjust to our purchase requirements (SUPPINV1). 2. Our supplier has carried out considerable product adjustments in order to meet our requirements (SUPPINV2). 3. Our supplier has made heavy investments in storage and transportation equipment in order to deal with deliveries to our firm (SUPPINV3). 4. Our supplier has restructured their production processes in order to realize higher quality of the specific products sold to us (SUPPINV4).
OEMINV $\chi^2(2) = 1.33$ $p > .05$ CFI = .99 Reliability $\alpha = .76$	1. Our firm has committed a lot of time and resources to develop specific equipment and routines for control of deliveries from this supplier (OEMINV1). 2. Our firm has made comprehensive investments to restructure and integrate our production facilities with this supplier's production facilities (OEMINV2). 3. Our firm has invested extensively in production equipment specifically adapted to work with the products we buy from this supplier (OEMINV3). 4. Our firm has committed a lot of time and resources to developing an acceptable quality assurance program at this supplier's plant (OEMINV4).
VERT $\chi^2(5) = 18.9$ $p < .05$ CFI = .92 Reliability $\alpha = .78$	1. We regularly exchange information about production costs with this supplier (VERT1). 2. We regularly consult with this supplier about its selection of raw materials and components incorporated in the product(s) we order (VERT2). 3. We regularly exchange information about price development and market conditions with this supplier (VERT3). 4. Our firms make regular joint efforts to improve the quality of the products we order from this supplier (VERT4). 5. We cooperate closely with this supplier on quality control of products delivered to our company (VERT5).
UNCT $\chi^2(2) = 3.7$ $p > .05$ CFI = .93 Reliability $\alpha = .54$	1. The demand for our end products varies continually (UNCT1). 2. The demand conditions for our supplier's product are very irregular (UNCT2). 3. Our most important competitors are regularly carrying out product adjustments and development of new products (UNCT3). 4. The products we purchase from our supplier have very high innovation rates and short life cycles (UNCT4).
TRANSCOST $\chi^2(2) = 7.9$ $p < .05$ CFI = .95 Reliability $\alpha = .78$	1. Our firm uses far too much time and resources to deal with the product design and production processes of this supplier (TRANSCOST1). 2. It is very time consuming and difficult to get necessary verification of product performance and costs from this supplier (TRANSCOST2). 3. The coordination of the relationship with this supplier is too costly compared to the resulting outcomes of these interactions (TRANSCOST3). 4. It is very time consuming and difficult to accomplish negotiations between our firms about price and payment terms (TRANSCOST4).

significant, and the model fit is acceptable. We estimated a series of models nested within this model to test whether the between-construct correlations were significantly different from 1.0. Table 3 shows that all the relevant χ^2 difference tests are significant, which indicates discrimination between each pair of constructs.

In Table 4, we show the results of a similar analysis for the second subset. Again, all the loadings are significant, and the χ^2 difference test indicates discrimination between the two constructs.

Tests of Hypotheses

Hypothesized effects. The basic model required to test our research hypotheses can be expressed as

$$(1) \quad \begin{aligned} \text{TRANSCOST} = {} & b_0 + b_1\text{UNCT} + b_2\text{SUPPINV} \\ & + b_3\text{OEMINV} + b_4\text{VERT} + b_5\text{VERT} \\ & \times \text{UNCT} + b_6\text{VERT} \times \text{SUPPINV} \\ & + b_7\text{UNCT} \times \text{SUPPINV} + b_8\text{OEMINV} \\ & \times \text{SUPPINV} + b_9\text{VERT} \times \text{UNCT} \\ & \times \text{SUPPINV} + b_{10}\text{OEMSALES} \\ & + b_{11}\text{OEMPURCH} \\ & + b_{12}\text{LNLENGTH} + e. \end{aligned}$$

Our core hypothesis, H_1, involves predictions about a slope, so we turn to the coefficients of the expression for the derivative of Equation 1, following Schoonhoven (1981):

$$(2) \quad \delta\text{TRANSCOST}/\delta\text{VERT} = b_4 + b_5\text{UNCT} + b_6\text{SUPPINV} + b_9\text{UNCT} \times \text{SUPPINV}.$$

TABLE 2
Discriminant Validity Test

Items	Factor 1 Loading: Supplier Investments	Factor 2 Loading: Transaction Costs	Factor 3 Loading: Buyer Investments	Factor 4 Loading: Vertical Coordination	Factor 5 Loading: External Uncertainty
SUPPINV1	**.78**	.09	.18	.19	–.02
SUPPINV2	**.71**	.04	.20	.22	–.02
SUPPINV3	**.68**	.02	.20	.19	–.11
SUPPINV4	**.53**	.09	.23	.16	–.07
TRANSCOST1	–.04	**.85**	.05	.05	.09
TRANSCOST2	.16	**.72**	.07	–.15	–.10
TRANSCOST3	–.03	**.72**	.08	–.04	.22
TRANSCOST4	.16	**.43**	.32	–.03	.05
OEMINV1	.26	.10	**.68**	.15	.03
OEMINV2	.23	.05	**.62**	.11	–.05
OEMINV3	.23	.33	**.52**	.15	.10
OEMINV4	.33	.06	**.42**	.30	.16
VERT1	.25	.06	.23	**.75**	.00
VERT2	.03	–.11	.08	**.60**	.21
VERT3	.19	–.05	–.03	**.54**	.15
VERT4	.27	.03	.19	**.54**	–.03
VERT5	.20	–.30	.18	**.42**	.22
UNCT1	–.04	.09	.06	.02	**.62**
UNCT2	–.00	.01	–.11	–.06	**.37**
UNCT3	–.07	.03	.18	.06	**.37**
UNCT4	.12	.06	–.00	.13	**.32**

Notes: Variable names are explained in Table 1. Boldface numbers indicate the own-construct factor loadings.

TABLE 3
Discriminant Validity Test

Item	Factor 1 Loading (Buyer Investments)	Factor 2 Loading (Supplier Investments)	Factor 3 Loading (Uncertainty)
OEMINV1	.56[a]		
OEMINV2	.57*		
OEMINV3	.72*		
OEMINV4	.63*		
SUPPINV1		.56[a]	
SUPPINV2		.80*	
SUPPINV3		.83*	
SUPPINV4		.66*	
UNCT1			.81[a]
UNCT2			.25*
UNCT3			.23*
UNCT4			.28*

[a]Indicates fixed parameter.
*Indicates t-values significant at $p < .05$.
Notes: Overall model fit: $\chi^2(51) = 142$, $p < .05$, CFI = .87. Nested model with Cov(1,2) set to 1.0: $\chi^2(52) = 192$; $\Delta\chi^2(1)$ is significant at $p < .05$. Nested model with Cov(1,3) set to 1.0: $\chi^2(52) = 171$; $\Delta\chi^2(1)$ is significant at $p < .05$. Nested model with Cov(2,3) set to 1.0: $\chi^2(52) = 169$; $\Delta\chi^2(1)$ is significant at $p < .05$.

TABLE 4
Discriminant Validity Test

Item	Factor 1 (Vertical Coordination)	Factor 2 (Transaction Costs)
VERT1	.07[a]	
VERT2	.67*	
VERT3	.60*	
VERT4	.86*	
VERT5	.64*	
TRANSCOST1		.25[a]
TRANSCOST2		.74*
TRANSCOST3		.70*
TRANSCOST4		.90*

[a]Indicates fixed parameter.
*Indicates t-values significant at $p < .05$.
Notes: Overall model fit: $\chi^2(26) = 38$, $p > .05$, CFI = .97. Nested model with Cov(1,2) set to 1.0: $\chi^2(27) = 231$; $\Delta\chi^2(1)$ is significant at $p < .05$.

Equation 2 shows the effect of changes in VERT on TRANSCOST. Consider the two posited effects in H_1.

First, according to H_{1a}, the derivative should be negative at low levels of specific investments. Because the terms involving SUPPINV in Equation 2 vanish at low levels of this variable, Equation 2 reduces to δTRANSCOST/δVERT = $b_4 + b_5$UNCT. For the derivative to be negative (the beneficial effect), we must find that b_5 is negative. Turning to b_4, we expect that at very low levels of UNCT, VERT would simply increase governance costs, because the adaptation needs are so low. Thus, the derivative should be positive at this point, which then requires b_4 to be positive.

H_{1b} is tested as follows: Observe that as UNCT and SUPPINV increase jointly, the last term (UNCT × SUPPINV) dominates Equation 2. For the derivative to be positive in this region (the deleterious effect), the coefficient of the last term (b_9) must be positive.

TABLE 5
Dependent Variable: TRANSCOST

Independent Variables	Hypotheses	Unstandardized Coefficient (Base Model)	Unstandardized Coefficient (Reduced Model)	Unstandardized Coefficient (Expanded Model)
CONSTANT (b_0)		$-2.03^{n.s.}$	$-1.13^{n.s.}$	$-1.40^{n.s.}$
UNCT (b_1)		1.16*	1.10*	$1.00^{n.s.}$
SUPPINV (b_2)		1.91**	1.89**	2.40**
OEMINV (b_3)		.36*		$-.60^{n.s.}$
VERT (b_4)	+ (H_{1a})	1.09**	1.07*	.94*
VERT × UNCT (b_5)	– (H_{1a})	–.33**	–.32**	–.30*
VERT × SUPPINV (b_6)		–.47**	–.47**	–.58**
UNCT × SUPPINV (b_7)		–.43**	–.43**	–.57**
OEMINV × SUPPINV (b_8)	– (H_2)	$-.03^{n.s.}$		$-.04^{n.s.}$
VERT × UNCT × SUPPINV (b_9)	+ (H_{1b})	.12**	.12**	.15**
VERT × OEMINV				$.23^{n.s.}$
UNCT × OEMINV				$.27^{n.s.}$
VERT × UNCT × OEMINV				$-.06^{n.s.}$
OEMSALES (b_{10})	sig (H_3)	$-.03^{n.s.}$	$-.06^{n.s.}$	$-.02^{n.s.}$
OEMPURCH (b_{11})	sig (H_3)	.02**	.02**	.02**
LNLENGTH(b_{12})	– (H_4)	–.19**	–.18**	–.18**
		$R^2_{Adj} = .24$	$R^2_{Adj} = .20$	$R^2_{Adj} = .23$
		$F_{12,148} = 5.26$, $p < .05$	$F_{10,150} = 5.11$, $p < .05$	$F_{15,145} = 4.22$, $p < .05$

*Indicates $p < .10$ (two–tailed).
**Indicates $p < .05$ (two–tailed).
Notes: All estimates of standard errors are heteroskedastic-consistent estimates. n.s. = not significant.

For the remaining hypotheses in turn, observe that H_2 requires a negative coefficient for OEMINV × SUPPINV (b_8). The nondirectional hypothesis, H_3, requires significant coefficients of either sign for OEMSALES and OEMPURCH (b_{10} and b_{11}, respectively). Finally, H_4 is supported by a negative coefficient for LNLENGTH (b_{12}). We summarize these expectations in Table 5.

Other effects. We included additional variables in our empirical specification to account for the lower-order interaction terms while testing the posited three-way interaction term implicated in H_{1b}. This controls for the unavoidable multicollinearity between interaction terms in nonexperimental designs. It protects us from attributing variance incorrectly to the posited variables. However, we do not interpret the sign of these lower-order interactions, such as UNCT × SUPPINV (b_7) or the main effects of SUPPINV, OEMINV, and UNCT (b_2, b_3, and b_1, respectively).

Estimation and Results

In Table 5, we display the estimates. Parenthetically, we note that we estimated the reported standard errors using White's (1994) procedures to guard against heteroskedasticity biases. The estimates show a good fit of the basic model (R^2_{Adj} = .24, F(12,148) = 5.26, $p < .05$). As expected, multicollinearity (see Table 6) between the interaction variables and their components is high, which creates in more imprecise, but nevertheless unbiased, estimates. We stress that the significant results for the higher-order interaction terms in the presence of the lower-order terms mean that the imprecision (reduced power) due to multicollinearity is not a validity threat. As described subsequently, we also assessed the robustness of our results using different specifications. The core model and the results appear to describe the data adequately, so we can turn to the interpretation of the coefficients.

H_1. Consistent with H_{1a}, we find that b_5 is negative (b_5 = –.33, t = –2.22, $p < .05$). Beneficial effects of greater vertical coordination in the face of greater uncertainty are present in low specific asset conditions. Also, as expected, b_4 is positive, which confirms the idea that more vertical coordination in the absence of uncertainty and specific investments simply adds governance costs (b_4 = 1.09, t = 2.11, $p <$ .05). Turning to H_{1b}, we observe that b_9 is positive, as we expected (b_9 = .12, t = 2.93, $p < .05$). This supports our central notion that greater vertical coordination in the face of greater uncertainty is detrimental in high supplier investment conditions.

H_2. Our expectation in H_2 was that reciprocal, symmetrical investments should decrease ex post transaction costs. The relevant coefficient, b_8, is in the correct (negative) direction, but it is not significant (b_8 = –.03, t = –.82, $p > .05$).

H_3. The nondirectional effects of OEM size posited in H_3 are partially supported. The OEM's gross sales have no significant effect (b_{10} = –.03, t = –.48, $p > .05$). However, OEMs with larger annual purchase amounts from a supplier report greater ex post transaction costs (b_{11} = .02, t = 3.80, $p < .05$).

H_4. Consistent with this hypothesis, the prior length of the relationship (LNLENGTH) reduced ex post transac-

TABLE 6
Correlation Matrix and Descriptive Statistics

Variables	1	2	3	4	5	6	7	8	9	10	11	12	13
1. TRANSCOST	1.00	–.09	.17	.30	.09	.02	.21	.06	.14	.272	.02	.29	–.04
2. VERT		1.00	.41	.36	.15	.73	.37	.75	.65	.421	.06	.13	.001
3. SUPPINV			1.00	.51	.02	.27	.76	.87	.72	.805	.35	.09	.08
4. OEMINV				1.00	.12	.33	.48	.55	.53	.881	.03	.18	.07
5. UNCT					1.00	.76	.61	.07	.54	.098	–.17	–.10	–.14
6. VERT × UNCT						1.00	.66	.52	.80	.343	–.09	.01	–.08
7. SUPPINV × UNCT							1.00	.70	.92	.682	.15	.01	–.01
8. VERT × SUPPINV								1.00	.84	.784	.29	.13	.05
9. VERT × SUPPINV × UNCT									1.00	.707	.13	.05	–.005
10 SUPPINV × OEMINV										1.00	.195	.204	.079
11. OEMSALES											1.00	.24	.10
12. OEMPURCH												1.00	.20
13. LNLENGTH													1.00
Mean values	2.59	4.04	3.55	2.77	3.70	15.20	13.16	15.21	57.08	10.94	5.78	12.56	2.22
Standard deviation	1.21	1.34	1.54	1.36	1.16	7.51	7.53	9.30	41.91	8.77	1.48	26.65	.93

Notes: r > .16 and r < –.16 are significant at $p < .05$ (two-tailed) for n = 161.

tion costs reported by OEMs ($b_{12} = -.19$, $t = -2.22$, $p < .05$).

Additional models. In summary, our theoretical expectation of a contingent effect of vertical coordination is supported after we control for the safeguarding effects of reciprocal investment, length of tie, and size. Because of the large number of interaction terms in our model and our use of the OEMs' perspective, we estimated additional models to verify the robustness of our results. We first estimated a smaller, reduced specification that consists of the core model in Equation 1, but without any of the OEM's investment variables. The direction and significance of the coefficients (b_4, b_5, b_6, b_9, b_{10}, b_{11}, and b_{12}) implicated in the three hypotheses that do not involve the OEM's investments (H_1, H_3, and H_4) remain unchanged in this reduced model, as shown in Table 5.

Next, we estimated an expanded model that consists of the core model from Equation 1 with three additional OEM investment variables. These are the two two-way and one three-way interactions among OEM investment, uncertainty, and vertical coordination. This controls for symmetric effects of OEM and supplier investments. These added variables are all insignificant. In contrast, the coefficients implicated in our hypotheses (b_4, b_5, and b_9) maintain their direction and significance. Indeed, the magnitudes of the coefficients themselves are quite consistent across the three models. The robustness of the effects across the three models enhances the validity of our statistical tests.

Discussion

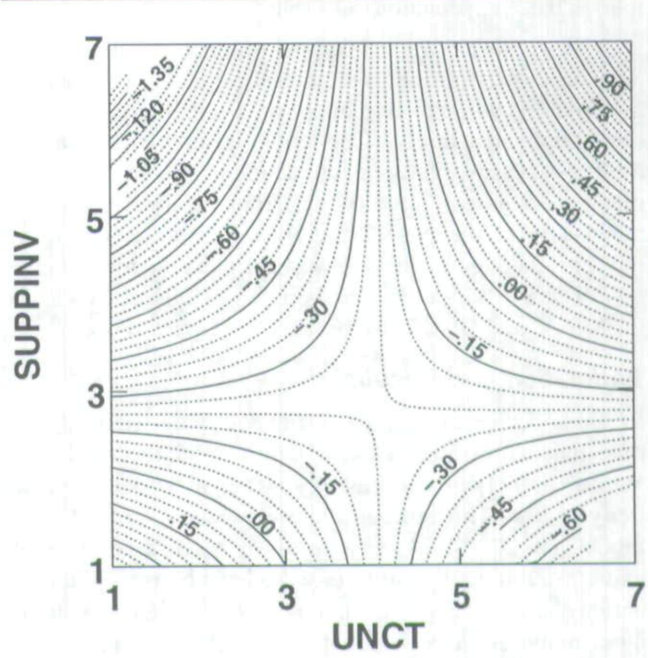
Limitations

Perhaps the most significant limitation is the limited reliability (.54) of our uncertainty scale. Additional limitations include the use of cross-sectional data that make it difficult to rule out unobserved dyad-specific effects. Finally, the use of a multi-industry setting is a mixed blessing. Although it ensures variability in the constructs, it also introduces ambiguity in the interpretation of the response formats. A high level of specific investments in one industry may be a low level in another industry. We hope that these are not insurmountable obstacles to drawing conclusions from the work.

Relevance to Theory

Summarizing vertical coordination effects. When does vertical coordination improve hybrid ties? To answer this, we developed the contour plot in Figure 1. It plots values of δTRANSCOST/δVERT for various combinations of supplier investment and uncertainty in the data. Negative num-

FIGURE 1
Contour Plot of δTRANSCOST/δVERT



Notes: Positive (negative) numbers on contour lines indicate that vertical coordination increases (decreases) transaction costs.

bers on a contour line indicate that vertical coordination is beneficial in that circumstance, whereas positive numbers indicate that vertical coordination has harmful effects.

The deleterious effect of vertical coordination is shown in two regions. First, as we predicted, in the face of simultaneous increases in supplier investment and uncertainty (upper right-hand corner) vertical coordination has deleterious effects. It is simply unable to function as intended because of the hazards that are magnified. Second, the same effect occurs for different reasons at the other extreme (lower left-hand corner) when neither supplier investments nor uncertainty is problematic. Here, vertical coordination fails because it is costly and unnecessary. Everywhere else, vertical coordination improves matters in hybrid ties.

Studying multiple effects. Research investigating the match between particular transaction attributes (e.g., specific investments) and particular governance mechanisms (e.g., longer duration contracts) has offered considerable insight into the three fundamental exchange problems of safeguarding, adaptation, and performance measurement. However, Rindfleisch and Heide (1997) remind us that individual governance may serve multiple purposes and that we need to understand how to align governance mechanisms with multiple problems simultaneously. We believe our work illustrates the importance of their call. The deleterious effects of vertical coordination would have remained uncovered if we had studied a single exchange problem in isolation. We encourage further study of multiple effects of governance mechanisms. In particular, the analysis must be extended to incorporate all three processes in TCA, including the performance measurement issue we omit here.

Specific assets and internalization: an artifact? Our data also address a large controversy in the literature on governance effects. In dramatic contrast to the positive conclusion of TCA reviews (e.g., Klein and Shelanski 1996; Rindfleisch and Heide 1997), Ghoshal and Moran (1996) conclude that TCA is bad for practice. Specifically, they dispute the TCA position that nonmarket governance is chosen because markets are less able to cope with specific investments. According to them, specific investments improve the performance of internal organization, so the probability of observing hierarchical governance forms increases with specific investments. Notice that their explanation is dramatically different from TCA but the descriptive predictions are the same. This means that the many studies documenting hierarchical governance increasing with more-specific investments cannot discriminate between these alternative explanations.

We fashion a discriminating test with our data by following Masten, Meehan, and Snyder's (1991) focus on normative predictions. Transaction cost analysis holds that specific investments (and uncertainty) increase transaction costs in all governance forms but that the effect is smaller in hierarchies than in markets. Ghoshal and Moran's (1996) position is that the effect is positive in markets but negative in hierarchies (and hybrids).

We can test these contrasting expectations using our estimated model. The coefficients for the effect of supplier investments on transaction costs show a positive effect ($b_2 = 1.91$, $p < .05$). The same is true for OEM investments as well ($b_3 = .23$, $p < .05$). This refutes Ghoshal and Moran's (1996) position directly, in favor of the TCA position. Indeed, uncertainty ($b_1 = 1.16$, $p < .10$) also increases transaction costs. In summary, the TCA view that these two attributes of exchange increase exchange difficulties is borne out. Our result is limited to the case of hybrid ties. Other varieties of ties must be examined similarly (e.g., franchising, internal suppliers) to resolve this challenge to the core theory.

Relevance to Practice

Purchasing ties that are not based on contractual safeguards have become the subject of considerable managerial interest. Various industry initiatives, such as early supplier involvement, just-in-time relationships, and vendor partnerships, have become popular. Typically, their proponents present them as universally desirable on the grounds that coordination and cooperation are always win–win mechanisms. This is not supported by the scholarly research. Noordewier, John, and Nevin (1990) first demonstrated that information exchange and planning improved gains from trade only when large uncertainties placed a premium on adaptation.

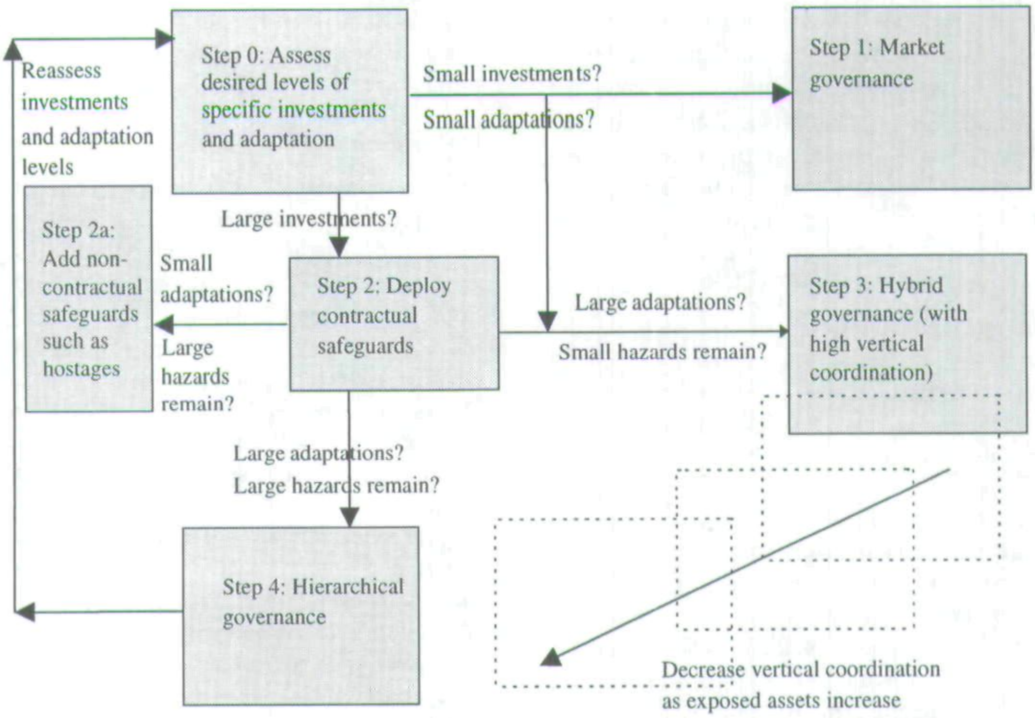
Our study extends the contingent conditions even further. Gains from vertical coordination occur only when (1) specific investments are modest and (2) high environmental uncertainty is present. In Figure 1, both the upper right-hand and lower left-hand corners depict circumstances in which vertical coordination is counterproductive. Specifically, managers must account for vertical coordination facilitating adaptation but also magnifying the safeguarding problem, and so a careful balance must be struck between the two problems to promote higher performance. We offer the blueprint in Figure 2 for striking this balance.

Decision framework. We use the institutional design framework presented by Carson and colleagues (1999) to develop our managerial decision framework shown in Figure 2. Although it is a simplified version of their approach, it still includes effects and links not explicitly considered in the current study. Certain points about our discussion should be noted at the outset. First, we do not discuss some of the links and focus on the subset of issues that is most closely tied to the current study's results. Second, the stopping points do not completely solve the safeguarding and adaptation problems in each case. As Carson and colleagues observe, fully efficient designs are not possible. Finally, notice that our choice of a starting point at Step 0 is essentially arbitrary given the ongoing nature of these decisions. The results converge after sufficient iterations, no matter where the design process is started.

At Step 0, we identify the desired level of specific investments and adaptation. These desired levels derive from the additional end user value created through making specific investments compared with nonspecific investments and through not committing to courses of action compared with making such commitments. Specific investments are made, and adaptation mechanisms should be introduced commensurate with these value accretion possibilities.

As an illustration, suppose that inventories could be reduced if a supplier were to locate a warehouse adjacent to an industrial manufacturer's plant instead of making deliveries from a regional warehouse. Suppose further that additional sales to end users of the buyer's product are made

FIGURE 2
Managerial Blueprint for Vertical Coordination in Buyer–Supplier Relationships



possible with greater supply chain responsiveness to unanticipated changes in product configurations that are ordered by end customers. Finally, suppose that supplier-managed inventories increase responsiveness compared with buyer-managed inventories. The net value is the gain from the co-located warehouse and the supplier-managed inventory minus the relevant investment costs.

When these desired levels of investments and adaptation have been identified, the manager must consider the merits of three basic governance modes relevant to nonintegrated ties, namely, market, contractual, and noncontractual governance. For small, specific investments and small adaptations, market governance (Step 1) is preferred. In this example, the supplier would deliver from a regional warehouse on a standard delivery schedule.

Staying with the small investment case for the moment, we suggest that as adaptation needs become large, the firm should use more vertical coordination per se (Step 3). For example, the parties may deploy an electronic data interchange mechanism to provide the supplier's warehouse staff with real-time information about end customer orders from the buyer's plant. This high-bandwidth information infrastructure would increase the supply chain's responsiveness to unanticipated changes in the configuration of specific end customer orders.

Returning to Step 0, we note that the large investment case is more complex. Here, both contractual and noncontractual safeguards must be considered. There is a particular sequence of decisions that must be followed because the contractual protection available for the specific investments delimits the level of vertical coordination that can be implemented as an adaptation mechanism.

Accordingly, for large investment needs, we suggest that available contractual safeguards should be deployed first (Step 2). In our warehouse location example, the buyer could offer a contractual take-or-pay volume guarantee that covers the supplier's specific investment in the co-located facility. Often, such desired levels of contractual protection are not completely forthcoming. In this event, after the available contractual safeguards are deployed, we suggest the use of noncontractual safeguards such as hostages to cover the remaining exposed assets, provided that the adaptation needs are small (Step 2a). For example, the supplier may ask the OEM for a reciprocal supply arrangement tied to the co-located warehouse decision.

For the other possibility at Step 2 (large adaptation needs), the appropriate response depends critically on the size of the remaining hazards. If the remaining exposed assets are small, we suggest using hybrid governance with high vertical coordination (Step 3).

However, as these remaining exposed assets grow, the viability of such adaptation mechanisms diminishes. For intermediate levels of remaining exposed assets, hybrid governance is still useful, but vertical coordination should be reduced to balance adaptation needs against the hazards posed to the exposed assets. The dashed boxes in Figure 2 show lower levels of vertical coordination as the exposed assets increase. Finally, at high levels of remaining exposed assets, the firm resorts to hierarchical governance as the appropriate response (Step 4).

It is important to remember that productivity is sacrificed as firms cut back on vertical coordination. The parties increasingly pass up profitable revisions of activity sets. However, this is an unavoidable consequence of the insufficiency of the available safeguards.

If neither stronger contractual safeguards nor hierarchical governance is available and the productivity loss from sacrificing profitable revisions appears too high, firms can recycle back to the beginning (Step 0) to consider a reduction in the specific investments, even though this also entails productivity losses. For example, the co-located warehouse might be sacrificed, though buyer-specific information technology investments might still be retained. The offset is that the exposed assets remaining at Step 2 are smaller, which thus enables more vertical coordination. This process iterates until no further gains appear feasible. In Carson and colleagues' (1999) terminology, this will yield a remediably efficient design.

Applying the framework to the auto supplier. Consider applying the framework to the automobile parts supplier described at the outset of the article. At Step 0, the supplier desired rather large specific investment and adaptation levels. Production lines that are OEM-specific are likely to be more productive, and adapting to frequent design, engineering, and production volume revisions are anticipated to yield large gains. Market governance (Step 1) is not attractive as a result.

The one-year sole-source contract protects much of the OEM-specific production line investment, but substantial noncontractible assets remain exposed at Step 2. Specifically, the supplier's trade secrets and intellectual property used to design sound-deadening covers for the component in question are not protected contractually. To cope with the anticipated revisions, the supplier is obliged to share closely held planning and engineering process data extracontractually with the buyer. Although greater coordination of this variety would improve the supplier's ability to make profitable revisions, it would also make the exposed assets even more vulnerable to appropriation by the OEM's staff.

Given that hierarchical governance (Step 4) is not a relevant option, more complete contractual safeguards, such as a multiyear contract with specific intellectual property ownership rights, might have given the supplier the confidence to engage in more vertical coordination. However, this OEM insists on writing one-year contracts with all of its component suppliers.

At this juncture, the supplier should reassess its anticipated deployment of such a high level of specific investments back at Step 0. To the extent that it can serve the buyer reasonably well using investments that are more redeployable, it faces lower levels of exposed assets by remaining at Step 2. Although this sacrifices some productivity, it may be offset by an increased ability to engage in sharing information with the OEM.

Indeed, for this supplier, such a rebalancing is quite realistic. The supplier designed the cover for the focal component using proprietary methods to make it fit seamlessly with the under-hood contours of this specific model of automobile. This seamless fit reduces the noise generated by the part and differentiates the automobile itself. In contrast, using an industry-standard cover design would have increased noise but would leave other aspects of the component's performance undisturbed. Moving to this latter design would reduce the supplier's exposed intellectual property. In turn, the supplier could be more confident about engaging in greater vertical coordination.

The importance of including safeguarding and adaptation considerations simultaneously is evident in this case. An interesting postscript is that this supplier did not engage in this type of analysis before entering into the extant contract. Predictably, the two firms have struggled to coordinate actions because the supplier remains wary about protecting its exposed intellectual property.

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