When Does Vertical Coordination Improve Industrial Purchasing Relationships?

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Abstract

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, we analyze vertical coordination as a response to external uncertainty. We 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. We use survey data from a sample of 161 industrial buyers to test our hypotheses. When specific investments are modest, greater vertical coordination diminishes transaction difficulties in adapting to high environmental uncertainty. On the other hand, vertical coordination increases transaction difficulties in adapting to high environmental uncertainty when specific investments are substantial. We discuss the importance to these results for transaction cost theory. We develop our results into a managerial decision framework for designing purchasing ties that balances safeguarding and adaptation.

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INTRODUCTION

The productivity of purchasing ties are particularly significant to a buyer since gains from purchasing drop straight to the buyer's bottom line. Not surprisingly, sophisticated industrial and commercial buyers have advocated contemporary initiatives like supply chain management, early supplier involvement and purchasing alliances. While the particulars of these initiatives differ, they coalesce around the idea of greater *vertical coordination* of action between buyer and seller. Here, 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 acquiring power over one's suppliers.

Although March and Simon (1958) provided 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 ordering* rather than through *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 developed data showing that closer (relational) ties improved 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 our 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[3] test descriptive implications. Expected governance modes arising from specific investments and uncertainty are compared against observed modes. Insights about performance are based on extrapolating from these descriptive results. Unfortunately such extrapolation is suspect here 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, while 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 (non-contractually) to work as partners with the OEM's internal engineering staff, using linked computing facilities to exchange very detailed engineering information, and to coordinate frequent design and manufacturing changes over the term of the contract. Clearly, such interactions could reduce costs and/or increase quality by improving their responsiveness to marketplace changes. However, this supplier felt that such interactions also magnified the threat posed to its intellectual property. They 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 paper.

Goals of Paper

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. Hence, we expect that vertical coordination might have positive or negative effects depending on the levels of exposed assets.

The remainder of the paper 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 a 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). TCA and the closely related incomplete contracting literature (e.g., Grossman and Hart 1986) expand on this notion 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 non-integrated governance modes that might play a supportive role. As noted previously, the core aspects of these various non-integrated 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 it 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 re-assignment of roles and tightly coupled activities can be accomplished more smoothly because of the reduced likelihood of stepping on each other's toes inadvertently.

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

Ex Post Transaction Costs as a Performance Metric Carson et al (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 as per the Coase theorem. In the real world, however, transaction costs measure the height of the roadblock and thus the opportunity loss. Since we are particularly concerned with the revision of initially agreed-upon activity sets, *ex post* transaction costs measure the size of the relevant roadblocks. These include the costs of haggling, documentation and renegotiating margins, etc. associated with the new activities being contemplated.

Vertical coordination is an effort to reduce reduces the problems of making product design changes, production planning, etc. (Dowst 1988; Drozdowski 1986; Spekman 1988, Frazier, Spekman and O'Neal 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, in order to answer the

question of when vertical coordination improves exchange, ex post transaction costs are the relevant dependent variable.

Hypotheses

Effects on OEM's 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) concluded that firms purchasing standardized maintenance, repair and operating items showed lower transaction costs with increases in relational contracting under high external uncertainty conditions. In contrast, such increases had no effect in low uncertainty conditions. Supportive evidence also comes from the Pilling, Crosby and Jackson (1994) experiment. More uncertainty led their subjects to anticipate more transaction costs of developing an exchange relationship.

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

First, since our context involves independent firms, neither de jure nor de facto hierarchy is relevant. Complete, contingent contracts are of little relevance either because we are unable to

specify the relevant contingencies. Under these circumstances, obligating parties to more vertically coordinated exchange patterns carries costs and benefits.

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

Of course, the prospects of such behavior will set off efforts by the aggrieved party to uncover and correct it. In short, attempts to improve adaptation via 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 does permit 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 to implement either 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 argument that the private ordering process is quite fragile:

> "I conjecture that the 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*." (1991: 291) (emphasis added).

Baker, Gibbons and Murphy (1997) derive the same conclusion from a formal model of incomplete contracts where 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 will 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 to be 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 in order 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 his own advantage. The supplier will react to the threat of such exploitation by being more cautious and suspicious about implementing proposed revisions. In sum, these OEMs will report higher ex post transaction costs. Formally, there are two hypotheses about the slope of the coordination-transaction cost relationship:

> H1: (a) Under conditions of minimal levels of OEM-specific investments made by an independent supplier, increased vertical coordination in the face of greater environmental uncertainty will have a beneficial effect (*decrease*) on ex post transaction costs reported by the OEM.
>
> (b) Under conditions of substantial levels of OEM-specific investments made by an independent supplier, increased vertical coordination in the face of greater environmental uncertainty will have a deleterious effect (*increase*) on ex post transaction costs reported by the OEM.

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 his direct access to the end-user. Since 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 his 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 should expect such OEMs to report lower transaction costs. Formally, we have:

> H2: OEMs 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 has to be balanced against the larger prospective gains available from trading with a large OEM. Additionally, 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. 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, we have:

> H3: 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-Run Ties Hakansson (1982) and his associates identify elapsed time as the primary enabler of relationship development. Their work can be tied to our situation by observing relationship development effectively reduces the threat of opportunism in longer-run ties (Ring and Van de Ven 1992) which in turn reduces ex-post transaction costs. In sum, performance should be higher in long-run ties. Kalwani and Narayandas (1995) offer evidence consistent with this view. Suppliers with longer run ties to their buyers were found to have lower inventory costs. Formally, we have:

> H4. OEMs 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 in order to capture adequately the domain of each construct in the model. Next, we conducted an exploratory study to verify that our constructs did materialize 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.

Following this initial effort, we examined the contents of actual purchasing contracts and related documents obtained from 24 manufacturers. These documents supported our expectation that purchasing contracts were incomplete in a material way within these settings. For instance, they were often based on standard-form contracts, and 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, with 8-10 year-old relationships being quite common. We conclude that these firms are relying 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. Based on 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, etc., but found that these sub-scales 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 8 individuals from the sampling frame to be used for the final data collection. This questionnaire was a revised version of the one used in the previous pre-test. 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 SIC groups from this frame. Of this initial selection, 114 fell outside the scope of the study because their firm 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. Table 6 shows the correlation matrix, means and standard deviations of all the variables. This sample includes OEMs from a wide range of industries. The formal contracts lasted less than 18 months on

average. However, they continue to buy from these suppliers over long periods of time (almost 10 years on average).

Non-Response Bias

As we lacked population statistics, we tested for non-response bias by comparing early respondents against late respondents (Armstrong and Overton 1977). Firms that responded prior to our call-back efforts (64%) were placed into the early category, while the other firms constituted the late group. We found no significant differences on "demographic" variables like 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 non-response bias to permit further analysis.

Reliability of Scales

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Table 1 about here

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Multi-Item Scales We estimated the correlation matrix of the items for each construct. The item-total correlations were inspected to check for ill-fitting items that were then dropped. Second, a congeneric model of each item set was fitted to assess unidimensionality. [5] Once an adequate fit

was achieved, the estimated loadings were used to calculate construct reliability.[6] Table 1 reports 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 Nygaard (1992) provided items for our scale. Based on item-total correlations, we deleted two of the original items. Confirmatory factor analysis showed an acceptable one factor solution. The final 4 item scale's reliability estimate is 0.78.

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 5 item scale's reliability is 0.78.

Uncertainty (UNCT) is the unpredictability of the task environment. Previous empirical studies provided 8 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 4 items of the original 8 items. The 4 item scale's reliability is estimated at 0.54. This is somewhat low, and prompted additional analysis. Since multi-factor 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. Based on the comparative fit index, the

single factor model describes the data better than the two-factor model (CFIs are 0.93 and 0.83 respectively).

Supplier Asset Specificity (SUPPINV) is the investment 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 4 item scale shows a reliability of 0.82.

OEM Asset Specificity (OEMINV*)* is the investment made by the OEM in physical assets, production processes, tools and knowledge tailored to the focal supplier. Studies by Anderson and Weitz (1992) and Heide and John (1990) provided items for our scale. Following an item-total correlation check, and an acceptable single factor solution, the reliability of the 4 item scale is estimated at 0.76.

Single-Item Measures Some of the variables were measured using single item grounded measures. As such, they cannot be subjected to the unidimensionality and reliability assessment procedures described above. These measures are described below.

Size of the OEM is represented by two different measures. The gross annual sales of the manufacturer (OEMSALES) is one measure, while 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-Run 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 the Heide and Miner study (1992), 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; supplier's specific assets (SUPPINV), OEM's specific assets (OEMINV) vertical coordination (VERT), uncertainty (UNCT) and ex post transaction costs (TRANSCOST). Common factor analysis revealed a five factor solution based on eigenvalue cutoffs and scree tests. The varimax rotated factor loading matrix is presented in Table 2.

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Table 2 about here

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The own-construct loadings are quite large, and are all above the 0.30 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 re-organized the items into two subsets for analysis. The first subset consisted of the items from the OEM's specific assets scale, the supplier's specific assets scale and the uncertainty scale. The second subset consisted of the items from the vertical coordination scale and the transaction cost scale.

Table 3 shows the results of the three factor LISREL model specified for the first subset. All the loadings are 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. The table shows that all the relevant χ^2 difference tests are significant, which shows discrimination between each pair of constructs.

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Table 3 about here

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

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Table 4 about here

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Tests of Hypotheses

Hypothesized Effects The basic model required to test our research hypotheses can be expressed as:

(1) $$TRANSCOST = b_0 + b_1UNCT + b_2SUPPINV + b_3OEMINV + b_4VERT + b_5VERT*UNCT + b_6VERT*SUPPINV + b_7UNCT*SUPPINV + b_8OEMINV*SUPPINV + b_9VERT*UNCT*SUPPINV + b_{10}OEMSALES + b_{11}OEMPURCH + b_{12}LNLENGTH + e$$

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Table 5 about here

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Our core hypothesis, H1, involves predictions about a slope, so we turn to the coefficients of the expression for the derivative of equation (1) as per Schoonhoven (1981).

(2) $$\delta TRANSCOST/\delta VERT = b_4 + b_5UNCT + b_6SUPPINV + b_9UNCT*SUPPINV$$

Equation (2) shows the effect of changes in vertical interaction (VERT) on ex post transaction costs (TRANSCOST). Consider the two posited effects in H1.

First, as per H1a, the derivative should be negative at low levels of specific investments. Since the terms involving SUPPINV in equation (2) vanish at low levels of this variable, equation (2) reduces to $\delta TRANSCOST/\delta VERT = b_4 + b_5 UNCT$. In order for the derivative to be negative (the beneficial effect), we must find that b_5 is negative.

Turning to b_4, we would expect that at very low levels of uncertainty, vertical coordination would simply increase governance costs since the adaptation needs are so low. Thus, the derivative should be positive at this point, which then requires that b_4 must be positive.

H1b is tested as follows. Observe that as uncertainty and specific investments increase jointly, the last term dominates equation (2). In order for the derivative to be positive in this region (the deleterious effect), the coefficient of the last term (b_9) has to be positive.

Turning to the remaining hypotheses in turn, observe that H2 requires a negative coefficient for OEMINV*SUPPINV (b_3). The non-directional hypothesis, H3, requires significant coefficients of either sign for OEMSALES and OEMPURCH (b_{10} and b_{11} respectively). Finally, H4 is supported by a negative coefficient for LNLENGTH (b_{12}). These expectations are summarized 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

H1b. This controls for the unavoidable multi-collinearity between interaction terms in non-experimental designs. It protects us from attributing variance incorrectly to the posited variables. However, we do not interpret the sign of these lower order interactions like UNCT*SUPPINV (b_7) or the main effects of SUPPINV, OEMINV, and UNCT (b_2, b_3, and b_4 respectively).

Estimation and Results

Table 5 displays the estimates. Parenthetically, we note that the reported standard errors are estimated using White's (1984) procedures in order to guard against heteroskedasticity biases.

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Table 5 about here

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The estimates show a good fit of the basic model (R^2_{Adj} =0.24, F(12,148) =5.26, $p < 0.05$). 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 later, 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.

H1 As per H1a, we find that b_5 is negative ($b_5 = –0.33$, t= – 2.22; $p < .05$) Beneficial effects of greater vertical coordination in the face of greater uncertainty are present in low specific assets 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 H1b, we see that b_9 is positive as per our expectation ($b_9 = 0.12$, $t = 2.93$, $p < .05$). This supports our central notion that greater vertical coordination in the face of greater uncertainty is detrimental in high supplier investment conditions.

H2 Our expectation in H2 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 ($b_8 = –0.03$, $t = –0.82$, $p > .05$).

H3 The non-directional effects of OEM size posited in H3 are partially supported. The OEM's gross sales has no significant effect ($b_{10} = –0.03$, $t = –0.48$, $p > .05$). However, OEMs with larger annual purchase amounts from a supplier do report greater ex post transaction costs ($b_{11} = 0.02$, $t = 3.80$, $p < .05$).

H4 As per this hypothesis, the prior length of the relationship (LNLENGTH) reduced ex post transaction costs reported by OEMs ($b_{12} = –0.19$, $t = –2.22$, $p < .05$).

Additional Models To summarize, our theoretical expectation of a contingent effect of vertical coordination is supported after controlling for the safeguarding effects of reciprocal investment, length of tie, and size. Given the large number of interaction terms in our model, and our use of the OEM's perspective, we estimated additional models to verify the robustness of our results. First, we 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}, b_{12}) implicated in the three hypotheses (H1a, H1b, H3, H4) not involving the OEM's investments remain unchanged in this reduced model as seen 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 2 two-way and 1 three-way interactions between 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 (b4, b_5, b_9) implicated in our hypotheses 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 enhance the validity of our statistical tests.

DISCUSSION

Limitations

Perhaps the most significant limitation is the limited reliability (0.54) 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. While it assures 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. Hopefully, 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.

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Figure 1 about here

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

The deleterious effect of vertical coordination is seen in two regions. First, as we predicted, in the face of simultaneous increases in supplier investment and uncertainty (the northeast corner) vertical coordination has deleterious effects. It is simply unable to function as intended because of the hazards that are magnified. The same effect occurs for different reasons at the other extreme (southwest 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 us 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 think 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, one needs to extend the analysis to incorporate all three processes in TCA, including the performance measurement issue that is omitted here.

Specific Assets and Internalization: An Artifact? Our data also speak on 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) concluded that TCA is "bad for practice." Specifically, they dispute the TCA position that non-market governance is chosen because markets are less able to cope with specific investments. According to them, specific investments actually improve the performance of internal organization, so the probability of observing hierarchical governance forms increase with specific investments. Notice that their explanation is dramatically different from TCA but the descriptive predictions are the same. This means that the numerous 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. TCA holds that specific investments (and uncertainty) increase transaction costs in all governance forms, but that the effect is smaller within hierarchies compared to markets. The Ghoshal and Moran position is that effect is positive within markets, but *negative* within 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 ($b_3 = 0.23$, $p < .05$). This refutes the Ghoshal and Moran position directly in favor of the TCA position. Indeed, uncertainty ($b_1 = 1.16$, $p < .10$) also increases transaction costs. In sum, the TCA view that these two attributes of exchange increase exchange difficulties is borne out. Of course, our result is limited to the case of hybrid ties Other varieties of ties need to be similarly examined (e.g. franchising, internal suppliers, etc.) 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. A variety of industry initiatives like "early supplier involvement," "just-in-time," 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 (a) specific investments are modest, *and* (b) large environmental uncertainty is present. In Figure 1, both the northeast and southwest corners depict circumstances where vertical coordination is counter-productive. Specifically, managers must account for the fact that vertical coordination facilitates adaptation, but that it also magnifies the safeguarding problem, and so a careful balance must be struck between the two problems to promote higher performance. We offer the following blueprint for striking this balance.

****

Figure 2 about here

****

Decision Framework We use the institutional design framework presented by Carson et al (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 omit discussing some of the links, and focus on the subset of issues that are most closely tied to the current study's results. Second, the reader will observe that the stopping points do not completely "solve" the safeguarding and adaptation problems in each instance. As Carson et al observe, "fully efficient" designs are not possible. Finally, notice our choice of a starting point at #0 is essentially arbitrary given the on-going nature of these decisions. The results will converge given sufficient iterations no matter where one starts the design process.

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

To illustrate, suppose that inventories could be reduced if a supplier were to locate a warehouse adjacent to a industrial manufacturer's plant, relative to making deliveries from a regional warehouse. Suppose further that additional sales to end-users of the buyer's product are made possible with greater supply chain responsiveness to unanticipated changes in product configurations ordered by end-customers. Finally, suppose that supplier-managed inventories

increase responsiveness relative to buyer-managed inventories. The net value is the gain from the co-located warehouse and the supplier-managed inventory minus the relevant investment costs.

Once these desired levels of investments and adaptation have been identified, the manager must consider the merits of three basic governance modes relevant to non-integrated ties, viz., market, contractual and non-contractual governance. For small specific investments, and small adaptations, market governance (#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, they should use employ more vertical coordination per se (#3). For instance, 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 #0, we see that the large investment case is more complex. Here, both contractual and non-contractual safeguards need to 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 (#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 may not be completely forthcoming. In this event, after deploying the available contractual safeguards, we suggest using non-contractual safeguards like hostages to cover the remaining exposed assets provided that the adaptation needs are small (#2a). For instance, the supplier may ask the OEM for a reciprocal supply arrangement tied to the co-located warehouse decision.

Turning to the other possibility at #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 (#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 very large levels of remaining exposed assets, one resorts to hierarchical governance as the appropriate response (# 4).

It is important to remember that productivity is being sacrificed as one cuts backs on vertical coordination. The parties are increasingly passing 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, one can recycle back to the beginning (#0) to consider a reduction in the specific investments even though this also entails productivity losses. For instance, the co-located warehouse might be sacrificed although buyer-specific information technology investments might still be retained. The offset is that the exposed assets remaining at #2 are smaller, thus permitting more vertical coordination.

This process iterates until no further gains appear feasible. In the Carson et al (1999) terminology, this will yield a remediably efficient design.

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

The one-year sole source contract protects much of the OEM-specific production line investment, but substantial non-contractible assets remain exposed at #2. Specifically, their trade secrets and intellectual property used to design sound-deadening covers for the component in question is not protected contractually. In order to cope with the anticipated revisions, the supplier is obliged to share closely held planning and engineering process data extra-contractually with the buyer. Although greater coordination of this variety would improve their 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 (#4) is not a relevant option, more complete contractual safeguards such as a multi-year 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 their component suppliers.

At this juncture, the supplier should reassess their anticipated deployment of such a high level of specific investments back at #0. To the extent that they can serve the buyer reasonably well using investments that are more re-deployable, they face lower levels of exposed assets remaining at #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 re-balancing is quite realistic. The supplier designed the cover for the focal component using proprietary methods so as 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 served to differentiate 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 their 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 clearly evident in this instance. An interesting postscript is that this supplier did not engage in this type of analysis prior to entering into the extant contract. Predictably, the two firms have struggled to coordinate actions because the supplier remains wary about protecting their exposed intellectual property.

FOOTNOTES

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

[2] Private ordering does not rely on appeal to courts or other legal entities to enforce obligations. Instead, they 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).

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

[5] The fitted LISREL model is $y_i = \lambda_i\xi + \varepsilon_i$, where y_i is the i^{th} 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 $(\Sigma\lambda)^2/[(\Sigma\lambda)^2 + \Sigma\sigma^2]$.

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TABLE 1

Scale Items and Reliability Estimates.

Scale **Confirmatory Fit Statistics**	**Item**
SUPPINV $\chi 2(2) = 1.1$ $p > .05$ CFI=0.99 Rel = .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=0.99 Rel =0.76	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 = 0.92 Rel = .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=0.93 Rel = .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 = 0.95 Rel = .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)

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**

Variable names are explained in Table 1.

TABLE 3

Discriminant Validity Test

Item	Factor 1 Loading (Buyer Investments)	Factor 2 Loading (Supplier Investments)	Factor 3 Loading (Uncertainty)
OEMINV1	0.56†		
OEMINV2	0.57*		
OEMINV3	0.72*		
OEMINV4	0.63*		
SUPPINV1		0.56†	
SUPPINV2		0.80*	
SUPPINV3		0.83*	
SUPPINV4		0.66*	
UNCT1			0.81†
UNCT2			0.25*
UNCT3			0.23*
UNCT4			0.28*

† indicates fixed parameter
* indicates t-values sig. at $p < .05$
Overall Model Fit: $\chi^2(51)=142$; $p < .05$; CFI=0.87
Nested Model with Cov(1,2) set to 1.0: $\chi^2(52)=192$; $\Delta\chi^2(1)$ is sig at $p<.05$
Nested Model with Cov(1,3) set to1.0: $\chi^2(52)=171$; $\Delta\chi^2(1)$ is sig at $p<.05$
Nested Model with Cov(2,3) set to 1.0: $\chi^2(52)=169$; $\Delta\chi^2(1)$ is sig at $p<.05$

TABLE 4

Discriminant Validity Test

Item	Factor 1 Loading (Vertical Coordination)	Factor 2 Loading (Transaction Costs)
VERT1	0.07†	
VERT2	0.67*	
VERT3	0.60*	
VERT4	0.86*	
VERT5	0.64*	
TRANSCOST1		0.25†
TRANSCOST2		0.74*
TRANSCOST3		0.70*
TRANSCOST4		0.90*

† indicates fixed parameter
* indicates t-values sig. at p <.05
Overall Model Fit: $\chi^2(26)=38$; p > .05; CFI=0.97
Nested Model with Cov(1,2) set to 1.0: $\chi^2(27)=231$; $\Delta\chi^2(1)$is sig at p<.05

TABLE 5

Dependent Variable: TRANSCOST

Independent Variables	Hypotheses	Unstd. Coeff Base Model	Unstd Coeff Reduced Model	Unstd Coeff Expanded Model
CONSTANT (b_0)		–2.03 ns	–1.13 ns	–1.4 ns
UNCT (b_1)		1.16*	1.10*	1.00ns
SUPPINV (b_2)		1.91**	1.89**	2.40**
OEMINV (b_3)		0.36*		-0.60ns
VERT (b4)	+ (H1a)	1.09**	1.07*	0.94*
VERTxUNCT (b5)	–(H1a)	–0.33**	–0.32**	–0.30*
VERTxSUPPINV (b6)		–0.47**	–0.47**	–0.58**
UNCTxSUPPINV (b7)		–0.43**	–0.43**	–0.57**
OEMINVxSUPPINV (b8)	– (H2)	–.03ns		-0.04ns
VERTxUNCTxSUPPINV (b9)	+ (H1b)	0.12**	0.12**	0.15**
VERTxOEMINV				0.23 ns
UNCTxOEMINV				0.27 ns
VERTx UNCTxOEMINV				–0.06 ns
OEMSALES (b10)	sig (H3)	–.03ns	–.06ns	–.02ns
OEMPURCH (b11)	sig (H3)	0.02**	0.02**	0.02**
LNLENGTH(b_{12})	– (H4)	–0.19**	–0.18**	–0.18**
		$R^2_{adj} = 0.24$	$R^2_{adj} = 0.20$	$R^2_{adj} = .23$

	$F_{12,148}$ = 5.26	$F_{10,150}$= 5.11	$F_{15,145}$=4.22
	p < .05	p < .05	p < .05

All estimates of standard errors are heteroskedastic-consistent estimates
**indicates p < 0.05 (2–tail)
* indicates p < 0.10 (2–tail)

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 x UNCT						1.00	.66	.52	.80	.343	–.09	.01	–.08
7. SUPPINV x UNCT							1.00	.70	.92	.682	.15	.01	–.01
8. VERT x SUPPINV								1.00	.84	.784	.29	.13	.05
9. VERT x SUPPINV x UNCT									1.00	.707	.13	.05	–.005
10 SUPPINV x 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

$r > 0.16$ and $r <–0.16$ is significant at $p<0.05$ (two-tail) for n=161

FIGURE 1

Contour plot of δTRANSCOST/δVERT

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

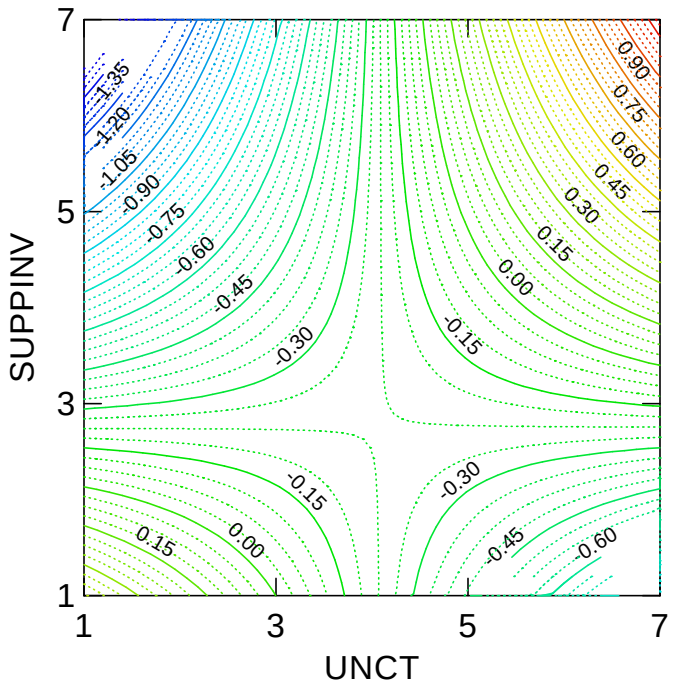

FIGURE 2

Managerial Blueprint for Vertical Coordination in Buyer-Supplier Relationships