Information Processing Moderators of the Effectiveness of Trust-Based Governance in Interfirm R&D Collaboration

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Abstract

It is generally assumed that improved outcomes accompany the use of trust as a governance mechanism in an interfirm relationship. Briefly, trust is a social lubricant that reduces the friction costs of existing trade and/or serves to increase the scope of trade. In contrast to this universalistic view, we posit that the performance of trust-based governance is contingent on the ability of trading partners to "read" each other and learn about counterpart behavior. These information-processing abilities allow firms to assess partner trustworthiness better, which reduces the risk of misplaced trust. The increased efficacy of communication and learning from one another also enables them to better capitalize from the adaptation and revision possibilities uncovered through trust-based governance during the task-execution phase. Given the central role of these cognitive requirements, we assess these contingent effects with data from a knowledge-intensive task setting. Using a sample of 129 firms that have engaged outside contractors on client-sponsored R&D projects, we find strong support for our thesis. Specifically, we find that trust-based governance has a larger positive impact on task performance when the client is more skilled at understanding the outsourced tasks at hand, the task itself requires skills that are relatively more readily taught (less tacit), and the task itself is organized in parallel with work being done at the contractor as well as the client. As a corollary, we also find that firms adopt trust-based governance to a greater extent as these information-processing abilities increase, as well as with the colocation of the contractor and client. Suggestions for engineering trust-based governance are offered.

(Trust; Alliances; Collaboration/Partnership; Information Processing; Governance)

Introduction

In recent years, the prominence of collaborative economic relationships between firms has motivated a large literature on the role of trust in these ties. Its central theme is that trust may be an efficacious means of coordinating economic exchange, very much like contracting or ownership; indeed, it may well outperform the latter alternatives. This literature has made considerable progress in identifying the mechanisms of interfirm trust (e.g., Gambetta 1988), but trust-performance outcomes have been dealt with in a largely undifferentiated manner. First, it is generally assumed that relationships governed by trust will unfold in a particular way—that firms which are trusted will cooperate with and behave towards each other in a trustworthy manner. Put another way, there is no systematic consideration of the costs and risks of misplaced trust. Second, it is assumed that the increased flexibility and superior information exchange associated with trust will enable greater responsiveness to environmental change—ultimately resulting in enhanced performance. Indeed, although the trust literature has often been criticized for its eclectic and often inconsistent underpinnings, these assumptions appear in both the economics stream (e.g., Kreps 1990) as well as the behavioral stream (e.g., Zaheer et al. 1998).

We challenge these assumptions about trust-based governance of economic exchange. In reality, trust-based governance is quite complicated. Our core argument is simple. First, it is plausible that there might be instances

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of misplaced trust. Furthermore, the extent of misplaced trust is likely to be systematically related to the parties' skills in assessing this threat. Second, the flexibility and information exchange superiority of trust is likely to improve adaptation only to the extent that the parties possess sufficient skills to converge quickly to a common interpretation of the changes in the task environment. The upshot is that trust will affect performance in a contingent fashion wherein the size and direction of the relationship depends on the levels of these information-processing abilities.

We undertake an empirical assessment of our contingent model as follows. Drawing on the organization information-processing literature (e.g., Huber 1991), we identify four variables that capture the parties' abilities to assess counter-party trust, as well as the ability to converge on common interpretations of changes in the task environment. We operationalize our model in a knowledge-intensive task environment because the variability in trust performance that we seek is more likely to be a function of these cognitive factors in a knowledge-intensive environment. Specifically, we study ties between client firms and their contractors engaged in client-sponsored research and development.

The remainder of the paper is organized as follows. Immediately below, we expand on the concept of trust-based governance and its presumed impact on performance by developing a series of hypotheses that describe moderating effects of information-processing abilities on the trust-performance relationship. The next section develops corollary hypotheses that describe the circumstances under which interfirm ties are likely to employ trust-based governance. We describe the data collection and analysis in turn, and close with a discussion of the ramifications of our results.

Theory and Hypotheses

Trust-Based Governance

There is an enormous literature on trust, and it covers a large number of substantive domains. We do not attempt to unify these strands; rather, we revert to a middle-range approach to develop our refutable propositions. We focus our discussion on firms that are developing a new product, and who have engaged a supplier to undertake research and development tasks associated with this product. Interfirm collaboration on knowledge-intensive tasks is a growing practice, particularly in R&D-intensive sectors as indicated by recent surveys (National Science Foundation 1999). Indeed, R&D outsourcing has grown to such a degree that new product development is now viewed fundamentally as an innovation process that is dispersed across collaborating firms (Dahan and Hauser 2001). Briefly, our context pivots on a few central features. The client firm typically initiates these engagements. As part of its product development process, it engages an outside supplier to design and/or engineer a component, subsystem, or process. The formal contract is usually a cost-plus type of arrangement, with payments tied to milestones. It is very unusual to find fine-grained incentive payment schemes (Banerjee and Duflo 2000).

For our purposes, we define trust as the confidence held by one party in its expectations of the behavior and goodwill of another party regarding business actions (Ring and Van de Ven 1992, Zucker 1986, Mayer et al. 1995). Our goodwill-based definition goes beyond calculative views of trust, which consider only expectations of behavior based on extended self-interest (Williamson 1993).

The main case argument about the economic consequences of trust in an interfirm setting stems from the ability of the firms to coordinate their activities better if there is trust between them. Any real-world setting includes some degree of uncertainty. As such, a complete contract specifying all relevant contingencies will be impossibly difficult or costly to write and enforce legally. Thus, it is inevitable that the parties will need to revise or renegotiate their initial agreements as the task execution proceeds. In fact, transaction cost analysts aver that parties will expressly devise incomplete contracts with the expectation that these gaps can be filled and revised as contingencies reveal themselves over time. For example, more profitable customer needs or cheaper product design possibilities might reveal themselves. Thus, it is economically valuable to be able to support ex post renegotiations with an appropriate governance mechanism. Among the prominent mechanisms studied include ownership/control and relational norms like trust.

In our context, trust-based governance is the use of trust to support ex post revisions to an incomplete contract between independent parties. Although many of the principles would also carry over into corresponding revisions between parties within a single organization, the literature makes sharp conceptual distinctions between these two settings, so we develop our discussion without reference to the intrafirm case. Trust supports economically valuable adjustments by lowering the friction costs of bargaining between profit-seeking parties. If one has confidence in one's trading partner, less monitoring and auditing is needed. Zaheer et al. (1998) discovered that these bargaining costs were indeed lower with more trust between firms. Relational contracting (Williamson 1985) also pivots on the same argument about constraints on opportunistic bargaining lowering the costs of exchange.

A second argument about the gains from trust holds that more fragile trades can be executed with more trust because it expands the range of self-enforcement. This expansion of profits from trust-based governance has been modeled formally in game-theory models of market reputation. Remarkably, in these models trust can support fragile exchanges even between anonymous traders engaged in a sequence of one-shot exchanges because institutions serve as repositories of reputation (e.g., Milgrom et al. 1990). Together, these arguments about the economic gains from trust-based governance lead us to posit the following:

HYPOTHESIS 1. *The extent of trust-based governance will be positively related to task performance for outsourced R&D arrangements.*

Information-Processing Limits to Trust-Based Governance

The discussion above assumes that trusted parties end up meeting expectations. However, a number of different perspectives have argued against this sanguine view. Rousseau et al. (1998) observe that just because one party trusts another party, it does not follow that the other party is indeed going to meet the expectations of the first party. In other words, there are risks associated with misplaced trust. These risks derive primarily from cognitive limitations on processing information. Williamson (1991) criticizes the Milgrom et al. (1990) game-theoretic models of trust and reputation on the same grounds. He observes that the models break down if there is noise in the observations made about behavior, and the interpretations are thus rendered ambiguous. Is it just an honest error or did they violate our trust? Theorists cannot simply assume away these errors and difficulties in observation and interpretation of behavior unless they assume unbounded rationality, which Williamson considers to be a counterfactual assumption. Unfortunately, Williamson does not elaborate on the empirical ramifications of bounded rationality, so we turn elsewhere for this task.

Organizational information-processing theories have long played a critical role in our understanding of firm performance and the need for firms to acquire and interpret environmental information to survive in the long term. This perspective suggests that the organization's ability to process information in a more accurate and timely manner will manifest itself in superior organizational performance (Galbraith 1977). In our context, these abilities result from the knowledge and skills of the organization relative to the characteristics of the particular R&D task, as well as from the structural features of the exchange itself.

The information-processing perspective contrasts with more objectivist perspectives, in which the meanings of environmental stimuli are perceived accurately regardless of the firm's information-processing abilities. This objectivist perspective implicitly assumes unlimited cognitive rationality. It also contrasts with enactment perspectives, in which environmental realities are completely enacted by the observer and may be disconnected from any exogenous, concrete reality (Sutcliffe 2001). Our perspective assumes intentional, albeit bounded, rationality wherein an exogenous, objective reality exists, but understanding this reality is a difficult and ability-dependent process.

To understand the ability of firms to process information within an interfirm tie, it is useful to briefly consider the general process of information acquisition, analysis, and interpretation. Much of our understanding of organizational information processing has derived from models of organizational learning. Huber (1991) recognizes that organizational members first acquire knowledge through observation of attended stimuli and interpretation of these observations. Second, these data and interpretations are disseminated across individuals. Third, consensus develops through communication, during which individual differences are resolved. The shared beliefs and interpretations that develop are termed schemas. It is these schemas that allow coordinated action.

However, these processes do not move firms forward in an inexorable fashion towards a veridical perception and common interpretation of the exogenous reality. Instead, they are fraught with potential missteps and errors as well as systematic biases. We turn now to factors that determine the information-processing abilities of firms engaging outside suppliers in a knowledge-intensive task like R&D.

Task-Related Skills of the Client

In our context, the risks of misplaced trust and the costs of not reaching consensus on profitable revisions fall mainly on the client. There are several institutional reasons for this conclusion. First, it is the client that pays for the work, typically under a time and effort or cost-plus contract, so it bears the financial risk. Second, in R&D tasks much of the value is realized only if the effort is completed fully. This enables an opportunistic supplier to plead difficulties at or near the completion of the task or milestone to force renegotiation of terms or else to appropriate the intellectual property after the focal project has been abandoned. The client's motivation and opportunity to behave in this fashion are more limited because delays for one component hold up a much larger product launch. Similarly, if profitable revisions are passed up because of disagreements, the client loses a much larger

revenue stream than the supplier. Finally, clients are much larger and more visible than the supplier, which makes their reputation for fair dealing a much more potent disciplinary device.

Thus, we measure the client's skills with respect to the engagement task. Assessing and interpreting the supplier's actions and being able to agree on the nature of profitable revisions depends squarely on the extant knowledge that the client possesses about the tasks in question, as well as the knowledge gained by the client during execution. From our previous discussion of organizational learning processes and schemas, this turns on the relevance of the client's schemas to the R&D task.

The efficacy of the client's preexisting knowledge is plainly higher with more overlap between the skill sets of the client and supplier. Likewise, new relevant schemas are easier for both parties to learn with a smaller gap to be closed. For instance, a client in the pacemaker business would possess fewer relevant schemas about a new battery being developed by a supplier and be harder pressed to learn new schemas from its interactions with this supplier as compared to an engagement to develop a new cardiac catheter. The latter task is closer to the technological core of the client. Of course, in the long run, the client endogenously creates its technological core. Nevertheless, for our purposes it suffices that we can regard the client's technological core to be exogenous at least in the short-run horizon of a single engagement with a supplier.

The economic gains from possessing more relevant and better-developed schemas are straightforward. Observe that it is not better-developed schemas per se that matter. Undoubtedly, better task skills can increase the likelihood of better task execution, provided that the task is moved in-house. However, once an outside supplier has been engaged, it is the reduced risk of misplaced trust and easier consensus with respect to profitable revisions that matters. As such, this client will now profit more from employing trust-based governance to coordinate the exchange as compared to a less-skilled client in the same situation. Thus, we hypothesize the following interaction effect.

HYPOTHESIS 2. *The positive effect of trust-based governance on task performance in outsourced R&D engagements is magnified as the client's task-related skills increase.*

Teachability of Task Skills

Information-processing capacity is derived in part from characteristics of the task, as well from schemas or skills. A critical dimension of the knowledge characteristics of the task is the degree of teachability (Kogut and Zander 1993). Skills are less teachable (more tacit) to the extent that they require face-to-face communication or direct experience with the task to be transferred. For instance, a performance milestone is very teachable or explicit, but the reproducibility of a new process is much less teachable as it is more difficult to document explicitly. Patentable knowledge is by definition more teachable.

For our purposes, teachability makes it easier for one party to learn task-related skills from the other party in a timely and accurate manner. This promotes more relevant schema development during the task-execution phase. It also allows the client to compensate more readily for deficiencies in the extant schemas that it brought into the engagement.

In addition to these interfirm effects, more teachable skills can be disseminated more readily within the firm. In fact, one strategy to raise teachable skills quickly is to hire certified employees. Tasks employing teachable skills are also easier to manage with respect to reaching consensus about proposed revisions without requiring rich media (i.e., face-to-face) communications or experiential involvement that may not be available at all times.

Again, it is not the degree of teachable skills required for task execution per se that matters, but rather its impact on reducing the risk of misplaced trust and easing the process of reaching consensus on profitable revisions to initial plans. As such, this increases the efficacy of trust-based governance, which leads to the following interaction:

HYPOTHESIS 3. *The positive effect of trust-based governance on task performance in outsourced R&D engagements is magnified as the teachability of the task skills increases.*

Colocation of Parties

Colocation refers to the physical proximity of the parties engaged in the collaborative effort. Observe that this does not involve moving physical assets in all instances. In R&D engagements, critical human assets can be colocated. For instance, the contractor's employees often work in the client's physical facility.

Colocation has three primary effects on information processing. First, it affords a greater opportunity to observe and learn compared to remotely located parties. Direct observation of behavior and high bandwidth (i.e., face-to-face) communications both increase exposure to key stimuli and facilitate learning. Second, colocation, by allowing interaction and experience, generates greater understanding of organizational cultures and other hard-to-communicate aspects of the partner that are important in assessing trustworthiness. Finally, organizational learning models hold that when parties are exposed to each

other at multiple and collective levels instead of being limited to a few liaisons or boundary-spanning positions, there is a reduced need to disseminate information to individuals who are not already exposed directly to the partner and task.

As above, our interest is not with the higher interaction levels of colocated parties per se, but with the lower risk of misplaced trust and the easier consensus with respect to profitable revisions that result from colocation. This increases the efficacy of trust-based governance, which leads to the following interaction:

HYPOTHESIS 4. *The positive effect of trust-based governance on task performance in outsourced R&D engagements is magnified with colocated clients and suppliers.*

Parallel Task Execution

Parallel task execution involves the client and supplier engaging in identical or overlapping tasks. However, there is no competition implied between the two programs, and the supplier is not at risk even if the internal efforts yield better results. R&D "shootouts" are quite different in that the winner of two or more competing programs garners a large prize or bonus. The important distinction between the two cases is that very little voluntary disclosure or communication occurs in shootouts.

Although parallel task execution appears to be wasteful duplication, several important information-processing benefits follow. It exposes the client to the task environment in a rich and detailed way. From an organizational-learning viewpoint, it replaces the difficult and time-consuming processes of information dissemination with direct acquisition of relevant knowledge. It helps to develop relevant schemas in ways that teaching and communication, and even colocation, often cannot, especially when the skills lack teachability or the job itself is executed along multiple subtracks.

These informational benefits have been recognized frequently in extant strategy and economics research as well as industry practice. For instance, Harrigan (1983) refers to this as "taper integration," while Bradach and Eccles (1989) discuss "plural forms." Industry terminology for this practice describes it with phrases like "learning to buy," which appear to recognize these informational benefits as well.

As before, our interest is not with the increased acquisition of relevant knowledge per se, but rather with the lower risk of misplaced trust and the easier consensus with respect to profitable revisions that result from it. This increases the efficacy of trust-based governance, which leads to the following interaction:

HYPOTHESIS 5. *The positive effect of trust-based governance on task performance in outsourced R&D engagements is magnified with parallel task execution by clients and suppliers.*

Use of Trust-Based Governance

Hypotheses 1–5 dealt with the impact of information-processing factors on the trust-performance relationship. Recall that increases in each of four factors were predicted to elevate the positive effect of trust-based governance on performance by reducing the risk of misplaced trust and increasing the ability of the parties to make profitable revisions to take advantage of the inherent flexibility of trust-based governance. There is a logical corollary to these arguments about improved performance that speaks to the use of trust-based governance itself.

It is safe to assume that our clients are motivated to improve performance. Indeed, most economic analyses assume that parties are profit-maximizing entities. As such, if decision makers are cognizant of the circumstances under which they can employ trust-based governance most profitably, we would expect them to do so. Indeed, the transaction cost analysis stream is predicated on the idea that firms will choose precisely those governance forms that improve performance. However, it is implausible to argue that our decision makers are fully aware of the causal processes at work and can make informed governance choices that maximize profits.

Given that our decision makers are unlikely to be aware of the precise causal processes underlying trust-based governance, we appeal to a weak form of selection pressure. Weak-form selection argues that a comparatively better alternative (not necessarily the best) enjoys better odds of survival in an environment. Thus, if we were to survey a sample of current interfirm ties engaged in outsourced R&D tasks, we would expect to find a greater use of trust-based governance in circumstances where this particular form has a comparative advantage. What are these circumstances?

Information-Processing Effects

Although a complete exposition of comparative benefits and costs of acquiring and deploying trust-based governance is beyond the reach of current theorizing, we can make some directional predictions. Recall that each of the four factors that we identified previously decrease the risk of misplaced trust as well as increase the ease of reaching consensus on profitable revisions. In effect, these factors are parameters that shift the comparative advantage of trust. In each case, they reduce the cost of and/or increase the benefit of trust-based governance; i.e., trust-based governance enjoys a greater comparative advantage in in-

terfirm ties characterized by higher levels of these factors. Consequently, these ties are also likely to employ trust-based governance to a greater degree. This leads to the following set of hypotheses:

HYPOTHESIS 6. *The use of trust-based governance in outsourced R&D engagements will be greater as the task-related skills of the client increase.*

HYPOTHESIS 7. *The use of trust-based governance in outsourced R&D engagements will be greater as the teachability of the task skills increases.*

HYPOTHESIS 8. *The use of trust-based governance in outsourced R&D engagements will be greater with co-located clients and suppliers.*

HYPOTHESIS 9. *The use of trust-based governance in outsourced R&D engagements will be greater with parallel task execution by clients and suppliers.*

Other Effects

In addition to the information-processing factors that increase the comparative advantage of trust-based governance, there are other variables in the extant literature that refer to the use of trust-based governance and related forms like relational contracting. We do not specify these effects as formal hypotheses, but consider them as control variables that improve the robustness of our empirical specifications.

These variables include the past (historical) length and the future (anticipated) length of the interfirm tie (Heide and Miner 1992). The logic for the former effect is the idea that positive experience breeds more trust, and voluntary commercial ties would not continue unless they were profitable. The latter effect is the notion that parties engaged in repeated interactions could bring to bear more potent self-enforcing pressures, like loss of future business, to maintain honorable behavior.

Another control variable is the clarity and strength of reputation transmission. This is motivated by the self-enforcement models of trustworthy reputation (Kreps 1990). According to these models, trust is only worth cultivating if deviations are swiftly and harshly punished in the marketplace.

The property-rights literature offers yet another control variable. Bakos and Brynjolfsson (1997) argue that reducing the number of suppliers in an outsourced task equalizes the bargaining power between the parties, which makes it easier to build trust. Finally, any form of specialized governance (including trust-based governance) requires management time and attention (Williamson 1985), and these costs are easier to defray if the interfirm tie is a large, important relationship. Thus, our final control variable is the size of the financial stake of the client in the outsourced R&D engagement.

Method

Research Context

Recall that we require knowledge-intensive interfirm ties between independent firms. To this end, we sampled outsourced R&D engagements. As such engagements are not uniformly distributed in the population of firms, we sought out knowledge-intensive sectors as follows. We used National Science Foundation surveys to identify the five, two-digit SIC sectors of the U.S. economy with the greatest R&D intensity, which we measure as the ratio of R&D to sales. Given the large variability within these five sectors, we identified the three-digit SIC groups that reported high levels of outsourcing of R&D, which we measured as the percentage of firms reporting such outsourcing. This procedure identified the following three-digit SIC code groups: Drugs and Medicines (283); Optical, Surgical, and Photographic Instruments (384, 385, 396, 387); Communications Equipment (366); Motor Vehicles and Equipment (371); and Aircraft and Missiles (372, 376).

Sample and Informant Selection

Based on preliminary field interviews, we chose to contact informants from client firms. Our primary reason is that the client is the lead actor in initiating the task as well as shaping the institutional arrangement. We purchased a list of contacts from a commercial list broker (American List Council, New York), which consisted of 2,600 names and addresses of a random sample of R&D managers employed at firms in the three-digit SIC groups identified above.

We contacted these individuals to qualify them as suitable informants. Typically, multiple calls were required to verify (a) the existence of an outsourced R&D task at their firm, (b) their willingness to participate, and (c) their knowledge of the project. If the contacted individual failed to possess sufficient knowledge, we asked for another contact at the firm. Using these procedures, we identified 573 qualified informants.

To encourage participation, we offered each firm a customized report with "par models" that contrasted their supplier engagement profile with other firms in the sample. In addition, we set up a Web-based discussion forum for exchanging views and opinions about the results. Our efforts yielded 405 informants who agreed to participate. After sending them the questionnaire and following up with reminders, we received 129 useable surveys (32% of 405 mailed). As per Armstrong and Overton (1977),

we assessed nonresponse bias by comparing early and late respondents across all variables in the study. No significant differences were found across the two groups. As a further check, we compared response rates across the three-digit SIC codes, which failed to find any significant differences.

Measure Development

The initial fieldwork consisted of open-ended interviews with engineers and scientists enrolled in a management of technology class. The primary purpose of this phase was to assure us that the conceptual issues were indeed material in our selected context. Our decision to sample from the research-intensive sectors grew out of these discussions. Following this phase, we sent a draft questionnaire to about a dozen participants to verify the suitability of the wording of items. This phase led to some minor changes in wording. The items used for each construct are described below and are reproduced in the Appendix.

Trust-Based Governance (TBG). An eight-item scale measures the extent to which norms of trust existed, operationalized as expectations for the fulfillment of obligations, mutuality, flexibility, and information exchange. Items were adapted from Zaheer et al. (1998) and Noordeweir et al. (1990). The items query for expectations not due to contracts.

Task-Related Skills of Client (CLIENTSKILLS). An eight-item scale measures task-related client skills present at the outset of the engagement. The scale consists of two dimensions within a second-order factor structure that incorporates the experiences and competencies of the client organization and those of individual managers. Each dimension is equally weighted for analysis.

Teachability of Task Skills (TEACHABLE). A five-item teachability scale was adapted from Kogut and Zander (1993) and focuses on the lack of need for first-hand experience and/or face-to-face communications to learn the skills involved in the work.

Colocation of Task Execution (COLOCATE). A single item asked whether a significant portion of the supplier's R&D work on the project was conducted at the client's physical site. The responses are entered as a dummy variable in the empirical analysis.

Parallel Task Execution (PARALLEL). A four-item scale addresses the extent to which R&D activities on the project were performed by the client paralleling the activities of the supplier in terms of dollar expenditures, value-added, hours of work, and numbers of workers.

Task Performance (PERFORMANCE). A 13-item scale measures performance on the outsourced R&D task. There are four dimensions, including (1) the (ex post) expected contribution of the technology to the client's product performance, (2) a comparison of actual performance to goals and objectives, (3) adherence to timelines, and (4) the creativity and innovativeness of the technology. Items are adapted from Ancona and Caldwell (1992), Andrews and Smith (1996), and Gatignon and Xuereb (1997). Each dimension is equally weighted in the final scale.

Control Variables. Items for multi-item control variables also appear in the Appendix. These include a three-item scale of the expected continuity of future interactions with this supplier (EXPCONT) using Heide's and Miner's (1992) items. The ease of assessing and communicating the reputation of this supplier (REPUTATION) is measured with a four-item scale developed specifically for this study.

Finally, three control variables are measured with single items. The estimated past history of the interfirm ties is measured in months (HISTORY), and the financial stake of the client is measured as the estimated development budget in dollars (INVEST). The number of suppliers is measured as the current number of independent suppliers engaged on the focal project (#SUPPLIERS).

Measure Validity

Our measure validation process began with unidimensionality and internal consistency assessment. We fitted congeneric measurement models to each of the multi-item scales using the LISREL VII software package. Client task skills and task performance were modeled using second-order factor structures. Chi-square statistics reported in the Appendix are all nonsignificant, indicating good fit. Other fit statistics also indicate reasonable fit. With the exception of the teachability scale, the composite reliabilities (indicated by REL in the Appendix) exceed the 0.6 guideline suggested by Bagozzi and Yi (1988).

Next, we assessed discriminant validity of each scale by estimating a series of nested multitrait measurement structures. Constraining each relevant intertrait correlation to unity and examining the difference in chi-square value, we find significant test statistics that enable us to reject the null hypotheses that each of the tested trait pairs is not discriminated from each other.

Finally, to assess the degree of common method variance problems, we utilize the one-factor test described in Podsakoff and Organ (1986). An exploratory factor analysis of all variables, except the colocation dummy, yields five significant factors (eigenvalues greater than one) explaining 68.6% of the variance (18.7, 15.4, 12.4, 12.0,

and 10.1, respectively), suggesting that the data are not explained by a single common method factor.

Hypotheses Tests

We test Hypotheses 1–5 using hierarchical models estimated using ordinary least squares. Independent variables are mean-centered with multiplicative interactions computed following mean-centering. Sample statistics and correlations appear in Table 1.

Proceeding with the hierarchical models, we first predict PERFORMANCE using only trust-based governance (TBG)—Table 2. As expected, a highly significant positive effect is observed. Next, we add the four information-processing variables. Recall that we refrained from offering main effect hypotheses for these variables. Nevertheless, we include them in the empirical specification to be conservative. R^2 increases significantly from Model 1 to Model 2 ($p = 0.017$) indicating significant main effects. However, the interpretation of these main effects is ambiguous because our theory specifies moderated effects.

The third estimated model includes the core interaction effects. R^2 increases significantly from 0.216 to 0.350 with the addition of the hypothesized interactions ($p = 0.001$), which indicates that the posited interactions are jointly significant as moderators. Each of the hypotheses is discussed in turn below.

We find support for Hypothesis 1 in that the coefficient of TBG is significantly positive (0.598, $p < 0.01$). Given mean-centering, this coefficient shows the effect of trust-based governance on task performance, holding the other variables at their mean values.

Supporting Hypotheses 2, 3, and 5, significant positive effects are found for the coefficients of the interactions of TBG with CLIENTSKILLS (0.223, $p < 0.05$), TEACHABLE (0.129, $p < 0.10$), and PARALLEL (0.340, $p < 0.01$). These results suggest that the impact of trust-based governance on task performance becomes more positive as (1) client skills increase, (2) skills become more teachable, and (3) the use of parallel task execution increases.

However, Hypothesis 4 is not supported, although the sign of the coefficient for the COLOCATE x TBG interaction is in the hypothesized direction (0.60, $p > 0.10$). We speculate that this might be due to our coarse dummy variable representation, which picks up a number of aspects such as logistics and operations unrelated to information-processing concerns.

The significant moderating effects correspond to partial derivatives, which are graphed in Figure 1. These graphs are critical to the interpretation of the moderating effects. Each shows that the size of the effect of trust-based governance on performance increases for a given level of the focal information-processing variable. For example, the impact of a one-standard-deviation increase in TBG on PERFORMANCE is nearly twice as strong (0.8) when CLIENTSKILLS is one standard deviation above its mean than when it is one standard deviation below its mean (0.35). Furthermore, it is worth noting that the effect sizes are rather large at higher levels of the contingent variables. For example, at one standard deviation above the mean on CLIENTSKILLS, a one-standard-deviation increase in TBG yields a 0.8 standard deviation increase in PERFORMANCE. To put this into perspective, Knack and Keefer (1997) report that a one-standard-deviation increase in country-level trust increases the economic growth rate by about 0.5 of a standard deviation.

Table 1 Means, Standard Deviations, and Correlations

	Mean	S.D.	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
(1) TBG	28.912	4.384	1.000										
(2) CLIENTSKILLS	24.850	10.776	0.160	1.000									
(3) TEACHABLE	10.020	3.646	0.095	−0.101	1.000								
(4) PARALLEL	22.273	25.253	0.207*	0.040	−0.153	1.000							
(5) COLOCATE	0.422	0.496	0.198*	−0.048	−0.046	0.252**	1.000						
(6) EXPCONT	14.838	4.297	0.271**	0.106	−0.064	0.022	0.018	1.000					
(7) REPUTATION	16.640	4.864	0.010	0.180*	0.074	−0.076	−0.147	0.090	1.000				
(8) INVEST	2.225	1.591	−0.070	0.109	0.025	−0.007	0.001	−0.054	0.130	1.000			
(9) #SUPPLIERS	2.170	5.842	−0.084	0.058	0.013	0.065	0.112	−0.049	−0.035	0.189*	1.000		
(10) HISTORY	25.532	39.038	0.038	0.096	−0.012	−0.189*	−0.093	0.293**	0.209*	0.108	−0.010	1.000	
(11) PERFORMANCE	36.333	7.492	0.340**	−0.168	0.085	−0.039	−0.026	0.370**	0.047	−0.042	−0.166	0.096	1.000

* Significant at $\alpha = 0.05$ level (two-tailed).

** Significant at $\alpha = 0.01$ level (two-tailed).

Table 2 Standardized OLS Estimates

Dependent Variable: PERFORMANCE				
Independent Variable	Model 1	Model 2	Model 3	Hypothesis
TBG	.390***	0.514***	0.598***	1(+)
	(p=0.000)	(p=0.000)	(p=0.000)	
CLIENTSKILLS		−0.300***	−0.292***	—
		(p=0.001)	(p=0.001)	
TEACHABLE		−0.033	−0.008	—
		(p=0.363)	(p=0.466)	
COLOCATE		−0.079	−0.069	—
		(p=0.204)	(p=0.226)	
PARALLEL		−0.145*	−0.223**	—
		(p=0.062)	(p=0.012)	
CLIENTSKILLS x TBG			0.223**	2(+)
			(p=0.013)	
TEACHABLE x TBG			0.129*	3(+)
			(p=0.064)	
COLOCATE x TBG			0.060	4(+)
			(p=0.302)	
PARALLEL x TBG			0.340***	5(+)
			(p=0.005)	
R^2	0.115	0.216	0.350	
F	13.596***	5.416***	5.634***	
Significance of Change in R^2	—	F=3.156; (p=0.017)	F=4.845; (p=0.001)	

Dependent Variable: TBG		
CLIENTSKILLS	0.174**	6(+)
	(p=0.024)	
TEACHABLE	0.194**	7(+)
	(p=0.014)	
COLOCATE	0.162**	8(+)
	(p=0.035)	
PARALLEL	0.188**	9(+)
	(p=0.019)	
EXPCONT	0.181**	—
	(p=0.024)	
HISTORY	0.068	—
	(p=0.230)	
REPUTATION	−0.021	—
	(p=0.406)	
#SUPPLIERS	−0.134*	—
	(p=0.063)	
INVEST	−0.088	—
	(p=0.158)	
R^2	0.176	
F	2.758***	

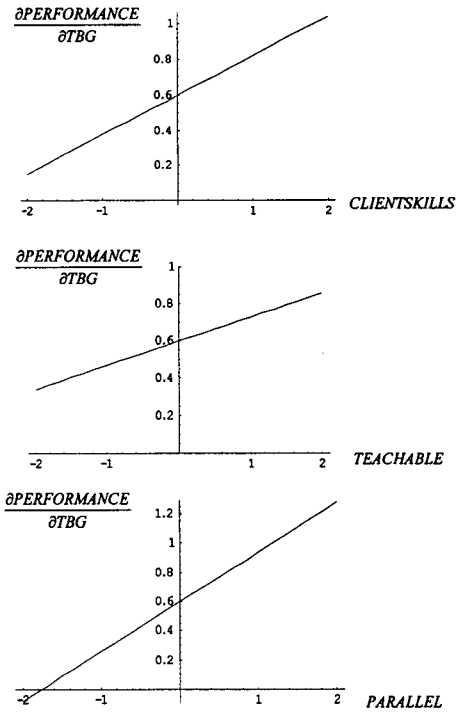
One-tailed alternative hypotheses.
* Significant at α=0.10 level.
** Significant at α=0.05 level.
*** Significant at α=0.01 level.

Finally, notice that the effect of TBG on PERFORMANCE is always positive in the range of our sample values, except for very low observed levels of PARALLEL. Thus, these are noncrossover interactions for the most part. Substantively, it suggests that even firms possessing very low levels of two of these enabling factors (i.e., low client skills and low teachability) can employ trust-based governance without suffering negative consequences, and this is true for most of the range of parallel task execution as well.

We test Hypotheses 6–9 with a regression model predicting TBG (Table 2). Significant and positive relationships with TBG are found for CLIENTSKILLS (0.174, $p < 0.05$), TEACHABLE (0.194, $p < 0.05$), COLOCATE (0.162, $p < 0.05$), and PARALLEL (0.188, $p < 0.05$), supporting Hypotheses 6, 7, 8, and 9.

Turning to the control variables, greater expectations of continuity (EXPCONT) are significantly related to TBG (0.181, $p < 0.05$), consistent with Heide and Miner (1992). Also mirroring their results, the past history of the relationship (HISTORY) is not significant (0.068, $p > 0.10$) in our data. A larger number of suppliers (#SUPPLIERS) reduce the use of TBG (−0.134, $p < 0.10$) as derived from Bakos and Brynjolfsson (1997).

Figure 1 Size of TBG-Performance Relationship



Note. X and Y axes in standard deviation units.

However, contrary to our expectation, the ease of transmitting supplier reputation (REPUTATION) did not affect the use of TBG (-0.021, $p > 0.10$), which casts empirical doubt on the prominent role played by this variable in a large number of conceptual models. Finally, contrary to our expectation, greater financial stakes (INVEST) did not increase TBG (-0.088, $p > 0.10$). Either the set-up costs of trust-based governance are not that large, or else our measure of the estimated dollar budget does not capture the nuances of the underlying process sufficiently.

Discussion

In this paper, we have focused on information-processing abilities as a contingent factor impacting the performance of trust-based governance between independent firms. Our focus on information processing is sensible because trust-based governance lacks legal remedies for opportunism, which places a premium on the client's abilities to assess partner trustworthiness and detect opportunism as quickly as possible. Likewise, the flexibility benefits of trust-based governance can be realized only if parties are able to process information and combine knowledge effectively as they search for the best adjustments to make.

Our theory and the accompanying hypotheses, which the trust-performance relationship would be moderated by four variables that increase or decrease information-processing abilities, receive strong support with three of four interaction effects significant in the expected direction. This level of support is particularly encouraging given the difficulty of uncovering multiple interactions in regression models due to multicollinearity.

Substantively, it is important to recognize that trust-based governance improved task performance in almost all instances in our data. Negative effects were confined to a rather small parameter space where the client engages in virtually no parallel execution of the R&D task in-house. We conclude that a pure "buy" option for R&D is not viable unless there are very strong alternative governance forms in place. Nevertheless, attending to the positive moderating effects is still important because of the large changes in effect sizes that we documented earlier.

The ramifications of our results for industry practice are that trust-based governance can be expressly engineered to maximize gains and/or to minimize risks. Like Heiman and Nickerson (2001), we think that firms should take steps to engineer knowledge management practices that eliminate information-processing barriers towards interfirm collaboration. Our results identify specific, controllable actions like colocating R&D activities and executing tasks in parallel to accomplish this goal.

Some of the information-processing factors are much less controllable. For instance, the teachability of skills is determined by the inherent nature of the task itself. To illustrate, electronic circuit design relies largely on explicit, teachable skills, whereas fermentation processes in biotechnology require very tacit skills. Likewise, the task-related skills of the client are largely noncontrollable at least within the short run. Client firms faced with problematic levels of these variables are well advised to consider alternatives to outsourcing. On the other hand, we remind the reader that firms endowed with high levels of these variables can enjoy trust as a source of competitive advantage (Barney and Hansen 1984) with respect to outsourcing.

From the standpoint of future research, we think that our paper responds in an important way to Sutcliffe's (2001) call that

> with increasing attention being paid to issues of opportunism and trust between organizations, research investigating the development of collaborative versus competitive interorganizational relations also may provide useful insights about flows of information across organizational boundaries. . . . Perhaps trusting behavior between economic actors can be identified and may lead to better outcomes (p. 225).

Our paper takes a significant first step in this regard, and we hope that it will encourage future work to probe into these issues more deeply.

A promising avenue in this regard is to extend our information-processing arguments to broader questions of governance choice. For example, if information-processing abilities are lacking, hierarchical governance may become more attractive. Hierarchies are relatively insensitive to information-processing abilities for purposes of safeguarding because it safeguards through low-powered incentives and limited residual profit claimancy that dull the actual motivation for opportunism.

Alternatively, "harder" contractual governance may become more attractive. While contracting involves considerable cognitive effort in forming the initial agreement, it is less demanding cognitively than trust-based governance because downside risks from misplaced trust and losses from failing to make adjustments ex post do not play prominent roles. Risk reduction is less critical to contracting because legal remedies allow losses from opportunism to be recovered, at least to some degree, which in turn places less importance on the complex and ambiguous process of qualifying partner trustworthiness and on detecting opportunism immediately. Likewise, agreeing to ex post adjustments is less critical under contracting because significant adaptation is not a key source of expected benefit. As with hierarchy, if contracting is less

sensitive to information-processing abilities, it becomes more attractive as these abilities decline. Future work along the lines of Heiman and Nickerson (2001) that addresses these governance trade-offs would be very productive.

Appendix. Multi-Item Scales and Measurement Statistics

Extent of Trust-Based Governance (TBG). Five items; REL = 0.807; $\chi^2(5) = 3.629$, $p = 0.604$, GFI = 0.989. *(1) The parties held mutual expectations about the contractor's responsibilities that went beyond what was specified in our formal agreements. (2) The parties expected that conflicts would be resolved fairly, even if no guidelines were given by our formal agreements. *(3) There were performance goals for the contractor's work that were understood and accepted by the parties even though they were not written in our formal agreements. (4) When an unexpected situation arose, the parties had a mutual understanding that a win-win solution would be found, even if it contradicted our formal agreements. *(5) Both parties were expected to share helpful information to an extent beyond that required by our formal agreements. (6) The parties held mutual expectations that each would be flexible and responsive to requests by the other, even if not obliged by our formal agreements. (7) Both parties understood that problems arising during the relationship would be solved jointly through communication and cooperation rather than just reference to our formal agreements. (8) Both parties understood that each would adjust to changing circumstances, even if not bound to change by formal agreements. (One = completely inaccurate description; seven = completely accurate description.)

Client Skills (CLIENTSKILLS). Seven items[a]; REL = 0.870; $\chi^2(13) = 19.799$, $p = 0.100$, GFI = 0.959. *(1) The skills which were typical of our unit were very similar to the skills of the contractor. (2) Most managers in our unit had prior personal experience with the type of work the contractor performed for us. (3) The contractor's R&D work was very similar to work regularly done throughout our unit. (4) The skills needed to perform the contractor's R&D work were also a core competency of our unit. (5) The R&D work for our most important products is very similar to the work the contractor was doing. (6) Most people in our unit had the same training and technical background as the contractor's people on our project. (7) Our unit was known for its successful performance of the type of work the contractor was doing. (8) Our internal R&D people had or could have easily learned the skills needed to perform the contractor's work. (One = completely inaccurate description; seven = completely accurate description.)

Teachability (TEACHABLE). Three items; REL = 0.527[b]. *(1) It was difficult for the contractor to explain decisions to our people, who lacked the knowledge used in the work (R). (2) The only way to understand the knowledge involved in the contractor's work is through first-hand experience (R). (3) Face-to-face discussions were required to really understand the issues facing the contractor and the decisions it made (R). (4) It is difficult for nonexperts to learn even the basics of the contractor's work (R). *(5) Our managers needed the same background as the contractor's people to communicate effectively with them (R). (One = completely inaccurate description; seven = completely accurate description.)

Parallel Task Execution (PARALLEL). Four items; REL = 0.955; $\chi^2(2) = 1.290$, $p = 0.525$, GFI = 0.995. Please estimate the percentage of R&D work on this technology performed by employees of your firm, as opposed to R&D contractors (write percentages in blanks): (1) Dollar expenditures: _____ % of total dollars were expended on work by our employees. (2) Value added: _____ % of total value added was from work done by our employees. (3) Hours of work: _____ % of total hours worked were accrued by our employees. (4) R&D workers assigned to work: _____ % of total R&D workers were our employees.

Task Performance (PERFORMANCE). Ten items[a]; REL = 0.945; $\chi^2(31) = 37.612$, $p = 0.192$, GFI = 0.943 (1) We were very satisfied with the technology. (2) The technology was very innovative. *(3) The technology will be more valuable than we expected. (4) The technology fully complied with specifications. *(5) The overall quality of contractor's work was very high. (6) The contractor exhibited a great deal of creativity in its work. (7) The technology incorporated a great deal of new knowledge and discoveries. (8) The technology will contribute a great deal to the functionality of our products. (9) The technology will contribute a great deal to the competitiveness of our products. (10) The technology will contribute a great deal to the profitability of our products. (One = completely inaccurate description; seven = completely accurate description.) *(11) How did the technology compare with your goals and objectives? (One = failed to meet objectives; four = exactly met objectives; seven = exceeded objectives.) (12) Were milestones reached on, ahead, of, or behind schedule? (13) Was the completed technology delivered on, ahead of, or behind schedule? (One = behind schedule; four = on schedule; seven = ahead of schedule.)

Expectations of Continuity (EXPCONT). Three items; REL = 0.806[b]. (1) The parties expect to work together on future projects. (2) The parties were expected to focus on long-term goals in the relationship. *(3) Our involvement with this contractor is open-ended. (4) We expect this contractor to grow into a lifelong partner. (One = completely inaccurate description; seven = completely accurate description.)

Assessing Reputations (REPUTATION). Four items; REL = 0.715; $\chi^2(2) = 1.577$, $p = 0.455$, GFI = 0.994. (1) It was easy to learn about how the contractor had behaved in its previous relationships with other firms. (2) If the contractor was less than cooperative in our relationship, this would greatly damage their reputation with other firms. (3) In our industry, it is widely known which contractors are the best in terms of performance and collaboration. (4) Contractors in our industry watch their reputations closely. (One = completely inaccurate description; seven = completely accurate description.)

Appendix Note.

*Item removed during scale purification.

(R) Reverse coded.

[a]Second-order factor structure.

[b]Trivial fit for three-item scale.

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