Organization Science

Vol. 15, No. 4, July–August 2004, pp. 394–410
ISSN 1047-7039 | EISSN 1526-5455 | 04 | 1504 | 0394

DOI 10.1287/orsc.1040.0074

Learning to Contract: Evidence from the Personal Computer Industry

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Organizational forms involving more detailed contracts than are found in traditional spot market exchanges appear to be increasingly prevalent. There has been relatively little analysis, however, of the extent to which firms learn how to use contracts to manage their interfirm relationships over time. In this paper, we conduct a detailed case study of a time series of 11 contracts concluded during 1989–1997 between the same two partners, both of whom participate in the personal computer industry, to explore whether and how firms learn to contract. We find many changes to the structure of the contracts that cannot be fully explained by changes in the assets at risk in the relationship, and evidence that these changes are largely the result of processes in which the firms were learning how to work together, including learning how to contract with each other. The nature of this learning appears to have been quite incremental and local, that is, not very far sighted. We suggest how and when contracts might serve as repositories for knowledge about how to govern collaborations, and suggest some boundary conditions for this phenomenon. Our findings also provide implications for the debate about whether contracts have a positive or negative effect on interorganizational trust. We conclude with suggestions for future research.

Key words: contracts; organizational learning; transaction costs

Introduction

It is widely observed that an increasing range of exchange activities is organized through interorganizational relationships in which complex contracting plays an important role, such as alliances, consortia, and long-term supply contracts (e.g., Malone et al. 1987, Davidow and Malone 1992, Dyer and Ouchi 1993, Daft and Lewin 1993). Transaction cost (Williamson 1985) and property rights theories (Grossman and Hart 1986, Hart and Moore 1990) have been used to understand aspects of the structures of such contracts. But although some recent studies have shown that the ability to effectively manage relational exchanges can improve various dimensions of organizational performance (Kale et al. 2000, Anand and Khanna 2000a), there has been relatively little analysis of whether and how firms learn to manage their interfirm relationships using contracting in particular.[1]

This lack of attention to the role of learning in contracting processes might be due in part to limitations of the theories that have been used to examine interorganizational relationships. Transaction cost economics, for example, has not yet fully incorporated learning into its theoretical framework (Williamson 1999). Another contributing factor might be that empirical investigations of contracting have tended to study older industries such as power generation, timber harvesting, or ocean shipping (Palay 1984; Masten and Crocker 1985; Joskow 1985, 1987, 1988, 1990; Hubbard and Weiner 1986; Goldberg and Erikson 1987; Leffler and Rucker 1991; Pirrong 1993). Slower rates of technological change in such industries might contribute to relatively stable contracting practices, and create fewer learning opportunities.[2] Studies of contracting in high-technology industries, however, have tended to use crosssectional, rather than longitudinal, data on contracts (e.g., Oxley 1997, Lerner and Merges 1998, Anand and Khanna 2000b), which also makes learning effects difficult to detect. Longitudinal contracting data from high-technology industries have rarely been analyzed. Meanwhile, the literature on interfirm cooperative relationships that draws more on sociology has also not focused on the phenomenon of learning to contract. Following on Macaulay's (1963) classic work, this literature has tended to de-emphasize the role of contracts, especially while interfirm relationships develop over time, emphasizing instead the role of trust as the more important basis for these relationships (e.g., Ring and Van de Ven 1992, 1994; Gulati 1995).

This paper explores whether and how firms learn to contract by studying a time series of 11 contracts concluded during 1989–1997 between the same two partners, both of whom participate in the personal computer industry. In addition to examining the contracts, we conducted numerous interviews with managers in both

of the partner companies concerning the evolution of contracts between them, and the relationship between the two firms more generally. We found a significant degree of development in the structure of the contracts that cannot be entirely explained by changes in the nature of the goods exchanged or assets at risk in the transactions. This finding, we argue, suggests evidence of learning by the parties, especially with regard to how to efficiently govern the projects through contracts. These learning effects appear to be caused in part by the rapid pace of innovation in what was a relatively new industry at the time of this study.

Consistent with evolutionary theories (e.g., Nelson and Winter 1982) and older behavioral theories (e.g., Cyert and March 1963), we find this learning to be quite local and incremental in nature. The parties to the contracts were relatively slow to recognize important contingencies and the contracting hazards and incentive misalignments associated with them, and to make provision for them in the terms and conditions of new contracts. Rather than anticipating such problems and contingencies, the parties had to actually experience an adverse situation before addressing it in new contracts. Moreover, initial attempts to address contracting hazards and incentive problems in contracts were often inadequate, requiring elaboration to be added in subsequent contracts. We also found that the parties used the contract as their main repository for learning, rather than relying exclusively on oral communications or memos that are much less enforceable, legally. We interpret this finding as evidence that contracts continued to play a central governance role in the relationship, independent of whether other relationship-support mechanisms (such as trust or reputation effects) became more important in the relationship, over time.

These findings offer some useful implications for theories of contracting. In particular, the important role for incremental learning that we observed as the contracting process proceeded suggests that the firms in question were quite limited in their abilities to "look ahead, perceive hazards, and factor these back into the contractual relation," which is a central presumption of transaction cost theory (Williamson 1996, p. 9). Moreover, although the firms were able to learn, this learning was quite gradual and incremental, and occurred over a relatively long period. On the one hand, this finding suggests that the far sightedness exercised by the firms was more limited than is usually assumed in contracting theories, such as transaction cost theory. On the other hand, governance features of the contract were very important, and indeed became increasingly important as the contractual relationship continued, so that the learning process occurred in directions that were largely consistent with transaction cost prescriptions. Taken together, the findings imply that in some industry contexts, especially those characterized by rapid innovation, contracts could play an important role as repositories of interfirm knowledge, in addition to their role as frameworks for governing exchange.

The paper proceeds as follows. We first discuss the transaction cost theory of contracting and literature on organizational learning. Next, we present evidence regarding the evolution of the contracts we examined. We then interpret the contracts in light of the theories of contracting and learning outlined earlier. We conclude with further insights and implications for developing theories of learning to contract.

Transaction Cost Theory of Contracting

Williamson's (1985, 1991) transaction cost approach to contracting has been highly influential in the organizational and economics literatures, and has received a substantial amount of empirical corroboration (Shelanski and Klein 1995). This theory views contracts as governance structures for managing relationships between commercial parties. Building on Macneil (1974, 1978), the theory distinguishes two types of contractual governance for transactions that recur over time: market and bilateral.[3] Market governance is efficient when transactions are relatively standardized and straightforward. This is the case when the transaction does not require significant idiosyncratic investments by the parties, so that if disagreement leads to cessation of the relationship both parties can easily contract with alternate partners on similar terms. Thus, market governance tends to be chosen when the surplus value to both parties of continuing their contractual relationship is relatively low.

Bilateral governance becomes efficient when the continuity value of a relationship is significant, especially because either or both parties will be making idiosyncratic investments that have low value in alternative uses. In this case, the parties will attempt to foresee the various kinds of disturbances and contracting hazards that could threaten the relationship. The contracting hazard discussed most prominently is hold-up, in which the party with less idiosyncratic investment at risk expropriates surplus from the other party (Williamson 1975, 1985; Klein et al. 1978). When a contract is used to govern a transaction in which the consequences from hold-up are significant due to the presence of relationship-specific investments, the parties will incorporate safeguards into the contract to protect these investments from opportunistic expropriation. Providing for contractual hostages is one example of such safeguards (Williamson 1983). Other kinds of disturbances that could upset the contractual relationship, the theory predicts, would also be contemplated by the parties, and mechanisms that facilitate joint adaptation by the parties to these disturbances, with the aim of protecting the relationship, would be incorporated into the contract. The mechanisms might include, for example, provisions

and administrative procedures aimed at dispute prevention and resolution, the distribution of costs and benefits under various future contingencies, and information disclosure.

The capacity for contracts to adequately safeguard relationship-specific investments against opportunistic behavior by a contractual partner is, however, limited. This is because foreseeing all the possible future contingencies under which a contractual hazard can emerge is very difficult, due to the bounded rationality of economic actors (Simon 1957). Contracts, therefore, are unavoidably incomplete (Grossman and Hart 1986, Williamson 1996). In addition, contract terms aimed at safeguarding assets can open up opportunities for novel and creative forms of opportunism (Klein 1993). Therefore, if the value of idiosyncratic investments at stake in the transaction rises to a sufficiently high level, contracts become costly in transaction cost terms, and unified governance (of which vertical integration is an exemplar) becomes a more efficient governance mode for facilitating exchange.[4]

As this discussion suggests, the two central assumptions in the transaction cost theory of contracting are that when designing and negotiating contracts the agents are (1) unable to anticipate all possible future contingencies that affect the contractual relationship, but (2) able to foresee major contractual hazards stemming from potential opportunism by their contractual partners, and to devise contractual structures to mitigate them. As Williamson (1996, p. 9) explains,

> Transaction cost economics . . . concedes that comprehensive contracting is not a feasible option (by reason of bounded rationality), yet it maintains that many economic agents have the capacities to learn and to look ahead, perceive hazards, and factor these back into the contractual relation, thereafter to devise responsive institutions. In effect, limited but intentional rationality is translated into incomplete but farsighted contracting.

Finally, transaction cost theory assumes a competitive economic environment and makes equilibrium predictions (Williamson 1985). Therefore, it predicts that firms that consistently misdesign contracts and that fail to learn quickly from these mistakes will perform poorly in the market. Consistently poor performers will be forced to exit the market, so that in equilibrium only alert agents and well-designed contracts will survive.

Learning to Contract

Although the quotation from Williamson (1996) above mentions learning, transaction cost theory has not systematically incorporated learning into its framework (Williamson 1999). Indeed, the theory's equilibrium assumptions can be interpreted to imply that learning is relatively quick and thorough. Although there been little study of learning to contract per se, there is a large literature suggesting that learning in general within and between organizations is an important phenomenon (e.g., Lieberman 1984, Lyles 1988, Darr et al. 1995, Argote 1999) and that it tends to be quite gradual and incremental. According to this literature, this importance is because agents' rationality is quite limited, and learning tends to occur through a relatively slow process of environmental selection of faster learners (Alchian 1950), or error detection and correction in "theories-in-use" (Argyris and Schon 1978, p. 10), or both. This limitation implies that periods of disequilibrium, during which underperforming firms can survive in the market, can be fairly long (Winter 1988). Moreover, individuals and organizations tend to learn through the repeated practice of routines, which gradually come to embody the fruits of prior learning, but which also constrain the range of new learning. As a result, learning tends to be incremental and local, in that it tends to occur in areas close to areas of previous knowledge or experience (Nelson and Winter 1982, Cohen and Levinthal 1990, Levinthal and March 1993). Several empirical studies have found evidence for this local character of organizational learning (e.g., Helfat 1994, Podolny and Stuart 1996, Martin and Mitchell 1998).

Scholars have also noted that organizations often learn how to collaborate with each other over time (Doz 1996, Anand and Khanna 2000a). For example, Child (2001) writes that one kind of learning in a strategic alliance involves "...the accumulation of mutual experience with and knowledge about how to manage interorganizational cooperation per se. Collaborative knowhow might be used later in design and management of other collaborations" (p. 664). Learning how to contract, in particular, might be an important component of learning to collaborate, more generally. For example, contracting experience might sensitize managers and their organizations to potential disturbances to contractual relationships about which they were previously unaware, enabling them to better foresee such contingencies in future contractual relationships. Contracting experience might also help managers and their firms to better understand the implications of contingencies for the relationship, for the firm's performance, and for its future contractual relationships. Such experience might also help firms to more effectively use contracts to facilitate adaptation to disturbances, or how to craft agreements that better safeguard vulnerable assets. Therefore, when applied to contracting, theories of organizational learning might imply that firms sometimes learn about potential contingencies and hazards slowly and incrementally—as they experience them—and do not apply foresight to anticipate as many contingencies as possible ex ante, many of which they might not have experienced themselves (e.g., Cyert and March 1963).

There is little direct empirical evidence, however, regarding whether and how firms actually learn to contract, or whether something close to an optimal contract

is agreed on from the start of a new contractual relationship. Although there is a substantial literature on learning in alliances, this literature has been primarily concerned with whether and how partners transfer knowledge—especially technological knowledge—to each other rather than with how they learn to manage the contractual aspects of the alliance per se (e.g., Doz 1996, Mowery et al. 1996, Larsson et al. 1998, Lane and Lubatkin 1998, Dyer and Singh 1998, Kale et al. 2000). Although Anand and Khanna (2000a) did find statistical evidence that firms learn to manage alliances over time, the aggregate nature of their data did not allow investigation of the underlying processes and mechanisms through which this learning occurred.

The qualitative (and limited quantitative) data described in the next section do not allow for statistical testing, but they do help to shed light on potentially important behavioral mechanisms in processes of learning to contract. Studying the details of particular contracts has been an important method by which theories of contracting such as transaction cost theory have been explored in the literature (e.g., Palay 1984, Pirrong 1993); this studying of particular contracts complements studies of more aggregated data on contractual form.

Contracting at Softstar

Methods and Setting

We draw our data from interviews with managers of and contracts provided by a computer software firm (fictitiously named Softstar) in Silicon Valley, California, and its customers. Softstar's software products consist of customized programming that is embedded in various computer hardware products such as microprocessors. With development facilities in North America, Japan, and Europe, Softstar is a multinational firm with a global customer base. At the time the interviews were conducted (1996–1997), a typical Softstar development project required innovative solutions to programming challenges, and took from three to nine months to complete. The length of customer relationships ranged from a few years to over a decade. Customers typically required one to three products per year from Softstar. As of 1996–1997, Softstar was just beginning to develop its custom products with an eye toward code reuse, with the idea of reaching some economies of scope across products. Code reuse was therefore not an aspect of the earlier development projects that we studied.

Softstar was incorporated in 1979, and made its initial public offering of stock in 1988. As a public company, it became profitable in 1992, and during the mid- to late 1990s had an average of return on assets (ROA) of 11% to 12%. It survives as of 2003.

We were given access to the contracts that governed the relationships between Softstar and several of its customers. We examined the relationships between Softstar and four of its larger customers, but our most-detailed data on contractual features and their evolution come from the 11 contracts between Softstar and a particular customer (fictitiously named HW Inc.) that were written over the period 1989–1997.[5] HW Inc. was, and remains today, a major diversified Japanese electronics producer. HW Inc. participated in the personal computer industry by producing system hardware, having entered the personal computer business just prior to beginning its relationship with Softstar. Softstar also produced embedded software for other major computer hardware producers. Softstar managers explained that these contracts between Softstar and HW Inc. were representative of Softstar's contracts with other customers.

Numerous employees from Softstar and HW Inc. were interviewed. Interviewees included engineering project managers, engineering managers (up to the director level), programmers, marketing personnel, and quality assurance personnel. Many of these managers had extensive experience in the computer industry. For example, the Softstar project manager in charge of working with HW Inc. had 25 years of experience as an engineer and manager at IBM. The interviews were semistructured, with broad, general questions oriented toward understanding the role of contracts in the evolution of Softstar's relationships with its customers, especially with HW Inc. As will be evident from the narrative below, we consistently asked subjects to describe the chronology and details of events that led to contract changes, rather than relying on unsupported or idiosyncratic interpretations they might offer. We also triangulated these descriptions with other interviewees (Jick 1979).

With regard to the Softstar–HW Inc. relationship in particular, the project manager in charge was interviewed 12 times over a 1-year period. Twelve additional personnel from Softstar and HW Inc. were interviewed from one to four times each. The combination of archival data (the contracts dating back to the beginning of the relationship) and extensive interviews provided a comprehensive picture of the relationship between Softstar and HW Inc., and gave a good picture of a typical relationship between Softstar and its customers in the 1990s.[6]

Evolution of the Softstar–HW Inc. Contractual Relationship

Softstar's relationship with HW Inc. began in 1989, just 1 year after Softstar went public, but approximately 10 years after its founding. According to managers, during most of Softstar's history the company was preoccupied with completing its complex software development projects, securing financing, and managing the kinds of day-to-day operational issues that are often especially pressing on small, resource-constrained firms facing tight product-release deadlines. As a result, little time and attention was devoted to documenting and systematizing contracting processes. One Softstar engineering manager described Softstar's operations as having

been ad hoc (Interview, 5/29/96). Therefore, in initiating its relationship with HW Inc., Softstar relied more on the general experience of its managers than on specific contracting experiences in its own history. However, the new project manager hired in 1994 took a very different approach to the management of the contracting process. She took on several initiatives designed to foster communication among the project managers and to get them to share what they had learned in dealing with their respective customers. The new manager adapted her previous experience to the way business was done at Softstar with a clear goal of enhancing knowledge sharing in the area of crafting and managing contracts.

Softstar maintained a two-part contractual structure for all the HW Inc. contracts, and indeed with each of its customers, during the period in question. The first part was an overall contract, negotiated by lawyers, which specified prices (such as labor cost) for software code development, and royalty rates. The prices stipulated in this part of the contract changed somewhat over the period, but its general structure did not. This first part of the contract did not, however, obligate the parties to undertake any particular project. Once the overall contract was in place, engineering project managers from Softstar and its customers negotiated the terms and conditions of individual projects. For each project, an addendum called a statement of work (SOW) was added to the overall contract that contained the project-specific terms. Lawyers played no direct role in the negotiation of the SOW. The changes in the structure of contracts with HW Inc. were concentrated in the SOWs. Each SOW was a legally valid part of the contract, but the Softstar project manager noted that because it often took "too long to get an SOW signed, work is done prior to having a signed SOW" (Interview, 4/15/97).

According to managers, this two-part structure was adopted because it was impossible in this setting to negotiate a single long-term contract for supplying HW Inc.'s future embedded software needs, because HW Inc.'s future products were not yet developed, and the details of its future technical needs were therefore unknown. In addition, there was concern at Softstar that, given the lack of a market price for such customized software, using completely independent contracts for each project would lead to excessive bargaining over prices, royalties, and so on. The two-part contract structure helped to mitigate these problems.

The first software product Softstar developed for HW Inc. in 1989 was fairly advanced for its time, but involved a very sparse SOW. This project involved the development of system software (specifically, BIOS) for HW Inc.'s computer product. The software incorporated some innovative features, but would not radically differentiate HW Inc.'s computer from those of its competitors. The purpose of the first SOW, which was written by an engineering project manager, was clearly to define the technological aspects of the project. It was largely silent regarding management of the project because the parties felt that once the technical details were specified the execution of the project would go smoothly. This first contract was only 11 pages long, seven of which were devoted to describing the product features required. Other than product features, this first SOW included a list of reference documents, an estimate of development time (measured in engineering days), associated nonrecurring engineering development charges, and items that HW Inc. was required to provide to Softstar to facilitate development. No delivery schedules were included. In addition, interviewees indicated that neither HW Inc. nor Softstar contributed much knowledge from previous contracts with other suppliers in devising the contract structure (Interview, 2/4/97).

The second SOW, similar to the first, was focused almost exclusively on technical detail. The first two projects occurred almost simultaneously, so there was no real chance to incorporate lessons learned from the first project into the second. Detailed measurement of the performance of the two projects is unavailable from Softstar. Testimony passed down from employees who were involved in the early projects, however, indicates that the relationship was not as smooth as either party had hoped. However, HW Inc. was looking for a supplier with whom it could build a long-term relationship, and Softstar wanted a long-term relationship in order to lock in an important customer. The parties demonstrated their goodwill by beginning work on projects before their SOWs were signed. The first two projects were both over budget, by modest amounts, and included more features than were in the SOW. In response to these problems, the parties attempted to resolve their differences and improve their working relationship. These efforts resulted in a series of important modifications to contract structures. The aims of those modifications can be classified into four categories: (1) enhancing the communication between personnel from the two firms, (2) clarifying responsibilities and expectations of both parties, (3) planning for contingencies, and (4) modifying the format. Most of the changes to the SOWs can be traced to problems encountered during the execution of prior SOWs. The details of each of these types of changes are described in detail below. These details are summarized in Table 1.

Enhancing Communication

Interfirm communication became an issue that Softstar and HW Inc. had to address because it was disrupting the working relationship between the two parties; they addressed it by crafting effective processes. The first problem the parties encountered during the first two projects was that HW Inc. was making changes based

Table 1 Changes to Contracts Between Softstar and HW Inc.

Changes to SOW	Feature introduced
Changes to enhance communication	
1. Changes to SOW must be in writing.	SOW #3
2. Changes to SOW must be reported in a timely manner.	SOW #6
3. Single point of contact at Softstar.	SOW #9
Clarification of responsibilities/expectations	
1. Softstar receives full hardware specifications from HW Inc.	SOW #6
2. Softstar deliverables section.	SOW #7
3. Project schedule directed to be negotiated after SOW signed.	SOW #7
4. Project schedule included in SOW.	SOW #8
5. Delivery schedule for hardware platforms from HW Inc. included in SOW.	SOW #8
6. Features to be included in each release are included in SOW.	SOW #10
7. Equipment and material required section gets additional detail.	SOW #11
Contingency planning in SOW	
1. Addition of risks or concerns section to SOW.	SOW #5
2. Hardware problems or changes lead to renegotiation of costs and schedule.	SOW #8
3. Impact of industry standards issues discussed in SOW.	SOW #10
Document processes in SOW	
1. Problem reporting process included in the SOW.	SOW #8
2. Engineering change process included in the SOW.	SOW #9
3. Quality assurance and testing process included in the SOW.	SOW #9
SOW format changes	
1. System architecture section added to SOW.	SOW #3
2. Revision history section added to SOW.	SOW #5
3. Table of contents added to SOW.	SOW #6
4. System architecture section expands to include more detail.	SOW #6

Source. Company interviews.

on oral authorization, and a variety of HW Inc. personnel were giving Softstar engineers conflicting instructions. This caused confusion at Softstar and led to delays as requirements and trade-offs were gradually clarified. The parties introduced a clause into the third SOW that required written change requests from HW Inc. This was an attempt to resolve the issue by making HW Inc. personnel more accountable for requested changes.

Requiring written changes helped resolve the problem of conflicting directives, but it resulted in an unanticipated side effect—delays in notifying Softstar of important changes. Forcing HW Inc. to make changes in writing made HW Inc. personnel reluctant to make themselves accountable by documenting their change requests. This reluctance resulted in changes being made at the last minute, which often forced Softstar to scramble to meet delivery dates. To address this problem, a clause was added to the sixth SOW that required HW Inc. to notify Softstar of changes "... in a timely manner." Although this clause did not completely solve the problem, it did serve to highlight the issue, which facilitated earlier communication to Softstar—which was typically via e-mail. Requiring that requests be made in writing, however, did not eliminate conflicting requests from customer personnel. Softstar managers therefore negotiated the addition of a problem reporting procedure in the eighth SOW, which helped define how information on technical problems or changes should be communicated. In practice Softstar sometimes accepted changes outside this process, but it did not hesitate to use these concessions as leverage in negotiations over changes to cost and schedule. Such give and take typically occurred within the same project, but the project manager at Softstar indicated two situations in which significant allowances in the preceding project were used as a negotiating point in the following project. The parties never actually went back and amended the current SOW to reflect changes, because the changes were too frequent. They did, however, try to include processes in future contracts that would limit the potential for future disputes.

Clarifying Responsibilities and Expectations

Major disagreements and conflicts arose in the first several projects concerning the roles and responsibilities of each of the parties. The first disagreements concerned the level of detail required by Softstar in order to design and deliver the products to HW Inc. The issue here was that HW Inc. wanted to include specification development as part of the deliverable, whereas Softstar's understanding was that it would provide software code written to a specification provided by HW Inc. The Softstar project manager believed that HW Inc. was

attempting to "push" specification development onto Softstar, and to otherwise "get us to do more than just write the code" (Interview, 5/28/96). To clarify this issue, clauses were added to the sixth SOW that called for HW Inc. to create a full hardware specification that spelled out minimum requirements. In the seventh SOW, a section was added that spelled out in detail the nature of the deliverables that Softstar would provide to HW Inc., including information on deliveries of source code, release notes, and so on.[7]

Conflicts over the project release schedule, which had always been problematic, became increasingly contentious. These conflicts eventually had to be "escalated to the Director level" at both Softstar and HW Inc. (Interview, 11/4/96). The schedule referred to the release dates for the alpha, beta, and final versions for each project.[8] The first attempt to deal with scheduling was to include a clause in the seventh SOW that directed the parties to negotiate a schedule immediately after the SOW was approved. This clause proved ineffective because it simply documented what the parties had already been doing, which had led to numerous conflicts over deadlines. Such a process was problematic in part because it required the parties to negotiate well into project execution, during which time managerial focus shifted away from negotiating contractual details, and onto project completion. Therefore, negotiations were little different from what they had been before the clause was included. Realizing that a different approach was needed, the parties, beginning with the eighth SOW, decided to negotiate the schedule up front, and to document it in each SOW. This structure forced the parties to determine mutually agreeable delivery dates early in the coding process, before managerial attention on scheduling was lost. The new structure also led to the inclusion of a schedule for HW Inc. to deliver test platforms to Softstar.

Having established the project release schedule, the firms then disagreed over the exact content of each release. Each successive release included additional features until the final release, which included everything. In order to meet the schedule, Softstar wanted to stagger the features and include about 50% in alpha, 75% in beta, and 100% in the final release.[9] HW Inc., however, wanted more functionality in earlier releases so it could accelerate its test schedule. To resolve this dispute, the 10th SOW not only listed the features, but also designated which features would be included in each release. Also, beginning with the 11th SOW, additional detail regarding hardware platform specifications were required from HW Inc. This enabled Softstar to have earlier access to fully functional hardware platforms, so that it could ensure that the completed system achieved the required functionality.

Planning for Contingencies

A key issue that arose during the early projects was the desire of HW Inc. for functionality that required Softstar to push the frontiers of certain technologies. When delays occurred during the projects as a result of technological problems related to these high-risk areas, HW Inc. expressed strong dissatisfaction with Softstar's performance. In an attempt to highlight the key technological challenges facing the project, the Softstar project manager inserted a "risks and concerns" section in the fifth SOW. The idea was to create a section of the SOW that listed major project risks to force the participants to think through the project and attempt to identify potential risks in advance.

Another problem that caused disputes was that HW Inc. made frequent changes to project requirements that impacted the project cost and schedule. HW Inc. assumed that minor changes should not impact price or schedule. Softstar, however, did not always agree with the designation of a change as minor and often believed that HW Inc. should share in the additional costs created by changes made after the SOW was approved. The short development times (generally about six months) made lengthy reviews of changes infeasible. To deal with this issue, a clause was added to the eighth SOW stipulating that project cost and schedule were subject to renegotiation whenever HW Inc. made a hardware change, problems were experienced with the performance of HW Inc.'s hardware platform, or HW Inc. requested additional functionality. This clause, however, was not particularly successful because it did not stipulate any guidelines for providing a new schedule or price. As a result, the ninth SOW introduced an engineering change procedure for changes required by HW Inc. after the SOW was signed. The engineering change process included an impact analysis that addressed cost and schedule impacts. As with the problem reporting process, the engineering change process was not always followed, but it provided a basis for negotiation between the parties.

Modifying the Format

The final category of changes were designed to facilitate review of the SOW prior to approval. HW Inc. had expressed frustration in the first two projects over the length of time it took Softstar to complete what HW Inc. perceived to be minor changes. To highlight key interdependencies and technological interfaces, Softstar added a system architecture section to the third SOW. This section allowed both firms to better understand how the entire product fit together and the impact to Softstar if HW Inc. made a late hardware change. The system architecture in turn allowed the firms to better deal with key technological issues ex ante, rather than to wait until Softstar discovered the problem midway through the project.[10] As with many of the other changes to the

SOWs mentioned above (e.g., adding a risk section and adding a schedule) the addition of the system architecture section was aimed at pushing the decision-making process toward the front end of the project, and at requiring HW Inc. to more carefully define their requirements earlier in the process.

Another issue related to decision making was the review of the SOW. As the relationship developed, more personnel from each firm became involved in reviewing and approving the projects. With the increase in the number of people who were peripherally involved came an increase in the review loop for both HW Inc. and Softstar. To facilitate review, the Softstar project manager added a revision history section to the fifth SOW so that all communications referencing the SOW could include the current revision level. This section prevented managers from unwittingly approving an outdated version of the document.

Other Characteristics of the Relationship

Managers and engineers reported that the relationship between Softstar and HW Inc. generally improved over time, and was driven more by its own internal dynamic than by influences outside the relationship. The parties rarely referred to the contents of the SOWs in day-to-day operations. The Softstar project managers did not report a sense of operating by rules in which each firm would jump to point out deviations from the procedures set forth in the SOWs. Rather than using the clauses in a legalistic sense, the parties tended to refer to them only when they needed to provide some give and take. For example, in one instance HW Inc. needed more time to provide an engineering platform to Softstar, but wanted Softstar to keep its final delivery date. When a clause from the SOW was mentioned, it was usually by the person who was breaking it. For example, in the case of the late engineering platform, the HW Inc. engineer called the Softstar project manager, acknowledged the agreed-on due date, and apologized for the fact that it would be late. He then asked Softstar to work overtime to complete its portion of the task according to the regular schedule. The Softstar project manager eventually agreed, but with a clear understanding that Softstar was doing HW Inc. a favor that it might redeem from HW Inc. at a later date. This kind of give and take became easier as the additional clarity in the SOWs made it clear who was asking for special consideration. In earlier projects, the parties often disagreed over whether something was standard or required special consideration.

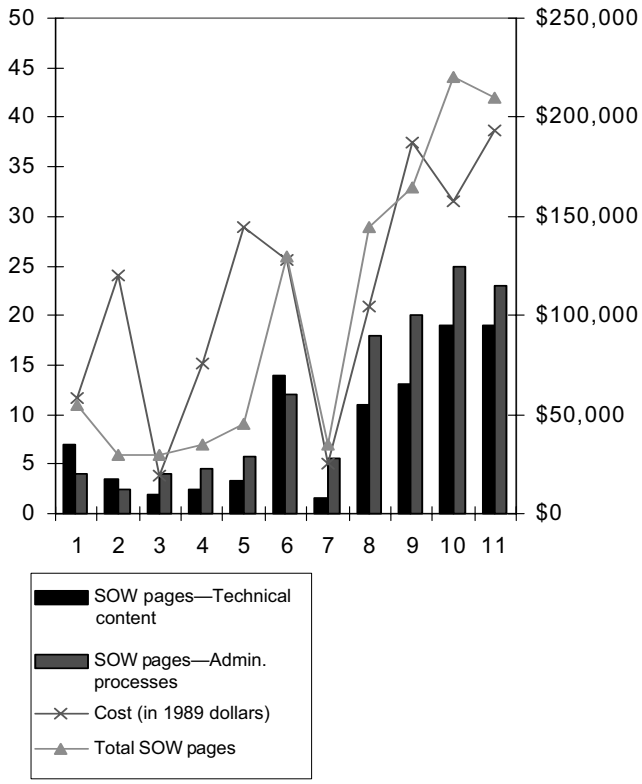
Another important feature of the Softstar–HW Inc. relationships was that the trust between the two parties appeared to grow over time. As noted earlier, work on a new project often began before the new contract was signed. Moreover, the Softstar manager in charge of the HW Inc. relationship stated in 1997 that he trusted the HW Inc. managers "more with each passing project," that he "trusts them to pay," "trusts their intentions," and feels that they "operate in good faith" (Interview, 6/19/97). Other managers and engineers shared this view, and explained that it was easier to build trust when the SOWs were more detailed because misunderstandings were avoided and agreement on expectations, roles, and responsibilities of the parties was facilitated (Interview, 6/19/97).

Finally, as the contracts' administrative structure developed there appeared to be very little reference by either party to other contracts each had with other parties, or to any influences from experiences gained from those other relationships. In part this might have been due to a lack of explicit processes and incentives for searching for and capturing any such knowledge. For example, there was no explicit component of project managers' salaries or bonuses that had any relation to sharing or acquiring knowledge from other project managers. One project manager mentioned that he had too much to do to be trying to figure out what was happening with other project managers (Interview, 5/29/96).

Summary Data

Figure 1 graphically depicts changes in a several variables related to the contracts. The horizontal axis shows the SOWs over time, from the 1st SOW in 1989 to the 11th SOW in 1997. For each SOW, the vertical axis

Figure 1 Project Size and SOW (Contract) Length



Source. Company archives.

measures project costs, the total number of SOW pages, and the pages devoted to administrative and technical matters. The latter two measures are useful indicators of the attention each category received in deliberations and negotiations between the parties.[11]

Unfortunately neither Softstar nor HW Inc. kept detailed measures of the performance of each project. We did, however, ask the project managers that we interviewed to qualitatively assess the performance of the projects in which they participated. Their assessments clearly indicated that performance increased significantly over time. Many problems were encountered during early projects, but both parties were more satisfied with the performance of the later projects (Interview, 6/19/97).

The Contracting Environment

Although the PC industry as a whole was experiencing the rising power of Microsoft and Intel, and computing efficiency continued to increase dramatically, there were no major shocks or trends that substantially influenced the contracts between Softstar and HW Inc. Softstar personnel indicated that events taking place in the broader industry had little or no effect on Softstar's bargaining power with HW Inc. or on other factors that could influence the terms of their SOWs with HW Inc. (Interview, 2/4/97). There were also no major changes regarding competitors, technological standards, or coding technology that had much of an influence on the contracts during this period.

In addition, there were relatively few changes within Softstar that influenced the contracts with HW Inc. Softstar was growing and adding new clients throughout the sample period. There was some turnover in personnel, although no more than the typical Silicon Valley firm experienced during this period. Three different project managers worked with HW Inc. over the sample period. Interviews reported relatively smooth transitions between project managers. The engineering manager who was in charge of the project managers was relatively hands off during most of the sample period.

New Policies

As noted above, Softstar did not attempt to apply any lessons from its own contracts with other partners to its contracts with HW Inc. At the very end of the period a new, more hands-on engineering manager was hired; she began to make changes that were beginning to be phased in as our data were being collected. Some of these changes were informed by the new manager's experiences in her previous job at another firm, and were aimed at creating more formal processes for sharing experiences within and between projects (Interview, 5/8/97). For example, she began calling regular meetings of the various project managers, using these meetings as forums to share status reports on customer relationships. In addition, she instituted a policy of conducting more-detailed postmortem analyses of completed projects and codifying and distributing the results of these analyses.

Theoretical Interpretations

Learning to Contract

The contractual relationship between Softstar and HW Inc. clearly falls into the category of bilateral governance (Williamson 1985). Both parties desired an ongoing supply relationship and were willing to make sustained efforts to maintain the relationship in the face of disturbances to it. Moreover, it is clear that Softstar was making significant idiosyncratic investments in the relationship. All software development for HW Inc. was completely customized to its requirements and hardware platform. Had any of the projects been cancelled before completion, Softstar's investments up to the point of cancellation would have been at risk of total loss. The contracts were not, however, life-or-death deals for Softstar. Transaction cost theory would suggest, therefore, that the degree of asset specificity was high enough to require complex contracting, but not high enough to require vertical integration (Williamson 1991). It is less clear from the data whether HW Inc. was making relationship-specific investments, but HW Inc. would have experienced costs associated with delays in switching to another supplier.

The interview data show how the structures of the contracts changed over time as the parties gained experience working together. In particular, as disagreements and problems arose in the context of one project, adjustments would be made in contracts negotiated for subsequent projects. Thus the primary driver for change was not potential problems, but actual problems that the parties encountered during projects. The changes did not always follow in the next SOW, but severe or persistent problems were eventually incorporated into the SOWs for future projects. These adjustments were made with the precise aim of preventing similar disputes from arising in the future, or to provide a contractual basis for resolving such disputes. The interview data thus strongly suggest a pattern of learning to contract.

The interview data also suggest that the Softstar–HW Inc. relationship involved different but related types of learning beyond learning how to write effective contracts per se. Indeed, one reason why the changes to the contracts are so theoretically interesting is because they reflect the learning that was going on in the broader relationship between the two firms. For example, as the relationship progressed the two firms gradually learned how each other operated (their internal organization structures, decision-making styles, and so on). This knowledge enabled them to eventually incorporate contract terms that took such factors into account. The single-point-of-contact clause added in the ninth SOW is an

example of this type of learning. Other added clauses reflected learning about how to work together that was relatively independent of the internal decision-making structures of each partner. Some of the project scheduling clauses added in the seventh and eighth SOWs might reflect this type of learning. It seems clear, therefore, that the relationship between learning to contract and learning to collaborate was very close in this case. The firms, thus, could not learn to contract with each other without also learning how to work with each other.

The character and speed with which the parties learned how to contract is also of particular theoretical interest. As the relationship proceeded over the period, the parties did not make serious efforts to anticipate how future contingencies could disturb the relationship—or at least they failed to gauge the probability or severity of the disturbances that did eventually arise. For example, the early contracts did not include terms aimed at mitigating problematic consequences of such disturbances. These contracts did not provide for any dispute resolution procedures, or even much basis or guidance for negotiating such resolutions, despite the fact that at least one party (Softstar) was about to make nontrivial relationship-specific investments. Even more significantly, however, the major disputes over specification development responsibility during the first and second SOWs, although they had important ramifications for the distribution of project costs between the parties, did not lead them to immediately develop something close to the optimal contract to address a wider range of such contingencies (say, in the third SOW). It would appear that the early disputes did not stimulate contemplation of, or at least serious efforts to deal with, a broader range of possible future contingencies, and incentive misalignments to which they might give rise. The parties did not, for example, make provision for the disturbances over release scheduling and content, change definitions, and so on that arose in later contracts. If such disturbances were considered at all, the probability of their occurrence, or the severity of their effects, was underestimated. And once again, as these later disputes arose, subsequent contract terms were devised to address them only ex post. At no time during the design of each of the 11 contracts did the parties attempt to arrive at a relatively inclusive and stable set of administrative procedures for governing similar projects in the future.

Moreover, even after adding contract terms aimed at better incentive alignment, dispute prevention, and dispute resolution, the parties were sometimes unable to anticipate problematic side effects of these terms, and had to further adjust them in subsequent contracts. For example, disputes led to the addition of simple terms calling for renegotiation when engineering changes were required. But these terms proved inadequate, and explicit engineering change procedures had to be added, although these did not emerge in full form until the ninth SOW.

In essence, then, the parties proceeded quite gradually and incrementally during the contracting sequence, responding to disputes one by one. Although each new contract negotiation provided an opportunity to attempt a more inclusive contracting approach, only after actually experiencing a dispute did the parties attempt to address it in later contracts. Indeed, major modifications to the governance features of the contracts were being made as many as nine years after the relationship began. This slow, incremental learning process thus bears a closer resemblance to processes described in evolutionary theories of organizational learning (Nelson and Winter 1982) and behavioral theories (Cyert and March 1963) than it does to the kind of foresighted contracting contemplated in transaction cost theory. Indeed, the learning process in the Softstar–HW Inc. relationship seems well described by Cyert and March's (1963) notion of "problemistic search," in which learning is motivated by the search for solutions to immediate problems, rather than by long-term planning needs. Thus, the organizations tended to limit search to "the neighborhood of the problem symptom" (p. 122) as "they moved from one crisis to another" (p. 102).

One reason for the incremental nature of the learning might have been the perceived success of the projects. Managers explained that despite the problems that arose during the execution of the projects, most projects were considered to have been moderately successful. Starbuck and Hedberg (2001) argue that successful outcomes often cause managers to be reluctant to embrace significant changes for fear of creating a worse outcome. Although moderate levels of failure can draw attention to potential problems (Sitkin 1992), they might not generate a sufficient level of urgency to overcome organizational inertia, which acts to delay or even counteract problem solving (Hedberg 1981).

A second explanation for the incremental nature of learning offered by interviewees is that the engineers who managed these contractual relationships for Softstar faced a variety of challenges in their daily jobs that prevented them from taking the time to plan for the future. In particular, the engineers were under strong time pressure to meet the technical challenges involved in the projects, and to complete the development work in a timely way. Projects were occurring in quick succession, as HW Inc. raced to introduce new computer products into a market in which product life cycles were very short. As a result, engineers reported allocating less of their attention to the organizational and contracting issues. In addition, the Softstar project manager in charge of the HW Inc. relationship indicated that Softstar was usually understaffed due to strong growth. Engineers worked hard to keep things going on a daily basis, and therefore had little time to reflect about future contract contingencies or which of the possible problems was most likely to occur. This implies that the farsightedness assumption that transaction cost economics

employs might not always hold for resource-constrained firms operating in high-velocity environments.

Lack of Knowledge Spillovers

The interview data suggest that the source of the learning was almost entirely internal to the contractual relationship. Managers absolutely did not report, for example, that either Softstar or HW Inc. learned about potential contingencies or their management from their contractual relationships with other contractual partners. The Softstar project manager clearly indicated, for example, that HW Inc.'s role in bringing new knowledge to the contracting process from experience with other suppliers was almost nonexistent. Even more surprising, it appears from the interview data that, until the very end of the period, project managers within Softstar were not sharing their contracting experiences with each other, at least not in extensive, formal ways. The data indicate that at the end of period the new engineering manager was making efforts aimed specifically at promoting more intrafirm learning of this kind. Thus, the interview data suggest that in the absence of explicit policies aimed at stimulating managers and engineers to learn from other contracting experiences, such learning might not happen at all. Finally, managers and engineers also reported having little time to attend industry association meetings in which contracting knowledge might be shared across firms.

This finding regarding the lack of effort to capture knowledge spillovers might be somewhat surprising. Managers explained this lack of effort as resulting from the extreme time pressures they faced in striving to complete complex software development projects on time and within budget. Another possibility is that the parties expected the learning to be mostly local and partner specific, and therefore not very applicable across relationships. Zollo et al. (2002) find, for example, that more partner-specific experience was associated with better alliance performance in their sample. Similarly, Gulati (1995) argues that more partner-specific experience increases partner-specific trust, which again would limit the utility of learning from different contractual partners. Moreover, the fact that software development remained relatively ad hoc at Softstar (and at most other firms; see Cusumano 1992), with few standardized procedures, probably made wide applicability of contracting experiences more difficult. We discuss other, related effects of this feature of software development on learning to contract in the next section.

Learning: Communication, Codification, and Governance

As suggested in the interview data, provisions were added to the contracts between Softstar and HW Inc. for purposes of communication, codification, and governance. With regard to communication, provisions required written notification of engineering changes, project scheduling, and disclosure of information about system interactions, and the like. These additions were aimed at achieving better information flow between the parties to avoid coordination failures and other honest mistakes due to miscommunication. With regard to codification, the SOWs served to record lessons from previous experiences in the relationship, and did so in a single document that was the guiding reference for dealing with uncertainties or disputes between the parties. Such codification helped avoid ambiguity, and prevented organizational forgetting (Argote 1999).

With regard to governance, several provisions were added that were clearly aimed at preventing behavior that was self-interested, if not opportunistic. For example, provisions requiring complete specification were clearly added to deal with what were perceived by Softstar managers to be self-interested attempts by HW Inc., to shift project costs onto Softstar. Similarly, after the written notification provisions were added in the third SOW, further timeliness requirements were added in the sixth SOW to respond to delays caused by a perceived lack of effort by HW Inc. Many provisions no doubt served governance, production, and communication purposes simultaneously, such as those concerning project scheduling (aimed at both avoiding hold-up and communicating plans), and those defining major and minor engineering changes (aimed at reaching common understanding and avoiding self-serving definitions).

Although it is difficult to separate the relative importance of governance, communication, and codification in the Softstar–HW Inc. contracts empirically, it appears, consistent with transaction cost theory, that the governance functions were quite important. We draw this conclusion because it would seem that the information and administrative procedures that were written into the contracts could easily have been communicated and codified in other ways. For example, the parties could have communicated face to face more frequently or for longer periods. They also could have developed a single legally nonbinding document file to which each could refer when questions of procedure arose. The fact that the parties insisted on incorporating all the administrative procedures into a legally binding contract suggests that the parties were concerned with defining the transaction carefully in order to reduce the potential for opportunistic interpretation of the contract.

Alternative Explanations

Transaction cost theory might suggest an alternative explanation for the pattern of contracting observed—one that does not rely at all on learning effects. For example, it is clear from Figure 1 that the contracts struck between Softstar and HW, Inc. tended to become longer over time, as contract terms and conditions were gradually added. This lengthening tendency was not a

smooth one, but was established clearly by the seventh SOW. Figure 1 also shows that total project cost began to increase monotonically by the seventh SOW. Recall that, because each software development project undertaken for HW Inc. was completely customized, total project cost is highly correlated with the degree of asset specificity in the transaction. Therefore, a plausible alternative explanation for the expansion of contract terms aimed at preventing and resolving disputes is that Softstar (and possibly HW Inc.) had an increasing amount of relationship-specific investment (i.e., the development cost of the project) at risk of expropriation through hold-up. Under this explanation, the contracts were lengthened only when the level of relationship-specific investment reached a minimum threshold, such that the parties became willing to spend more time and attention on contract design.[12]

This alternative explanation, however, cannot completely explain away the learning effects. First, as Figure 1 shows, the close association between total project cost and total number of SOW pages covering administrative procedures only begins at the seventh SOW. For the first through sixth SOWs this association does not exist. Therefore, the importance of learning effects during at least the first three years of the contractual relationship cannot be ruled out with this alternative explanation, although it might carry explanatory value for later contracts. Second, this explanation does not take into account the interview data, which indicate a learning process through the 11th SOW. Even if engineers only turned their attention to contract development when they thought it worthwhile, recall that they still often failed to identify a satisfactory remedy for a problem the first time it occurred. Indeed, they occasionally failed multiple times before arriving at an acceptable solution.

A related explanation might focus on specific investments related to how to work together, rather than to the product-related investment. Early in the relationship, little other than the current project was at risk. However, once the parties invested in processes to work together effectively—processes that might have been partly partner specific—a disturbance leading to the termination of the relationship would have carried a much higher cost. This is because the investments in the relationship itself would have been lost. Whereas this consideration might have been a factor, it does not receive strong support from the interview data, nor can it explain the link between problems in one SOW and clauses to deal with that specific issue in later SOWs. This alternative explanation implies that the firms were anticipating contingencies in the new contracts, whereas the interview data suggest that the parties were actually reacting to past contingencies in writing those contracts. Moreover, these reactions continued to be incremental, and sometimes ineffective, even late in the relationship.

It is also important to note that communication considerations alone do not explain the increases in contract length observed. Such considerations might suggest that longer, more-detailed contracts were caused by increases in the complexity of the projects, because more-complex projects require more communication procedures in order to solve more-difficult coordination problems. However, although it is the case that the parties were undertaking increasingly larger projects that required more product features, the fact that the administrative sections of the SOWs, which dealt with processes and responsibilities, were growing faster than the sections of the SOW that dealt with technical requirements is evidence that learning and governance considerations were also important.

In addition, if complexity alone was driving the changes to the SOWs, then the addition of new contractual clauses would have been driven by communication challenges in contemporaneous transactions, and perhaps by the anticipation of increasing complexity in future transactions. The interview data demonstrate, however, that new clauses were specifically responses to problems in earlier contracts. Although it is likely that complexity played a role in affecting the evolution of contractual provisions (especially in the 8th through 11th SOWs) learning and governance considerations were evidently important driving forces in this evolution.

Implications for Theory Development

Contracts as Knowledge Repositories

One of the key findings from our study of the Softstar–HW Inc. relationship is that over time the contracts between them came to serve as repositories of knowledge about how to efficiently work with each other. As the parties worked together over the years, they encountered problems and challenges that were not addressed in the contract that prevailed at the time. As these collaboration problems were resolved, the solutions were gradually incorporated into later contracts, such that these later contracts came to codify the parties' knowledge about efficient ways to collaborate. Thus, the written contracts enabled later projects to benefit from experiences gained in earlier collaborations, thereby improving the performance of those later collaborations.

Traditional views about the role of contracts in the economic, sociological, and legal literatures have not paid much attention to this possible role of contracts as knowledge repositories. As mentioned above, economic theories of contracting such as transaction cost economics have paid scant attention to learning in general. Sociology-based views of contracting have also been focused elsewhere. As noted earlier, many organizational scholars have tended to downplay the importance of contracts and related formal structures in facilitating economic exchanges, emphasizing instead the roles of trust

and social ties in exchange processes (e.g., Macaulay 1963, Larson 1992, Ghoshal and Moran 1996, Uzzi 1997). As a result, the attention of organizational scholars has not been focused on contracting processes in general, and therefore has not been focused on processes of learning to contract.

Traditional legal scholarship on contracting has also not focused on processes of learning to contract. Such scholarship has been highly influenced by Llewellyn's (1931) classic work, in which he advances the concept of a contract as a flexible framework of yielding rules, rather than iron rules for managing commercial relationships. This view stands in contrast to previous emphases on the legalistic contract forms and black letter contract law. Llewellyn explains that many key provisions of business contracts are relatively open ended, vague, or of dubious legal enforceability in order to allow parties the flexibility they need to get the job done with as little recourse to the courts as possible (so-called private ordering). Macneil (1974, 1978) also takes this view of contract as framework, developing the distinction between transactional and relational modes of contracting.

This tradition of legal scholarship emphasizes the role of contracts as frameworks whose provisions are flexible to changes in circumstances as the underlying relationship moves forward in time. This approach certainly appears applicable to the contracting relationship studied in this paper; it does not, however, address the key phenomenon of interest here. That phenomenon is the addition of entirely new provisions, and the transformation of older ones, as a commercial relationship develops through a series of relatively short-term contracts—where these new provisions are aimed at preventing conflict in the exchange process.[13] Our findings therefore imply that it might be fruitful for organizational scholars to broaden views of the role of contracts as flexible frameworks or governance structures, to include a notion of contracts as knowledge repositories—in at least some sets of circumstances. We describe some of these circumstances below.

The role of contracts as repositories of organizational knowledge has also not been fully appreciated in evolutionary economics, although it is quite consistent with theories in that tradition. Evolutionary economics has tended to focus on intraorganizational routines as the main locus of firm capabilities (Nelson and Winter 1982), although scholars have recently emphasized interorganizational routines as another possible locus of organizational knowledge. Dyer and Singh (1998) argue that knowledge-sharing routines are one form of relationship-specific capital on which parties can earn relational rents from an alliance. Contracting processes, our evidence suggests, might in some instances serve to help develop and codify such knowledge-sharing routines. Moreover, it is well-established that transferring knowledge within or between organizations often requires at least some codification (e.g., Nonaka and Takeuchi 1995). By providing a means for this to occur, contracting processes could facilitate the development of such relational capital, in the form of a collaboration capability. Zollo and Winter (2002) discuss the codification of organizational knowledge as a critical step in the creation of firm-level capabilities in general. Kale et al. (2002) find that firms possessing an alliance capability have better success with alliances than firms that do not.

When Contracts Might Become Knowledge Repositories

When are contracts most likely to play this role as knowledge repositories? It is still early in this line of research to attempt to state a definitive set of conditions, but the fieldwork does suggest some possibilities. One of these is technological uncertainty. It is clear from the descriptions above that the managers and engineers in question were dealing with very high levels of technological uncertainty. One source of such uncertainty involves the management or technical processes. During much of the period in question, there were still few techniques, routines, and guidelines established for managing software development projects in general (Cusumano 1992). The production process for software remained highly individualistic, which frustrated attempts to capture economies of scale. The difficulty Softstar was having capturing such economies by developing code-reuse techniques illustrates the relatively immature state of software development management practices. Moreover, the category of customized software products produced by Softstar was less than 10 years old. This uncertainty about management or technical processes made it especially difficult for managers and engineers to anticipate the kinds of problems and disagreements that would come up during development processes and to identify procedures that would be effective in preventing them. Even if an array of potential problems could be foreseen, identifying those that were most likely to occur was problematic. This suggests that the role of contracts as knowledge repositories will be a more important one for transactions involving complex and innovative goods or services that are customized than for transactions involving simpler goods or services whose underlying technology is well understood.

A second possible condition for contracts to serve as knowledge repositories is when there is an important interaction between technological uncertainty and technological interdependence. In the early personal computer industry there was significant uncertainty as to the kinds of innovative code that would control client hardware in desired ways; that is, there were uncertainties regarding the technical relationships between the software and the hardware. These uncertainties regarding

compatibility were exacerbated by the fact that HW Inc. was innovating its hardware systems. Therefore, it was especially difficult for the parties to anticipate the kinds of engineering changes that might be required as projects proceeded, and to develop effective engineering change procedures and specification requirements descriptions until some experience had been acquired. Thus, the need for precise compatibility with the buyer's product, and the innovative nature of that product, combined to make learning to contract especially important. This suggests that the role of contracts as knowledge repositories is likely to be more important when the industry for which the contracted products or services will be produced is characterized by rapid and fundamental technological innovation, and when compatibility requirements are high between the buyer's and the supplier's technology.

It is important to note that these conditions for contracts to act as knowledge repositories—technological uncertainty, complexity, and interdependence—are conditions that, if extreme enough, would, according to transaction cost theory, require vertical integration rather than contracts (Williamson 1985, Teece 1984). Our suggestion is that when these conditions are present but not extreme the transactions in question can be handled with complex contracts (consistent with Williamson 1991) and that it is in these circumstances that contracts are most likely to serve as knowledge repositories.

Another important question regarding contracts as knowledge repositories concerns who was doing the learning. For whom were the contracts acting as knowledge repositories? It is clear from the data that collaboration knowledge that was codified in the SOWs was primarily accessed by the engineers and managers working on the Softstar–HW Inc. projects. This is because the engineers involved in day-to-day operations governed by the SOW were the negotiators of those SOWs, and they largely excluded lawyers from this part of the contracting process. Indeed, the knowledge about how to contract that was codified in the stream of contracts to a significant extent substituted for contracting knowledge typically held by attorneys.

In part this substitution occurred because the engineers and managers were focused on creating an agreement that would allow them to begin the project quickly, and would preserve a good working relationship between the parties. Lawyers, on the other hand, would likely have focused on identifying hypothetical contingencies that might arise in order to minimize the chances of litigation against their clients. Engineers and managers, however, often see such hypothesizing as potentially harmful to a business relationship (Macaulay 1963). In this case they preferred to actually experience an adverse contingency before addressing it in a contract. Although it is difficult to know exactly how the Softstar–HW Inc. relationship might have evolved differently had lawyers been involved in SOW negotiations, it seems clear that the contracts would not have functioned as knowledge repositories in the same way. For example, the contracts likely would have been longer and more formalistic from the start of the relationship, and would have played less of a role in codifying the lessons from actual experiences.

Effects of Contracts on Trust

The interview data in this study also have implications for the debates about the effects of contracts on trust. Many scholars have argued that trust and contracts are substitutes for one another (e.g., Macaulay 1963, Larson 1992, Uzzi 1997, Dyer and Singh 1998), and increasingly so as a relationship develops (Ring and Van de Ven 1994, Gulati 1995). For example, because one partner to an exchange will trust the other only if she perceives that she is trusted by the other, and because the introduction of formal contractual modes is taken as a signal of lack of trust by these partners, contracts drive out trust. Conversely, the presence of trust is said to obviate the need for contracts, because each partner already expects the other will fulfill her promises. Malhotra and Murnighan (2002) find experimental evidence for this negative effect of contracts on trust. Other scholars argue that, to the contrary, contracts can enhance trust (e.g., Sitkin 1992, Lorenz 1999, Poppo and Zenger 2002). According to this view, contracts improve trust because the contracting process promotes expectations of cooperation and generates commitment to the relationship. Poppo and Zenger (2002) find empirical support for a positive effect of contracts on trust in survey data.

Our field data show that the governance portions of the contracts between Softstar and HW Inc. lengthened over time, but that trust between them did not appear to decline. One piece of evidence for the latter is that, as noted above, once an SOW was agreed to on principle, work often began before the SOW was formally signed and therefore became legally binding. Hence, some investment was put at risk of hold-up (by refusal to pay, for example). This practice continued throughout the relationship, and suggests some trust on the part of Softstar. As discussed above, managers and engineers reported increases in trust as the relationship proceeded, in part because the contracting process helped to clarify each party's roles and responsibilities over time. On a more speculative level, we suggest a related but distinct behavioral mechanism that might have been operating to increase trust over time: the positive atmosphere created by joint learning. The process of learning how to collaborate seemed to foster a trusting spirit on both sides. Thus, while in some circumstances the forces causing contracts to drive out trust might be overwhelming, this research suggests that mutual understanding of roles and expectations, and possibly joint learning, can contribute to a positive effect of contracts on trust.

Conclusion

This paper uncovers and describes processes of learning to contract in a context where contracts played an important role in governing an interfirm relationship. We find strong effects of learning to contract in the data that have characteristics more consistent with behavioral and evolutionary theories of organizational learning than with transaction cost theory. We do find, however, that the learning effects occurred in directions consistent with those predicted by transaction cost theory. Finally, we find that contracts played an important role as repositories of knowledge about how to collaborate and contract in the relationship we studied—a role that is not fully appreciated in important notions of contract in law, sociology, or economics.

Our findings also suggest that, in contexts characterized by high technological uncertainty and tight resource constraints, firms might enter contracts with rationality that is more bounded than transaction cost theory assumes. Moreover, managers cannot always expect to rely on extended foresight to reach an optimal level of contractual completeness early in their contractual relationships. Instead, they sometimes must be prepared to respond to contingencies and learn how to address them contractually as the relationship unfolds. This implies that in such contexts ongoing management, including frequent evaluations of past contracting experiences, might be critical in moving parties toward efficient contracts. An important area for future research, therefore, is to gain a better understanding of the costs involved in performing contingency planning early in a contractual relationship and the precise sources of these costs.

Early contingency planning, on the one hand, might cause excess haggling costs that are not recouped later in the form of dispute prevention or resolution. It also might inhibit the development of trust. On the other hand, perhaps the sheer cognitive demands of such planning are too large in many contexts. One related possibility is that the actual experience of an adverse contractual contingency might be required in some circumstances in order for the value of certain kinds of contract terms to be appreciated by the parties, or for their presence in a contract to become effective. Because firms' approaches to contracting could differ significantly depending on the relative importance of these various possible sources of planning costs, a better understanding of them has the potential to improve the management of alliances and buyer-supplier relationships. For example, a better understanding of learning processes in contracting might have been useful in helping U.S. auto assemblers avoid some of the costs associated with replacing short-term relationships with many suppliers, with long-term relationships with a few suppliers (e.g., Dyer and Ouchi 1993, Sako and Helper 1998, Vlasic and Stertz 2001).

Finally, our study carries some potential implications for the classic make-or-buy decision studied by transaction cost and other theories. Recall that managers and engineers reported very few positive spillovers of contracting knowledge across Softstar's contracts with various customers, but that at the end of our study period a new manager began initiatives to facilitate such spillovers. This suggests that with sufficient resources, intent, and time, firms might be able to build up their firm-level contract design capabilities, and that firms might differ in their levels of such capabilities (Argyres and Mayer 2004). If so, then firms with superior contract design capabilities might be quicker to use the market to organize the marginal transaction—i.e., the transaction whose asset specificity level is close to the point at which the firm is just indifferent between make and buy according to transaction cost theory. By contrast, firms with weaker contract design capabilities might tend to internalize those same marginal transactions. We look forward to more research into the role of contracting capabilities in strategy and organization.

Acknowledgments

The authors thank the engineers and managers who gave generously of their time for this research. They also thank Erin Anderson, Michael Jacobides, Joe Mahoney, Tarun Khanna, Jackson Nickerson; and seminar participants at Carnegie Mellon University, MIT, and the Academy of Management for many helpful comments.

Endnotes

[1]Doz's (1996) study includes an investigation of how alliance partners learned to work together over time ("process learning") but does not investigate the role of contracting in these processes.

[2]This is not to say that the contractual structures in these industries remained completely stable over long periods. For example, as noted in this literature, contract structures are affected by changes in government regulation (e.g., Masten and Crocker 1985). Nevertheless, whether and how firms learn to contract (even in the face of changes in regulation, for example) has not been a focus of this literature.

[3]A third type of governance, trilateral governance, is argued to be appropriate for nonrecurrent transactions in which some asset specificity is present. This form of governance makes use of outside arbitration. Because this paper is concerned with the governance of recurrent transactions, it does not treat trilateral governance.

[4]Unified governance is said to uniquely possess features that (at a cost) prevent opportunistic behavior such as hold-up—namely, the availability of fiat as a last resort, and relief from court ordering (Williamson 1991).

[5]By examining data from more than one relationship, we were able to verify Softstar's claim that its contractual relationship with HW Inc. was generally similar to its relationships with other customers.

[6]Our notes from the interviews and contract examinations are available on request.

[7]Softstar maintained ownership to all code they developed, but granted a license to HW Inc. that was exclusive for a certain period of time (generally six to nine months), and then allowed

Softstar to license features developed for HW Inc. to other customers.

[8]There were occasionally other interim releases if required by HW Inc. All releases were to be included in the project schedule.

[9]Disputes were not limited to the percentage of functionality. Disputes also arose about which features to include.

[10]The changes described in the "modifying the format" category were not directly related to how Softstar and HW Inc. interacted during the execution of the project, nor did these changes significantly influence the overall structure of the SOW (other than adding the architecture section). Of the four types of changes described above, these changes were considered by all parties involved to be the least significant because they were less related to the ongoing interaction of the parties and involved only minor structural changes to the SOWs.

[11]Note that the seventh SOW was an outlier to some degree. This was a small project that emerged as a last-minute spin-off from the sixth SOW, but was nevertheless independent of other projects. For these reasons, it did not conform to the trend of longer SOWs that began with the sixth project.

[12]Another explanation is that Softstar's bargaining power over HW Inc. increased over time, independent of levels of specific investment, allowing it to gradually wring better terms for itself at HW Inc.'s expense. As noted above, we did not find evidence for this explanation. For example, the evidence suggests that both parties tended to see the major contract changes as ultimately enhancing the joint value of the relationship. Thus, while bargaining power might have had an effect that we did not detect, it is highly doubtful that this effect was strong enough to overwhelm the learning effects we did observe.

[13]We thank an anonymous reviewer for encouraging us to think along these lines.

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