4 ORGANIZATIONAL PARTNERSHIPS AND THE VIRTUAL CORPORATION

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Organizations are transforming their relationships with their business partners. For example, instead of playing off dozens or even hundreds of competing suppliers against each other, many firms are finding it more profitable to work closely with only a small number of "partners". While these firms generally increase their amount of outsourcing, by focusing on a small number of partners they create value networks that are often referred to as "value-added-partnerships", "virtual organizations" or "modular corporations". In this work we explore some causes and consequences of this transformation. We apply the economic theory of incomplete contracts to study the optimal number of business partners, with particular attention to the role of information technology. Surprisingly, we find that organizations will often maximize profits by limiting their options and reducing their own bargaining power. This may seem paradoxical in an age of cheap communications costs and aggressive competition. However, unlike earlier studies that focused on coordination costs, we focus on the critical importance of providing incentives for business partners. Our results spring from the need to make it worthwhile for business partners to invest in "non-contractibles" like innovation, responsiveness and information sharing. Such incentives will be stronger when the number of competing partners is small. The findings of the theoretical models appear to be consistent with observations from empirical research which highlight the key role of information technology in enabling this transformation.

1. Introduction

The relationship between information technology (IT) and economic organization can be quite complex, but the emerging area of "coordination theory" is beginning to provide a foundation for theory-building and empirical validation. For instance, the hypothesis of Malone, Benjamin and Yates (Malone *et al.* 1987) that IT will lead to increased outsourcing of activities as it lowers coordination costs, has found some empirical support (Brynjolfsson *et al.* 1991). However, we are still far from a complete understanding of the organizational impacts of IT. In particular, as numerous authors have argued, IT does not

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appear to have simply increased firms' reliance on market coordination, but rather to have engendered new forms of organization such as "networks", "virtual corporations" and "value adding partnerships", which involve close links with a relatively small number of business partners (Antonelli 1988, Brynjolfsson *et al.* 1991, Johnston and Lawrence 1988). The combination of these two trends—increased outsourcing but to fewer partners—has been identified as the "move to the middle hypothesis" by Clemons and Row (Clemons and Row 1992) and Clemons, Reddi and Row (Clemons *et al.* 1993).

As Bakos and Kemerer (1992) point out, the organizational implications of IT are increasingly the focus of research at the intersection of information systems and institutional economics. In this work we study a firm's relationship with its business through a theoretical model in the institutional economics tradition, following the research direction established in our earlier work (Bakos and Brynjolfsson 1993). However, while our earlier paper addressed the impact of the number of suppliers on the social surplus and pursued the maximization of social welfare, here we adopt the perspective of a firm wishing to pursue its narrow self-interest in maximizing its profits. Unlike other research in this volume, we not directly address the question of identifying appropriate firm boundaries. Since there are a number of situations in which internal production is not a viable option, we start with the assumption that the decision to outsource has been made, and proceed to analyze the optimal strategy for a firm which must choose the number of partners it will employ. We show that looking at coordination costs alone can provide an incomplete picture; incentives must also be considered in a more complete analysis.

The remainder of this chapter presents a framework for analyzing the choice of an optimal number of business partners. Section two discusses the tradeoff between coordination costs and improved partner "fit". The third section introduces the concept of "incomplete contracts" and considers the incentive impacts of increasing the number of partners. A key result is that the need to provide incentives for non-contractible investments can limit the desirable number of business partners. The fourth section discusses the implications of this analysis, and the last section offers some concluding remarks.

2. IT, coordination costs and the number of partners

When a firm can select among many business partners, as in a market, it can typically secure a favorable cost because of production efficiencies and competition, but in the process it must incur relatively high coordination costs (Malone *et al.* 1987). On the other hand, single-partner arrangements such as hierarchies restrict the firm's choices, but the resulting tight relationship reduces search costs by eliminating the need to gather and analyze information about many potential partners. Thus the "make *vs.* buy" decision can be seen as a tradeoff between production and coordination costs. Williamson (1975), referring to Coase (1937), extends this tradeoff by pointing out that transaction costs are lower in hierarchies than in markets.

Malone, Yates and Benjamin (1987) argue that IT as it reduces coordination costs, it will facilitate a move from hierarchical arrangements and internal production to market arrangements where the firm has several business partners. For example, it has been argued that technological developments that lower buyers' search costs, such as electronic marketplaces, should increase the number of suppliers considered by a given buyer, especially in markets with differentiated products (Bakos 1991). It follows that, to the extent IT tends to lower coordination costs (Clemons and Row 1989), its wide adoption should lead to an increase in the number of suppliers for most firms, other things being equal.

It is natural to start with the premise that a firm would benefit by increasing the number of its business partners, thereby broadening the range of its choices. This number is limited by organizational and technological considerations, such as the cost of setting up a relationship, search costs and transaction costs, which can be collectively labeled "coordination costs".

It may be assumed that potential business partners offer abilities that differ in some desirable feature, such as price, product characteristics, or simply "fit". However, interacting with each partner entails a coordination cost. When doing business with a number of partners, an organization can select each time the partner that provides the best value according to its set of criteria. The optimal number of partners would then be determined by trading off the cost of coordination against the expected benefit from a wider choice of partners. A formalization of this tradeoff between coordination cost and fit, which is illustrated in Figure 1, can be found in (Bakos and Brynjolfsson 1993).

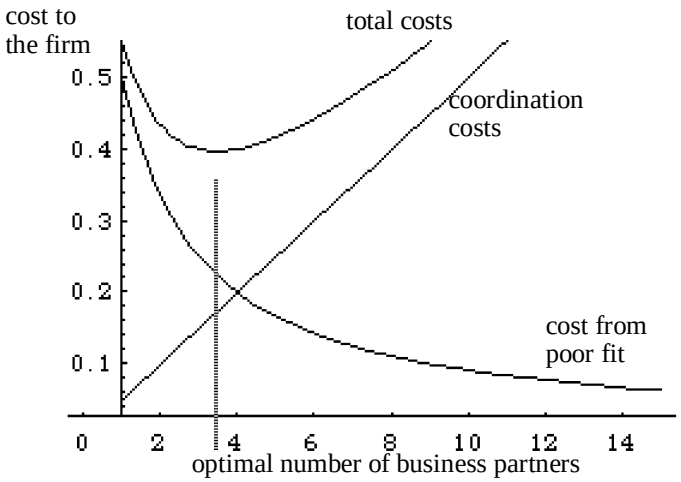

Figure 1: Balancing coordination costs and "fit"

As mentioned earlier, it is widely believed that IT lowers the costs of inter-firm coordination. Figure 2 shows the impact of lower coordination costs on the curves of Figure 1, thus illustrating how lower coordination costs should lead to an increase in the

number of business partners. This increase is driven by the lower *marginal* cost of coordination with each additional partner, and would occur even in the presence of a large set-up cost for introducing IT-based coordination mechanisms, such as electronic data interchange (EDI).

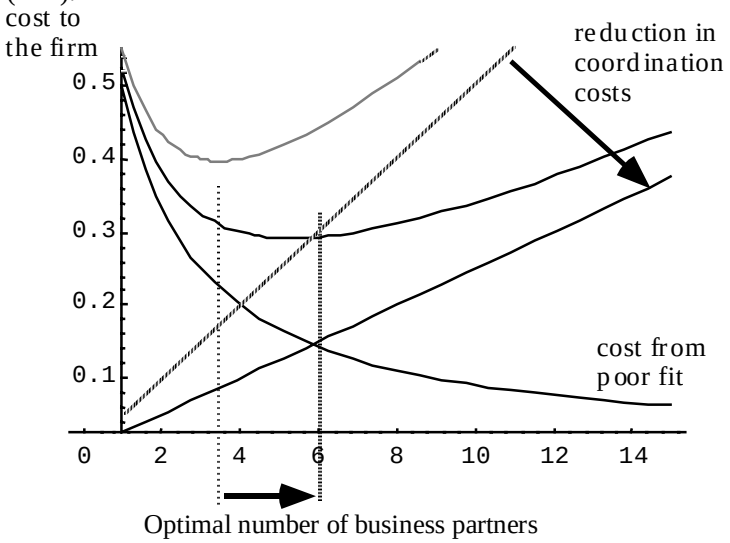

Figure 2: The effect of lower coordination costs

As firms are outsourcing more activities to external partners (Brynjolfsson *et al.* 1991, Johnston and Lawrence 1988), managing relationships with business partners becomes particularly important. There is evidence, however, that despite this increased reliance on markets, firms tend to rely on fewer business partners. For example, the average number of suppliers in the automobile industry decreased by 25% between 1983 and 1988 (Helper 1991a). In (Bakos and Brynjolfsson 1993) we reviewed evidence from a number of studies pointing to the same trend (Antonelli 1988, Cusumano and Takeishi 1991, Jarillo 1988).

A danger of relying on few business partners is the higher risk that they will behave opportunistically and hold up the firm (Klein *et al.* 1978, Williamson 1975). On balance, however, investments in IT are less likely to be relationship specific than other investments designed to reduce coordination costs between firms. As Clemons, Reddi and Row (1993) have argued, IT can reduce the specificity of investments in coordination with business partners, while simultaneously improving the ability of the firm to monitor compliance with contracts. As a result, the risk of opportunistic behavior inherent in "small numbers bargaining" situations, which involve bargaining among few parties highly dependent upon each other, can be greatly alleviated. Clemons, Reddi and Row argue that this will not only facilitate increased outsourcing, but will also enable firms to work with fewer business partners.

An alternative explanation why IT promotes tighter relationships with fewer business partners, is that it actually increases the total costs of coordination, leading to a steeper

coordination cost curve in Figure 1, and resulting in the opposite effect from that depicted in Figure 2. For example, if the adoption of IT requires firms to make larger fixed technological and organizational investments to communicate with each business partner, firms will in turn do business with fewer partners to economize on these coordination costs. Similarly, if investments in electronic integration are specific to a particular business partner, and thus are not transferable to new relationships, they create switching costs, which in turn limit the number of business partners employed over a period of time.

In the aerospace industry, for example, Boeing is promoting tightly coupled relationships with its suppliers in developing the 777 aircraft, to deal with the extraordinary complexity of the project, while reducing costs and the length of the development period. This has required Boeing and several of its suppliers to adopt the same computer-aided design system (CATIA), to design procedures for the development and electronic interchange of compatible three-dimensional blueprints, and to make substantial organizational investments to promote direct communication between design teams at Boeing and the supplier firms. Such investments may tie a firm to a particular set of business partners, and may thus limit its ability to explore new potential relationships.

While arguments like these may explain why the need to invest in information technology to link with other organizations could initially reduce the number of business partners, it is widely believed that in the long run IT lowers coordination costs and switching costs (Clemons *et al.* 1993, Malone *et al.* 1987). For example, once an EDI standard has been adopted in an industry, the cost of basic electronic integration between any supplier and buyer who have implemented this standard will be relatively small. In Boeing's case, for example, adequate translation protocols exist for two-dimensional CAD drawings, and thus the setup cost of electronic integration with a potential supplier of parts which do not require three-dimensional blueprints is relatively low. Consequently any increase in transaction and coordination costs resulting from the adoption of IT is likely to be temporary. In fact, the increase in outsourcing that has been observed suggests that, on balance, there has not been an increase in transaction costs. Similarly, direct measures of most basic types of computer-aided transactions show rapid cost declines, averaging 25% per year (Brynjolfsson 1993). Overall, the theoretical and empirical evidence appears to weigh heavily on the side of *reduced* coordination costs in the past decade.

In addition to reducing coordination costs, however, IT seems to facilitate the move to fewer partners. For example, Clemons, Reddi and Row (1993) argue not only that recently there has been a "move to the middle" from both ends of the markets-hierarchies spectrum, but also that IT has been a significant driving force behind this trend. As they point out, this move to fewer partners and away from spot markets in the face of the presumed decline in coordination costs promulgated by IT, makes it important to account for factors other than coordination costs.

In fact this move to fewer partners is against some conventional wisdom. For example, according to Porter's popular "five forces" model, firms should be eager to seize the opportunity to increase the number of their business partners. In addition to potentially achieving a better fit, having more partners would reduce the potential of any one of them

to bargain aggressively. Within the confines of such a framework, the move to fewer partners seems unwise. For example, as Porter (1980) put it:

> In purchasing, then, the goal is to find mechanisms to offset or surmount these sources of suppliers' power. ... Purchases of an item can be spread among alternate suppliers in such a way as to improve the firm's bargaining position.

In this work we advance the thesis that the increasing importance of non-contractible investments by business partners, such as quality, information sharing and innovation, has forced firms to provide their partners with incentives to make these investments. As formally shown in the next section, reducing the number of partners increases their *ex post* bargaining power, and thus increases their *ex ante* incentives to make non-contractible investments specific to the particular relationship. These business partners they are less likely to act like opportunistic "contractors" who must be aggressively bargained with and monitored. While prior work in economics has emphasized the downside of "opportunism" inherent in bargaining with a small number of partners (Williamson 1975), our analysis shows how increasing the bargaining power of a firm's partners in some cases can *improve* the firm's own situation. Only a partner who can credibly insist on a share of the benefits from the relationship will make investments above and beyond the "letter" of the contract. Thus a firm who strengthens his bargaining position by "shopping around" with numerous potential partners may ironically undercut the incentives of any one of them to make non-contractible investments. It may thus be optimal for a firm to employ fewer business partners than the number allowed by the cost of coordination.

3. Combining incentives with coordination costs

Focusing exclusively on coordination costs is appropriate when the incentives of business partners are not important. However, this is not typically the case. In this section we discuss how incentive and coordination considerations can be combined in a more general model of relations with business partners. Specifically, we assume that the firm and its business partners must make relationship-specific investments which are not feasible to describe in a comprehensive contract. We continue to incorporate a fixed coordination cost associated with each potential partner, and we assume these partners have different competencies, thus giving the firm an incentive to search for the best fitting partner. For simplicity, we study these issues in a buyer-supplier setting.

Incentives and the number of business partners

Considerations discussed earlier, such as setup costs, switching costs and the risk of opportunistic behavior, are undoubtedly important in a firm's decision to work with fewer business partners and in IT's potential to affect this decision. For instance, Clemons, Reddi and Row (1993) cite examples in which buyers have used information technology to improve monitoring and to reduce the specificity of their investments, thereby decreasing their suppliers' potential for opportunistic behavior. Without taking anything away from

these explanations, our model explores a complementary explanation for the move to fewer business partners which builds on the increasingly popular idea of *cooperation* and *partnership* between firms (Henderson and Venkatraman 1990). Our approach is motivated by field studies of buyer-supplier relations which suggest that in many cases the shift to fewer partners is not driven simply by changes in economies of scale, coordination costs, asset specificity, or monitoring, but by the advantages that smaller, tighter networks of partners enjoy in non-contractible characteristics such as innovation, adoption of new technology, quality, information exchanges, trust, flexibility and responsiveness (Cusumano and Takeishi 1991, Helper 1991b, Johnston and Lawrence 1988).

Firms that make such non-contractible, relationship-specific investments must depend on the goodwill of their partners or their own *ex post* bargaining power to reap a share of the benefits created by these investments. These considerations have largely been ignored in the more formal literature on buyer-supplier relations. Notable exceptions include Clemons, Reddi and Row (Clemons *et al.* 1993) and Helper (Helper 1991a). In particular, Clemons, Reddi and Row posit that closer relationships with suppliers can lower operations risk and opportunism risk, and they go on to argue that this will be especially true as the use of IT increases. These approaches, however, do not explicitly address how to provide incentives for supplier investment and, specifically, how the number of partners affects these incentives.

This section shows how adding incentive considerations to the coordination cost considerations previously addressed helps understand the move to fewer partners. While in our earlier work we showed that reducing the number of suppliers may be socially optimal in the sense of increasing the resulting social surplus (Bakos and Brynjolfsson 1993), we now show that a firm may be driven to reduce the number of business partners it employs by its narrow self-interest. By committing to a small number of business partners, a firm can guarantee them greater *ex post* bargaining power and therefore greater *ex ante* incentives to make non-contractible investments, such as investments in innovation, responsiveness and information sharing. The increased level of these investments can more than compensate for the reduced bargaining power of the firm, which ends up being better off by keeping a smaller piece of a bigger pie.

Intuitively, if non-contractible partner investments are important, we might expect that the firm does best for some intermediate level of bargaining power, as shown in Figure 3. When the firm has no bargaining power, it won't get an adequate share of the non-contractible surplus; yet if it has all the power, then its business partners will not make any non-contractible investments, and there will be little to bargain over. This is consistent with the formal results from the model, as shown below in Figures 4 and 5.

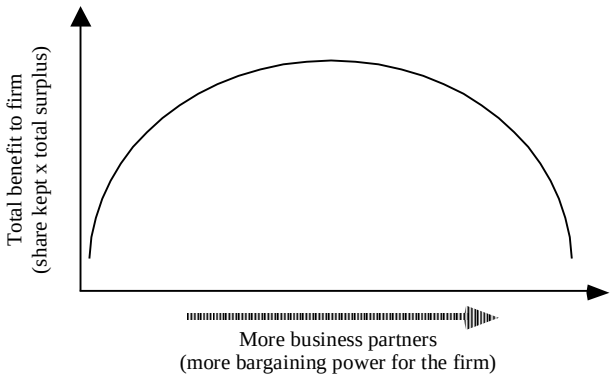

Figure 3: The tradeoff between buyer bargaining power and supplier investment.

The incomplete contracts approach

If contracts are "complete" (in the sense that they cover all possible contingencies), then the required level of investment by each party can be explicitly specified. Grossman, Hart and Moore point out that certain variables may be non-verifiable by a third party, such as a court or an arbitrator, even though they may be observed by the parties entering in the relationship, in the sense that these parties can take actions and make decisions based on the outcome of these variables (Grossman and Hart 1986, Hart and Moore 1990, Hart 1988). They term such variables as observable but non-verifiable, and suggest that parties cannot enter into a contract based on the outcome of these variables. For example when judging a supplier's effort to innovate in the developing a specific part, both the firm and the supplier may be able to observe whether adequate innovation has been realized compared to industry norms and technological developments, but it may be impossible to demonstrate this to the satisfaction of a court. Hart and Moore (Hart and Moore 1990) show that in the absence of complete contracting, optimal investment levels generally cannot be sustained and a "second-best" outcome results. Without the ability to contractually specify in advance the division of surplus from non-contractible investments, this surplus will be divided based on the *ex post* bargaining power of the parties involved. This bargaining power, in turn, will be largely determined by what alternatives each party has to the proposed division of the surplus. Based on this principle, we can analyze how changing the number of partners affects investment incentives and therefore output.

Specifically, reducing the number of suppliers employed by the buyer firm will increase the bargaining power of each remaining supplier. This will increase the share of the marginal returns on investment received by these suppliers in *ex post* bargaining and, ultimately, their *ex ante* incentives to invest in the relationship. Thus when non-contractible supplier investments are important, limiting the number of partners may be the best way to insure that they have adequate incentives to make these investments. In the remainder of

this section we present a model of buyer-supplier relationships that integrates incentive considerations with the coordination cost considerations discussed earlier.

An integrated model for the optimal number of partners

Following (Bakos and Brynjolfsson 1993), we consider a two-period setting with N risk neutral potential suppliers indexed by $i = 1, \ldots, N$. Before the first period, the buyer determines the number of suppliers from which it can purchase.[1] All suppliers possess identical technology and there are no binding capacity constraints, so the buyer can make a credible threat to shift the order to any other supplier. In the first period, each supplier i makes an investment x_i at private cost $C(x_i)$, to produce a non-contractible outcome. When the buyer uses supplier i, it creates non-contractible value $v(x_i)$. In addition to potential differences in the value of $v(x_i)$, supplier offerings also differ in a desirable product characteristic which we label "fit". Unlike the benefits from non-contractible supplier investments, the value of "fit" is contractible and provides to the buyer utility ε_i, distributed according to a known density function f_ε.

In the second period, the buyer orders from the supplier with the most desirable product characteristic, production takes place, the goods are delivered, and payments are made.[2] Assets are specific in the sense that a supplier must sell its output to the buyer to create value, and similarly the buyer must gain access to the assets of at least one supplier (e.g., by purchasing from that supplier) in order to create value. We also make the standard assumptions of increasing marginal costs and diminishing marginal returns to investment.[3]

In the absence of a contractual arrangement on sharing the profits from the non-contractible supplier investments, the surplus generated in the second period will be apportioned according the relative bargaining power of the parties involved.[4] Firms which are not easily replaced will have more bargaining power and thus will be able to garner a larger share of the surplus generated from transacting. The *ex post* bargaining power of the

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[1] For instance, it establishes an interorganizational information system with $n < N$ suppliers. We assume that the choice of n cannot be changed until after period 1.

[2] Since returns to scale are assumed constant, the buyer will always order from the most efficient supplier—the one with the highest ε_i. We assume that supplier efficiency is discovered only after a relationship has been established with that supplier, and is ex post observable by the buyer firm and all n suppliers.

[3] Formally we assume that $\frac{dC_i(x_i)}{dx_i} > 0$, $\frac{d^2C_i(x_i)}{dx_i^2} > 0$, $\frac{\partial v}{\partial x_i} > 0$ and $\frac{\partial^2 v}{\partial x_i^2} < 0$.

[4] In the parametric analysis, we follow Shapley (Shapley 1953) and assume that each firm will receive an amount equal to the value of each potential coalition less its value without the firm, multiplied by the probability that the firm will be in any given coalition. The exact rule for division of the surplus will generally have no qualitative effect on our results as long as each firm's share of output is positively correlated with its access to essential assets via coalitions with other parties.

parties will have a considerable effect on their *ex ante* incentives to invest in quality: each firm will invest until the marginal benefit it expects to receive equals the marginal cost of investment. Thus, the first order conditions for each of the *n* supplier firms are given by the *n* equations,

$$\frac{dB_i(\mathbf{x})}{dx_i} = \frac{dC(x_i)}{dx_i} \quad \text{for } i = 1, \ldots, n \quad (1)$$

where $\mathbf{x}$ is the vector of investments x_i ($i = 1,\ldots,n$) and $B_i(\mathbf{x})$ is the share of value received by firm i under investments $\mathbf{x}$. Under the above assumptions, the bargaining power of each supplier, and therefore the value received $B_i(\mathbf{x})$, is inversely related to the total number of suppliers with which the buyer contracts.[5] Thus increasing the number of suppliers will monotonically decrease their individual bargaining power, *ex post* surplus and incentives. Since reducing the incentives of any party will lead that party to invest less in the relationship, a key insight from equation (1) is that increasing the number of suppliers will reduce their non-contractible investments.

The buyer's problem in selecting the optimal number of suppliers *n* is to maximize the benefits from improved fit as the number of suppliers increases, while taking into account the negative impact on supplier incentives and the coordination costs $\kappa(n)$. More formally, the buyer is trying to maximize:

$$B(\mathbf{x}^*) - \kappa(n) + \max_{i \in \{1,2,\ldots,n\}} \varepsilon_i \quad (2)$$

where the first term captures the impact of changing incentives for non-contractible supplier investments, the second term reflects coordination costs, and the third term shows the impact of improved "fit". Increasing the number of suppliers *n* will improve "fit" (i.e., the maximum ε_i) but it will increase the coordination costs $\kappa(n)$. It will also have a negative impact on the investment incentives of the suppliers. Thus if the buyer wishes to induce significant non-contractible investments from its suppliers, according to equation (1), it must commit to buying from a relatively small number of suppliers.

This model demonstrates that a number of tradeoffs need to be made in determining the optimal number of partners. Not only must coordination costs be balanced against improved fit, but the impact of the various arrangements on incentives must also be considered. For example, if non-contractible supplier investments are unimportant, the incentive considerations suggest that the buyer should adopt the maximum feasible number of suppliers. This allows the buyer firm to maximize its bargaining power and keep most of the surplus, while no supplier will make a significant non-contractible investment. On the other hand, if non-contractible supplier investments are critical, the buyer should employ relatively few suppliers. Although the buyer will be able to keep a smaller fraction of the surplus generated, reducing the number of suppliers will induce each of them to make the

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[5] This is because adding suppliers increases the buyer's bargaining power by making it easier to threaten to shift to an alternative source. See (Bakos and Brynjolfsson 1993) for a formal derivation of this result.

requisite non-contractible investments, and thus will increase the total surplus to be divided. In other words, as the partners' non-contractible actions become more important, the optimal number of partners decreases. This will be true even if coordination costs become arbitrarily small.

Parametric example

To illustrate the model, we offer an example demonstrating how the number of suppliers affects investment incentives, assuming a production function for quality of $v(x_i) = Ax_i^{\alpha}$, where x_i is the investment of supplier *i*. The parameter *A* characterizes the importance of supplier quality: as *A* increases, supplier quality becomes relatively more important. We also include a uniformly distributed fit parameter ($f(\varepsilon) = 1$) and a constant coordination cost per supplier ($\kappa(n) = \kappa n$).

Figure 4 illustrates the relevant tradeoffs, when coordination costs are positive, for various values of *A* (larger values of *A* lead to higher curves). The figure shows how the number of suppliers that maximizes buyer surplus decreases as the importance of quality increases: the optimum when *A* is high (top curve) is at 1.5 suppliers vs. 2.6 suppliers when *A* is zero (bottom curve).

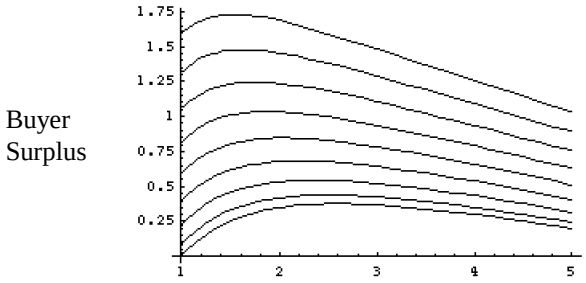

Figure 4: Coordination costs, "fit" and incentives

Figure 5 illustrates the corresponding tradeoffs when coordination costs are zero. If supplier investment is not important (bottom curve), the optimum number of suppliers is infinite. Each additional supplier slightly increases "fit", at no cost in coordination or incentives. The top curve is more interesting. It shows that the optimal number of suppliers is finite, (in this case 2) when it is important to provide incentives for non-contractible investments. The number of suppliers chosen by the buyer firm to maximize its surplus decreases as the importance of incentives increases, even with zero coordination costs.

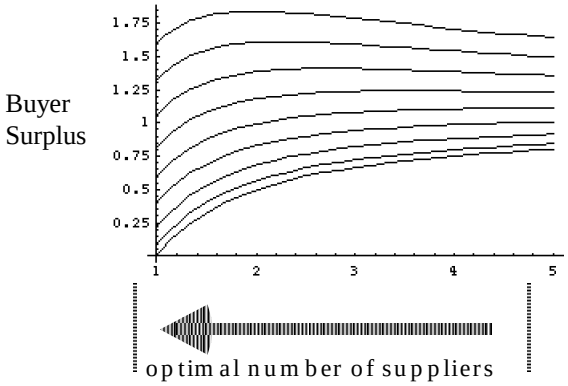

Figure 5: Optimal number of suppliers when coordination costs are eliminated

4. Discussion

Firms are increasingly relying on tightly coupled relationships with their partners in today's competitive environment, and thus require their partners to make substantial investments in these relationships. If these investments are *ex post* transferable to other equally valuable uses (i.e., if they are not specific to the relationship), or if they can be contractually specified (i.e., if they are contractible), no holdup problems arise, and thus the appropriate number of partners is determined by technological considerations, such as economies of scale and coordination costs. We saw that to the extent that information technology will decrease coordination costs, it is likely to promote the use of large numbers of partners. On the other hand, if the firm requires from its partners investments which are *ex post* specific and non-contractible, it will need to limit the number of partners employed in order to convince them that the return to their investments will not be expropriated in *ex post* bargaining. Under these circumstances, a smaller number of partners will be optimal, as shown in Table 1.

Investment characteristics	Contractible	Non-Contractible
Specific	Many	Few
Non-Specific	Many	Many

Table 1: Investment characteristics and incentive-compatible number of partners

According to our model, the emphasis on factors like quality, innovation and information sharing, and the partners' continuing effort to improve these characteristics throughout the relationship go hand-in-hand with partnering with fewer other firms. This

allows firms to increase their partner's incentives to go above and beyond the "letter of the contract". Hence the need to provide incentives for non-contractible investments means that the widespread adoption of information technology need not lead to the use of more partners.

On the other hand, as pointed out in (Bakos and Brynjolfsson 1993),

> "... reducing the number of suppliers will not always be beneficial. If there is no importance attached to non-contractible investments, then it is best to increase the number of suppliers searched until the marginal cost of search equals the expected marginal benefit from improved fit. This suggests that incentive considerations can be effectively ignored for easily specified products such as commodities. For these products, continued reductions in coordination costs should lead to an increase in the number of suppliers considered."

The well-documented evolution of the airlines' computerized reservation systems is indicative of such a situation. The non-contractible investments made by individual travel agents and airlines in each other are neither large, nor relationship specific, at least insofar as choosing a flight for a traveler is concerned. Thus, the primary impact of the technology has been to reduce search costs. Consistent with the low significance of providing incentives for non-contractible investments, reducing coordination costs has resulted in increasing the average number of suppliers (airlines) considered for each purchase (reservation). There are some emerging "electronic markets", for instance in used cars, aircraft parts, computers and certain information services, that also fit this description.

Why has the number of business partners declined in many industries?

To help understand why American firms are increasingly relying on a smaller number of partners, we conducted a series of interviews with managers on both sides of the buyer-supplier relationship. These interviews culminated in a one day workshop which was attended by approximately 30 managers from companies sponsoring MIT's Center for Coordination Science and MIT's Leaders for Manufacturing Program, as well as leading academics with interest in this area. Several managers pointed out that the general trend toward fewer partners can be explained by the increasing emphasis placed by American firms on quality, epitomized by the "Total Quality Management" theme currently popular in management circles, and by the increasing attention paid to "non-quantifiable" (i.e., non-contractible) attributes of the relationship. Although lowering coordination costs is likely to increase the reliance on market-based relationships as has been discussed elsewhere (Malone *et al.* 1987), we showed that the increased importance of non-contractible investments is likely to precipitate a move to fewer partners in order to provide the necessary investment incentives.

A leading manager at Digital Equipment Corporation pointed out that because of advances in information technology, both Digital and its partners now have far more detailed data on the projected demand for various products, the likely supplies that will be required to fulfill these needs and the potential cost savings created by various innovations or market conditions. Enormous opportunities for improved efficiency, increased flexibility and timeliness can be realized by the free sharing of this information. However, this same

information can also be used to exploit the party that provides the information, for instance by demanding lower prices whenever the supplier has found a way to reduce costs. Thus, freely sharing the information requires not only that the technical infrastructure be put in place, but also that an atmosphere of "trust" and "partnership" be created. According to our model, by reducing the number of business partners, a firm can reassure its remaining partners that it will not (indeed cannot) exploit the information they share to appropriate all the benefits of the relationship. The above example shows one way in which IT has increased the importance of investment incentives and therefore can lead to what Digital terms "supplier partnerships".

While IT is frequently associated with increased exchanges of information, it is not a necessary prerequisite. For instance, another workshop participant, Bose Corporation, has instituted a system called JIT II, in which very high bandwidth information exchanges are enabled by having supplier representatives physically located in offices at Bose, which increases their ability to share information and to learn the details of Bose's needs. As predicted by our model, this increase in non-contractible information sharing has been associated with an increased reliance on partnerships. Having fewer partners helps assure that each party receives a fair share of the benefits from their investment in the relationship, and provides a partial safeguard against opportunistic behavior that could occur if Bose could easily threaten to switch to alternative suppliers. The success of Japanese firms in maintaining high-bandwidth communication between buyers and suppliers while keeping the number of alternative suppliers low is also consistent with this interpretation.

The Digital example suggests that the reason that American firms are now adopting a model closer to the Japanese partnership (or keiretsu) approach may not be simply a belated realization of the benefits from cooperation, but may result from changes in the underlying technology of production and coordination that have increased the importance of non-contractible investments. Indeed, Milgrom and Roberts (Milgrom and Roberts 1990) provide a formal model of "modern manufacturing" in which they argue that an emphasis on "quality" is a necessary complement for the successful use of "technologically advanced equipment". Similarly, exploiting IT to rapidly respond to changing market conditions may preclude detailed contracts or work rules. For instance, IT tends to automate the more routine tasks, which are typically those which are easiest to detail in a contract, leaving behind a residue of tasks that are neither automatable, nor contractible (Brynjolfsson 1990). The result is an increased need to rely on institutional mechanisms, such as reducing the number of partners, to provide the appropriate incentives.

Furthermore, as discussed more extensively in (Bakos and Brynjolfsson 1993), "... IT has contributed to the increased importance of non-contractibles, such as speed, flexibility and responsiveness throughout the economic environment, in the process increasing the number of future scenarios that would have to considered and provided for in any comprehensive contract between a buyer and a supplier. Furthermore, we believe that IT is likely to create a relative advantage for institutional over contractual governance mechanisms. In particular, IT facilitates the tracking of a large number of variables, enabling the efficient gathering of vast amounts of data, thus creating a large number of possible future contingencies. … As a result, it has become relatively more cost-effective

for both parties to share the benefits of their relationship relying on trust and *ex post* bargaining. In such an environment, a good partner is one who does not adhere merely to the "letter of the contract," but one who does whatever reasonably needs to be done. This requires an increased reliance on the institutional incentives available to deal with incomplete contracts, such as "partnering," leading to reduced numbers of suppliers and long-term relationships. In effect, IT has lead to a situation where the technology of production has outrun our ability write contracts that keep pace."

5. Concluding Remarks

The traditional, static analyses of the relationship between a firm and its business partners have stressed coordination costs and bargaining power to the neglect of incentives and investment. They suggested that appropriate response to a reduction in coordination costs is always an increase in the number of business partners. By explicitly modeling the roles of incentives and investments, our work suggests two important caveats to previous analyses of these relationships:

- Even when information technology provides the capability to cheaply connect to more potential business partners, managers cannot ignore the incentive effects such a move will have. In particular, when providing incentives is important, working closely with a small number of business partners may be optimal, *regardless of how low coordination costs become*.
- A firm can be made worse off by undermining the bargaining power of its business partners, contrary to the standard competitive model. If a firm wants its business partners to invest in the relationship, it must guarantee them a fair share of the benefits, and sometimes this can only be done by limiting the number of alternative partners.

The ability to increase partners' incentives to make non-contractible investments by reducing their number, and thus to partially compensate for the problems of incomplete contracting, provides an alternative perspective and an additional explanation for the "move to the middle". Furthermore, while in the long run IT will help reduce the coordination costs associated with a larger number of business partners, the incentive considerations are more resistant to technological solutions, and are thus likely to remain in place for the foreseeable future. We showed that in this case, even if search and transaction costs are eliminated, it could still be optimal for a firm to limit the number of partners it does business with.

In our analysis, we have emphasized the role of IT in increasing the importance of non-contractible investments by business partners in areas such as quality, responsiveness and innovation. Although this inference is supported in our discussions with managers, it is possible that this new emphasis is unrelated to IT, and is simply due to a belated realization that these investments ultimately affect profits, or to an increasingly fierce competitive environment that makes quality a competitive necessity and forces firms to find new ways

to differentiate their products. Whatever the forces driving the increasing importance of non-contractible investments, the end result will be an increased reliance on institutional factors to provide the right incentives, as we model in section 3. This leads us to conclude that, even as technological developments continue to reduce coordination costs, the need to provide incentives for non-contractible investments will frequently limit the number of business partners.

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