

The Effects of Information Technology Investments on Contract Completeness and Buyer-Supplier Relationships

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The theory of incomplete contracting has been used to explain recent developments in buyer-supplier relationships, as modern information technology has been deployed to facilitate the coordination of activities between buyers and suppliers (Bakos and Brynjolfsson, 1993ab). Incomplete contracts arise when the contracting parties are not able to meet all conditions (Milgrom and Roberts, 1992) necessary to specify a complete contract. In contrast to previous work in this area, we argue that changes in inter-organizational information technology and telecommunications can alter the degree of completeness of a buyer's contracts with its suppliers. The degree of contract completeness can be changed through improved monitoring of supplier operations. A more complete contract with suppliers results in higher benefit for the buyer. Increases in contract completeness due to investments in inter-organizational information technology and telecommunications may result in a buyer either increasing or decreasing the number of suppliers it deals with, depending on the total cost of monitoring per contract. Increased use of information technology and telecommunication (ITT) may also reduce the coordination cost of buyer-supplier relationships (Bakos, 1991), leading to an increase in the number of suppliers the buyer chooses to do business with (Bakos and Brynjolfsson, 1993ab). The combined effect of changes in inter-organizational ITT on the number of suppliers used by a buyer could thus be positive or negative.

Bakos and Brynjolfsson (1993a) identify several factors in buyer-supplier relationships that have traditionally been considered non-contractible. These factors include quality, responsiveness, innovation and technology adoption, speed, flexibility, defect rates, trust and information exchanges. In this paper, we posit that ITT reduces the cost to monitor certain supplier operations, thus enabling a conversion of these factors from non-contractible to contractible. For example, Dumond and Newman (1990) outline five ITT-related activities that

facilitate valid due dates and supplier schedules that allow a buyer to legitimately hold a supplier accountable for delivery performance. Additional examples of this conversion with respect to product quality and responsiveness are provided below.

Product quality control often requires destructive testing of a sample of received parts. To improve quality of parts and reduce expensive destructive testing, the buyer may want the supplier to invest in improved process control. Process control, as manifested by vendor certification, involves thorough investigation of many of the factors contributing to the supplier consistently meeting buyer expectations of product quality (Lockhart and Etkin 1993). Without inter-organizational information systems, the cost to a buyer of monitoring a supplier's processes may be prohibitive, even if the supplier collects the necessary data. The introduction of inter-organizational information systems reduces the cost of monitoring contract compliance (Bakos and Brynjolfsson 1993b) and may thus convert process control as a proxy for product quality into a contractible signal.

In today's competitive environment, manufacturers increasingly have to offer their customers product variety and mass customization without increased delivery times. In order to meet these requirements, manufacturers rely on their suppliers to deliver a mix of parts in a timely manner. However, delivery performance depends on many different factors, such as finished parts inventory levels and work in process. Suppliers can track these factors inexpensively through the use of information systems. By specifying operating procedures, buyers can ensure that their suppliers are better able to deliver a dynamic mix of parts on a consistent schedule. In order to contract consistency in delivery times, the buyer has to be able to specify operational procedures and monitor the supplier's performance relative to the

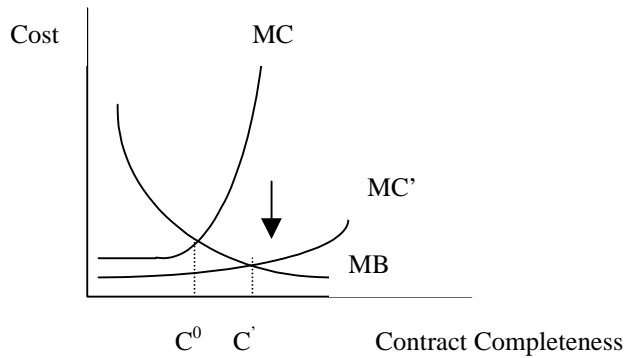


Figure 1. *ITT advances facilitate more contract completeness.*

specifications. Such monitoring is possible through the integration of information systems across organizations.

The decision problem for the buyer in this setting involves not only the selection of the appropriate number of suppliers but also selection of the identifiable and observable factors to include in the contract with each supplier. The mathematical analysis of the buyer's problem in this paper considers the optimization of the total benefit of contracting with the selected supplier using the selected monitoring signals, net of the cost of monitoring those signals. In this abstract, we present the economic intuition underlying this mathematical analysis.

Including more factors in the contract (as contractible vs. non-contractible) will increase the benefit of contracting, since the inclusion of such terms as contractible items will reduce the need to provide the supplier with incentives for the associated non-contractible supplier investments that are specific to the particular buyer-supplier relationship. Monitoring of contract terms carries with it a cost, and the buyer will include in the contract those factors for which the benefit is greater than their cost of monitoring. As argued above, certain advances in ITT reduce the unit cost of monitoring contract terms. This change in monitoring cost may change the optimal level of contract completeness and, thus, may change the total volume of monitored

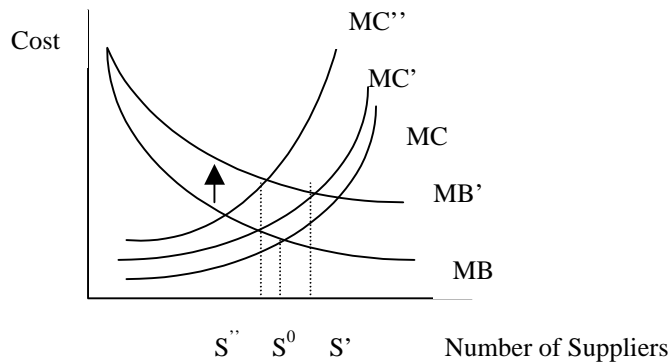


Figure 2. *Change in the number of suppliers due to more complete contracts.*

factors. See Figure 1 for a schematic illustration of an increase in the level of contract completeness due to a downward shift in the marginal cost curve following advances in ITT for any specific supplier.

The change in contract completeness may lead to an increase in the total monitoring cost of a contract (i.e., when the area under MC' is greater than the area under MC in Figure 1). However, for any fixed number of suppliers, by inducing more desirable actions by the suppliers, the optimal choice of contract detail will always result in an increase in the total net benefit of contracting when the unit monitoring cost decreases, whether there is an increase or decrease in total monitoring cost. For the purpose of illustration, the marginal cost and marginal benefit functions in Figure 1 are continuous. This is not a necessary condition for the mathematical analysis in this paper. The incremental cost and benefit when an additional term is included in the contract (if its benefit exceeds its cost) results in discrete (rather than continuous) shifts in the marginal cost and benefit functions.

If contracting is more complete due to an investment in inter-organizational ITT, the marginal benefit per supplier will increase. For any fixed number of suppliers, more contract completeness will increase the marginal benefit of the number of suppliers. Thus, in Figure 2,

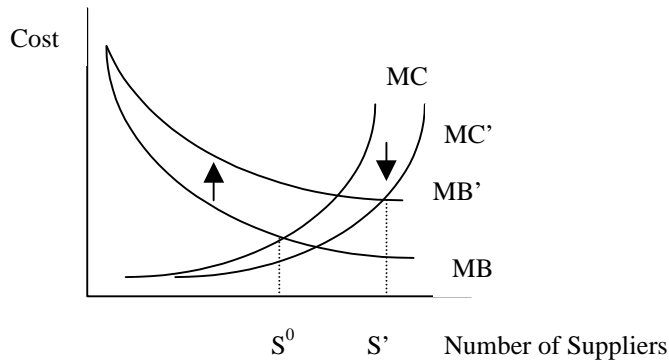


Figure 3. *Increase in the number of suppliers due to lower marginal cost.*

the marginal benefit curve MB will shift upward to MB'. Cost as a function of the number of suppliers consists of a number of factors, including coordination cost, cost of contract monitoring, cost of parts, etc. If buyers and suppliers invest in inter-organizational ITT, it may increase or decrease the total monitoring cost per supplier. However, the same investments may also change the coordination cost. The change in coordination cost is generally assumed to be negative. The combined effect of increased use of inter-organizational ITT may be either positive or negative, depending on the relative change in size of the individual cost components. If the marginal cost curve (MC) of the number of suppliers increases as a result of ITT investments, the outcome may be either a positive (S') or negative (S'') change in the number of suppliers with whom the buyer will enter into incomplete contracts, see Figure 2. If there is a downward shift of the marginal cost curve, the result will unambiguously be an increase in the number of suppliers used by the buyer, as illustrated by the point S' in Figure 3.

If the number of suppliers changes, there may be a change in the marginal benefit function of contracting in Figure 1, since the marginal benefit of contract completeness depends explicitly on the number of suppliers with which the buyer is doing business. In turn, the marginal benefit and marginal cost as a function of the number of suppliers in Figure 2 will

change. Thus, in order to find the optimal level of contracting and the optimal number of suppliers, both of these factors have to be considered simultaneously.

Summary

Changes in ITT are changing transaction costs, coordination costs, and the cost of converting previously non-contracted issues into contracted issues through post-fact observation and monitoring. Incomplete contracts are being made more complete through ITT advances. This is evidenced by the move toward supplier certification. This analysis demonstrates the impact of ITT on the number of suppliers used by a firm.

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