PRODUCTION COST, TRANSACTION COST, AND OUTSOURCING STRATEGY: A GAME THEORETIC ANALYSIS

Khai S. Lee [1]

Irene C L Ng [2]

University of Exeter

Discussion Papers in Management

Paper number 08/04

ISSN 1472-2939

[1] Associate Professor of Marketing, NUS Business School, National University of Singapore, 1 Business Link, Singapore 117592, Tel: +65 6516 3163, E-mail: bizleeks@nus.edu.sg

[2] Associate Professor of Marketing, School of Business & Economics, University of Exeter, Streatham Court, Rennes Drive, Exeter EX4 4PU, UK. Tel: +44 (0) 1392 263250, Fax: +44 (0) 1392 263242, Email: irene.ng@exeter.ac.uk

Production Cost, Transaction Cost, and Outsourcing Strategy: A Game Theoretic Analysis

ABSTRACT

This paper presents a game theoretic analysis of the impact of both production and transaction costs on the single-or-multiple source purchasing decision. Both dyadic interactions involving a buyer and a seller, and triadic interactions involving a buyer and two suppliers, are examined to gain a more precise understanding of how small number interactions might influence transaction cost. We show that transaction cost is maximized when a buyer follows a single source strategy and learning specificity is present. Only if a buyer follows a multiple source strategy that splits the supply contract in such a way as to equalize the effects of learning specificity across the suppliers, will transaction cost be maximized and will a buyer be able to appropriate the efficiency gains achieved by its suppliers. Production and transaction costs interact to influence governance decisions. The equilibrium is such that a single (multiple) source strategy is optimal when efficiency gains due to the economies of scale are large (small), but those due to learning specificity are small (large). When both the effects of economies of scale and learning specificity are large, internalization is the optimal strategy.

Key words: *Transaction Cost Economics, Game Theory, Small Numbers Interactions, Learning Specificity, Economies of Scale.*

INTRODUCTION

Purchasing managers often face the question of whether to purchase its materials from single or multiple suppliers. Research has shown that there are several advantages and disadvantages in following a single source strategy as compared to a multiple source strategy (e.g., Treleven, 1987; Segal, 1989; Presutti, 1992; Leavy 1994; Wilson, 1994). The common argument for a single source strategy is that it capitalizes on the economies of scale in bulk purchasing, and in the long run, a close exchange relationship develops, which is mutually beneficial to both buyers and suppliers. Hence, parties to an exchange relationship have been advised to forgo individual short-term gains, and to take a long-term perspective in following a single source strategy. However, such arguments implicitly assume that when parties are engaged in long-term dyadic exchange relationship, an equitable sharing of the efficiency gains would result. This ignores opportunistic behaviors by contracting parties and appropriable quasi rents which could arise in exchange relationships, especially when transaction specific assets are present (Klein, Crawford and Alchian, 1978).

Once a buyer is locked into an exchange relationship with a supplier, due to the presence of specific assets, the buyer is exposed to the hazards of opportunism in small numbers bargaining (Williamson, 1979). A multiple source strategy can be a means to safeguard against potential opportunistic behaviors by suppliers, and against delivery failures. However, should a buyer opt to source from multiple suppliers, the discount offered by the suppliers may not be as favorable. The superiority of a single source strategy over a multiple source strategy, or vice-versa, is therefore not as evident as it may seem (Leavy, 1994).

In this paper, we present a game theoretic model of outsourcing strategy based on the arguments of Transaction Cost Economics (Williamson, 1979 and 1981) (TCE). The objectives of this paper are to investigate how production and transaction costs impact a buyer's decision to follow a single source or a multiple source strategy and to identify conditions when each of these strategies might be superior.

The effect of transaction costs on governance decisions has been much researched into. However, the majority are empirical investigations (for a comprehensive review see Shelanski and Klein, 1995; and Rindfleisch and Heide, 1997). Our investigation follows a game theoretic approach in examining transaction cost so as to gain a more precise theoretical understanding of how dyadic interactions involving a buyer and a seller, and triadic interactions involving a buyer and two suppliers, might influence transaction cost. It is for the purpose of understanding opportunistic behaviors by parties in interactions that the use of game theory is most suitable (Moorthy, 1985). As Parkhe (1993) has also suggested, an integration of TCE and game theory could provide useful insights.

In addition, out investigation of triadic interactions is also important because, although the emphasis of TCE is on small numbers interactions, research attention has focused mainly on dyadic exchange relationships. Hence, whether the arguments based on dyadic interactions are similarly valid for triadic exchange relationship is not clear.

Less commonly researched into is our attempt to study the impact of both production and transaction costs on governance. As reported by Rindfleisch and Heide (1997, p47), "though TCA (transaction cost approach) recognizes that governance decisions involve a trade-off between transaction and production costs, few studies have examined the role of production costs". In our model, a supplier chooses prices and his production cost is endogenous on the economies of scales and learning specificity, the latter being a form of human asset specificity that arises from learning-by-doing (Klein *et al*., 1978; Williamson, 1979 and 1981; Shelanski and Klein, 1995). The buyer, on the other hand, chooses the outsourcing strategy that minimizes his cost of purchase. Both production cost and transaction cost concerns are therefore taken into consideration in our model. By doing so, the role of production cost vis-à-vis transaction cost in determining appropriate governance structures can be clarified, as suggested by Rindfleisch and Heide (1997).

Our study shows that transaction cost is maximized when a buyer follows a single source strategy and learning specificity is present. A single source supplier who is opportunistic can appropriate the efficiency gains from learning specificity, without passing any such gains to the buyer. In addition, because of learning specificity, the buyer will be locked into the exchange relationship with the single source supplier. This is true even if a buyer follows a multiple source strategy, but awards the supply contract in asymmetric proportions across the selected suppliers. Only if a buyer follows a multiple source strategy that splits the supply contract in such a way as to equalize the effects of learning specificity across the selected suppliers, will transaction cost be minimized. By doing so, the buyer will also be able to appropriate the efficiency gains, due to learning specificity, achieved by its suppliers.

However, the splitting of the supply contract results in a reduction in efficiency gains derived from the economies of scale. Hence, while a single source strategy is optimal when efficiency gains due to the economies scale are large and those due to learning specificity are small, a multiple source strategy is dominant when transaction cost due to learning specificity is substantial and the economies of scale effect is small. A multiple source strategy can therefore be an effective alternative to internalization in safeguarding against opportunistic behaviors by suppliers, under the condition that the economies of scale and learning specificity effects are low and high respectively. However, when both the effects of the economies of scale and learning specificity are high, then internalization is the optimal strategy.

The rest of this paper is organized as follows. The next section contains the literature review. In the third section, the game theoretic model is developed. Following which, in the fourth section, the transaction cost faced by a buyer is derived. The fifth section contains the analysis of single versus multiple source strategy, while the sixth section discusses the implication of the results derived and relates them to some empirical findings. The final section discusses the limitations of this paper and provides directions for future research. All proofs to the lemma and propositions presented in this paper are included in the Appendix.

LITERATURE REVIEW

The focus of transaction cost analysis is on the make-our-buy decision, which has been described as the paradigm problem of TCE (Shelanski and Klein, 1995). However, several studies have applied the transaction cost approach to examine other governance decisions. For example, Dwyer and Oh (1988) extrapolated TCE arguments to investigate three contractual channel systems (wholesale voluntary chains, dealer cooperatives, and independents). Dutta, Bergen, Heide and John (1995) applied TCE to examine how manufacturer lock-in (due to specific assets) and performance ambiguity might influence the use of single or dual distribution systems. Specifically, TCE argues that buyers should internalize their supply requirements to preempt against the hazards of opportunism in engaging external agents or suppliers, especially when transaction specific assets are involved in the exchange relationships. However, internalization is not the only means to safe guard against the opportunism of exchange partners. Several other alternatives have been proposed.

For example, long term contracts were suggested as substitute for vertical integration (e.g., Kleindorfer and Knieps, 1982; and Joskow, 1987). Williamson (1983, 1984) proposed the use of hostages to credibly commit to exchange relationships. Heide and John (1990) examined the utility of relationships to safeguard relationship-specific investments and to facilitate adaptation to uncertainty. Stump and Heide (1996) suggested that the buyers could control supplier opportunism through partner qualification and selection, incentive design, and monitoring. Anderson and Weitz (1992) proposed that pledges in the form of idiosyncratic investments could be effective in sustaining commitment in channel relationships, which suggests that opportunism could likewise be reduced. Klein *et al*.(1978) proposed that reputation & brand name could serve as collateral against opportunism. In particular, Klein and Leffler (1981) suggested that brand name is a form of specific asset that could serve as a collateral provided by suppliers to deliver high quality. Likewise, Farrel and Gallini (1988) proposed that second sourcing, or "invited" competition (Dutta and John, 1995), can serve as a safeguard for a buyer's specific investments. While, Dutta *et al*. (1995, p194) suggested that "adding a direct sales force to augment the rep channel serves as a safeguard against lock-in problems with reps" and "provides a manufacturer with insight into downstream marketing activities" when performance is ambiguous.

For small firms, which are often faced with resource limitations (Lee, Lim and Tan, 1999; Lim, Lee and Tan, 2000) and for which the internalization option is not feasible, Heide and John (1988) proposed that they develop close bonds with their accounts to safeguard against opportunistic behaviors by their principals. A multiple source strategy has been proposed as a safeguard against delivery failures (Leavy, 1994; Wilson, 1994), and against suppliers' opportunism post contract award (Seshadri, Chatterjee and Lilien, 1991). With the presence of competing suppliers, those who act opportunistically would therefore face the threat of being replaced.

According to TCE, transaction costs vary according to the characteristics of the transaction such as asset specificity, uncertainty, and frequency associated with the exchange relationship (Williamson, 1985). In our model, the transaction cost is formally derived and is endogenous on learning specificity, that is, the extent of idiosyncratic knowledge that a supplier acquires over time. This ex-post cost therefore differs from the agency cost that arises from the private information that agents have of their own productivity or nonverifiability of agents' effort (e.g., Grossman and Hart, 1986; Olsen, 1996). A supplier acquires specific knowledge in production only if he is awarded a supply contract (in part or in full), and that the knowledge acquired is not salvageable outside of the specific buyer-supplier(s) exchange relationship. The effect of frequency of transactions in terms of recurrence is represented in our model by way of a sequential game, in which the buyer's supply requirements are recurrent in each period; frequency in terms of size of transactions is captured in our model in the economy of scale and learning specificity effects. As the contracted volume of production increases, the unit cost of production decreases and the acquisition of specific knowledge of the production process increases. As with the basic tenets of TCE, the basic premise in this paper is that external agents are opportunistic in that they act in their self-interest and with guile.

Although Williamson has stressed that "the object is to economize on the sum of production and transaction costs", few studies have examined the combined effects of both transaction and production costs on governance decisions (Rindfleisch and Heide, 1997). An example is Anderson and Weitz's (1986) study of marketing productivity, which examined the trade-off between scale economies through the use of external agents, and the benefits of increased control and coordination achieved through vertical integration. Although a study by Noordeweir, John and Nevin (1990) focused on the impact of uncertainty on transaction cost, the authors also showed that cost performance improved when larger volumes were purchased, which suggests significant economies of scale effect and the importance of production cost on governance decisions.

More related to our study is that of Walker and Weber's (1984), which examined the influence of transaction cost on the make-or-buy decision through the effects of supplier market competition, and volume and technological uncertainty. Although the focus of their study is on the impact of competition and uncertainty on transaction cost, the authors also postulated that production cost advantage gained from a buyer's experience increases the likelihood of a buy decision (Walker and Weber, 1984). Their results showed that both transaction and production costs affect the make-or-buy decision, and that comparative production costs, between that of the supplier's and the buyer's, are strongest predictor of make-or-buy decisions, compared to volume uncertainty and supplier market competition. Walker and Weber (1987) replicated and extended their earlier study (Walker and Weber, 1984) by examining the interaction effects of supply market competition and volume uncertainty. A related study by Lyons (1995) examined the interaction effect between the economies of scale and asset specificity on the make-or-buy decision, and found empirical support for such an effect.

Compared to these studies that examined both transaction and production costs, this paper follows a game theoretic approach to examine how transaction costs arising from learning specificity, and production costs reduction that result from both learning specificity and economies of scale, affect governance decisions. In addition, the governance decision of concern in this paper is the single source versus the multiple source strategy, instead of the make-or-buy decision. The propositions derived in this paper provide a theoretical explanation of Lyon's (1995) empirical results and Walker and Weber's (1984) observations of the importance of comparative production cost in influencing governance decisions.

Although Seshadri *et al*. (1991) have also followed a game theoretic approach in examining the issue of multiple source procurements, the authors focus on the effect of multiple sourcing on competitive behavior prior to supplier selection, in which the decision to source from multiple sources is exogenous. Similarly, a later paper by Seshadri (1995), which examined both the issues of selection and control of suppliers post contract award, also took the decision to multiple source as given. McAffee and Schwartz (1994) also examined the issue of multilateral vertical contracting. However, their focus is on the monopolist supplier selling to competing downstream firms. In all these studies, the effects of production and transaction costs on governance were ignored.

Williamson (1979) described asset specificity as the mot important dimension affecting transactions. Although there are various forms of asset specificity (e.g., Klein *et al.*, 1978; Williamson, 1981; Nooteboom, 1993a), we focus on learning specificity because it is the most commonly assessed form of specificity in TCE studies (Rindfleisch and Heide, 1997). It has also been reported that specialized technical know-how has a stronger influence than specialized physical capital on the decision to integrate production within a firm (Masten, Meethan and Snyder, 1989). Like Irwin and Klenow (1994), we define the "learning-by-doing" effect as an efficiency gain from cumulative production. This is in contrast to the economies of scale effect, which is endogenous on current production quantity. In addition, the learning effect that this paper is concerned with arises because of specific human capital in form of technical knowledge (Klein, 1988; Monteverde and Teece, 1990), non-transferable, nor patentable (Monteverde and Teece, 1982).

Several authors have also examined the effect of leaning specificity in their studies. For example, Monteverde and Teece (1982) examined how specialized non-patentable know-how influence the make-or-buy decision, and showed that such know-how is positively related to the likelihood of vertically integrated production. However, the effect of the economies of scale on the make-or-buy decision was ignored. Pisano (1990) postulated that experience (or learning) impacts transaction cost and governance decisions, while Nooteboom (1993b) suggested that specific experience could be a barrier to change. There is also empirical evidence of learning specificity provided by Irwin and Klenow's (1994, p1200) study of learning-by-doing spillovers in the semiconductor industry, which showed that "firms learn three times more from an additional unit of their own cumulative production than from an additional unit of another's firm's cumulative production".

MODEL

Figure 1 illustrates the model in extensive form, which is a 4 stage sequential game played over 2 periods. Each period consists of 2 sequential stages. In stage one of Period 1, given the buyer's purchase requirements, a supplier decides on the price P_1 per unit product to charge. We assume that the market is competitive in that there are multiple competing suppliers (*m: m* > 2). After assessing the suppliers' price quotes, in stage two, the buyer decides on whether to award the contract to a single supplier or to split the contract between two suppliers. The buyer may therefore award a portion of the contract α_1, such that $0 \leq \alpha_1 \leq 1$, to one supplier and the remaining portion $(1- \alpha_1)$ to another supplier. Thus, $\alpha_1 \in (0, 1)$ means that the buyer chooses a single source strategy, while α_1 such that $0 < \alpha_1 < 1$, means that the buyer chooses a multiple source strategy, in Period 1.

In Period 2, given the buyer's sourcing strategy in Period 1 and purchase requirements for Period 2, the buyer again calls for competitive bids from *m* suppliers. The incumbent supplier(s) responds by deciding on whether or not to continue supplying the buyer. If he decides to do so, he chooses the price level P_2 (per unit product) in Period 2. Having observed the responses from the suppliers, the buyer then decides on the split of the contract by choosing α_2: $0 \leq \alpha_2 \leq 1$. The buyer may retain his incumbent supplier(s), or terminate the exchange relationship with his incumbent supplier(s). In the latter case, the buyer awards the contract to a new supplier(s) in Period 2.

(Insert Figure 1 Here)

With reference to Figure 1, $\pi_b(T)$ and $\pi_s(T)$ denote the buyer's and the supplier's payoffs respectively, when the incumbent supplier(s) chooses to stop supplying in Period 2. The notations $\pi_b(I)$ and $\pi_s(I)$ refer to the payoffs to the buyer and supplier(s) respectively, when the buyer awards the contract to the incumbent supplier(s) in Period 2. Finally, $\pi_b(N)$ and $\pi_s(N)$ denote the payoffs to the buyer and the supplier(s) respectively, when the buyer awards the contract to a new supplier(s) in Period 2, thus replacing the incumbent supplier(s).

As the purpose is to examine a buyer's optimal sourcing strategy, the sales and demand for the buyer's products, a long with the industry conditions, are taken to be exogenous. For simplicity, we assume a zero discount rate for payoffs in Period 2. Let the unit cost of production in Period *i* be c_i .The profit pr unit of the product supplied, earned by the suppliers in Period *i*, is therefore $(P_i - c_i),\ i \in \{1, 2\}$. Let the total quantity of supplies required by the buyer be Q per period, which is exogenous. A supplier's payoffs for each period is therefore $q_i (P_i - c_i)$, where q_i is such that $0 \le q_i \le Q$ and is dependent on the buyer's sourcing strategy as defined by α_1. Hence, the total costs to the buyer and the total profits to each supplier are given by $\pi_b = \Sigma_i (P_i Q)$ and $\pi_s = \Sigma_i (P_i - c_i) q_i$, respectively.

The buyer chooses the sourcing strategy $\alpha = \{\alpha_1, \alpha_2\}$ to minimize its cost of purchase. Hence, his objective function is as follows:

$$Max.\ \pi_b = Min._{\alpha}\ \Sigma_i (P_i Q)$$

In contrast, a supplier chooses prices $P = \{P_1, P_2\}$, to maximize his payoffs. Hence, his objective function is as follows:

$$Max.\ \pi_s = Max._P\ \ \Sigma_i (P_i - c_i) q_i$$

The unit cost of production is endogenous on the production quantity q_i and the cumulative production quantity to Period *i*, $z_y = \Sigma_i q_i$, that is $c_i = (q_i, z_y)$, where z_y is such that $0 \le z_y \le 2Q$, for the two-period game. To incorporate the effects of economy of scale and learning specificity, I assume that the function $c\ (q_i, z_y)$ is strictly decreasing and convex with respect to q_i and z_y that is $\frac{\partial c}{\partial q} < 0, \frac{\partial^2 c}{\partial q^2} > 0, \frac{\partial c}{\partial z} < 0 \frac{\partial^2 c}{\partial z^2} > 0$. The learning effect is transaction specific in that a supplier learns, or acquires specific knowledge in production, only if it is awarded the supply contract in part or in full, and that the knowledge acquired is not salvageable outside of the specific buyer-supplier(s) exchange relationship. We assume that the learning rate is exogenous and symmetric across suppliers. With the exception that suppliers may acquire specific knowledge asymmetrically, they are also assumed to be identical in terms of their production technology.

TRANSACTION COST ANALYSIS

Following the subgame perfection criteria, the incumbent suppliers' responses in Period 2 are first examined, given that the buyer outsources his requirement and splits the contract into two portions comprising $\alpha_i Q$ and $(1- \alpha_1)Q$ in Period 1. For an incumbent supplier who has been awarded a contract $\alpha_i Q$ in Period 1 and $\alpha_2 Q$ in Period 2, his unit cost of production is given by $c(q_2, z_2) = c(\alpha_2 Q, \alpha_1 Q)$, as a result of his acquisition of specific knowledge in Period 1.

In contrast, for suppliers who were not awarded a supply contract in Period 1, they would not be $c(\alpha_2 Q, 0)$ if they were awarded a contract $\alpha_2 Q$ in Period 2. Since $c(\alpha_2 Q, \alpha_1 Q) < c(\alpha_2 Q, 0), \ \forall \alpha_1 : 0 < \alpha_1 \leq 1$, incumbent suppliers would therefore have a cost advantage over their competitors as a result of learning specificity. In addition, since $c(\alpha_2 Q, \alpha_1 Q) < c(\alpha_2 Q,(1-\alpha_1)Q), \ \forall \alpha_1 : 0.5 < \alpha_1 \leq 1$, the incumbent supplier who is awarded a large portion of the contract in Period 1 will have a cost advantage over the other incumbent supplier who is awarded a smaller portion of the contract. This implies that, in Period 2, the incumbent supplier who is awarded a larger portion of the contract could offer a price that just undercuts the other incumbent's unit cost by a small amount ε, such that $\varepsilon \rightarrow 0$, to secure the whole contract. Hence, Lemma 1 follows.

Lemma 1: $P_2 = P^{**} = Max. \{c(q, \ \alpha_1 Q), c(q, (1-\alpha_1)Q)\}, \ \forall \alpha_1 : 0 \leq \alpha_1 \leq 1$.

Let $c_{min} = Min. \{c(q, \ \alpha_1 Q), c(q, (1-\alpha_1)Q)\}$, be the unit cost of the incumbent supplier with the lowest cost. Lemma 1 implies that the incumbent supplier with the cost advantage will charge a price that just undercuts the cost of the supplier with the next lowest unit cost, in Period 2. By doing so, he maximizes the appropriation of the efficiency gains derived from learning specificity, amounting to $(P^{**} - c_{min}) = / c(q, \alpha_1 Q) - c(q, (1-\alpha_1)Q) /$, which is greater than or equal to 0. The margin $(P^{**} - c_{min})$represents the transaction cost faced by the buyer in outsourcing his supply requirements, and is dependent on learning specificity and the buyer's outsourcing strategy as defined by $\alpha = \{\alpha_1, \alpha_2\}$.

Proposition 1: By outsourcing and splitting the supply contract $\{\alpha_1, \alpha_2\}$ in Period 1, a buyer faces a transaction cost, $(P^{**} - c_{min}) = / c(q, \alpha_i Q) - c(q, (1-\alpha_1)Q) /$, in Period 2.

Proposition1 implies that transaction cost will be maximized when $\alpha_1 \varepsilon (0, 1)$, that is, when the buyer follows a single source strategy, in which case $(P^{**} - c_{min}) / c(q, 0) - c(q, Q) /$. An incumbent supplier who is opportunistic can appropriate all the efficiency gains derived from learning specificity, without passing any such gains to the buyer in Period 2, if he is awarded the full contract in Period 1. Given that $P^{**} = Max. \{c(q, \alpha_1 Q), c(q, (1-\alpha_1)Q)\}$, the subgame equilibrium in Period 2 is such hat the buyer chooses $\alpha_2 = 1$ if $\alpha_1 \neq 0.5$, and chooses $\alpha_2 = 0.5$ if $\alpha_i = 0.5$, in which case $P^{**} = c(q, \alpha_1 Q) = c(q, (1-\alpha_1)Q)\}$. This result is stated in Lemma 2.

Lemma 2: The subgame equilibrium in Period 2 is such that the buyer chooses $\alpha_2 = 1$, if $\alpha_1 \neq 0.5$, which results in $P^{**} = Max. \{c(q, \alpha_1 Q), c(q, (1-\alpha_1)Q)\}$, and chooses $0 \leq \alpha_2 \leq 1$ if $\alpha_1 = 0.5$, which results in $P^{**} = c(q, \alpha_1 Q) = c(q, (1-\alpha_1)Q)$.

Lemma 2 implies that the transaction cost faced by the buyer can be minimized if the buyer follows a multiple source strategy and splits the contract symmetrically in Period 1. y doing so, $(P^{**} - c_{min}) = \{c(q, \alpha_1 Q), c(q, (1-\alpha_1)Q)\} = 0$, since $c(q, \alpha_1 Q) = c(q, (1-\alpha_1)Q)$, and in Period 2, the buyer will be able to appropriate the efficiency gains derived from learning specificity, achieved by its incumbent suppliers. Since $P^{**} = c(q, \alpha_1 Q) \quad c(q, (1-\alpha_1$

)Q), in anticipation that the buyer will optimally choose $\alpha_1 = (1-\alpha_1)$(Lemma 2), a supplier's best response in Period 1 is to charge a competitive price $P_1 = P^* = c(q, 0)$.

Proposition 2: By splitting the contract symmetrically across the suppliers, choosing $\alpha_i = (1-\alpha_i)$ *in period* $i = 1, 2$, *the buyer minimizes the transaction cost he faces and appropriates the cost savings achieved by his incumbent suppliers that results from learning specificity.*

Propositions 1 and 2 are therefore consistent with Dutta and John's (1995) observation that a monopolist supplier would "exploit the locked-in buyers unless checked by the presence of the second firm". Having determined the optimal reasons in each stage of the game, we shall now examine how transaction and production costs might influence the equilibrium outsourcing strategy.

SINGLE VERSUS MULTIPLE SOURCE STRATEGY

In the absence of the effect of learning specificity, Lemma 1 implies that $P^{**} = P^* = c(q,0)$ per unit, because of competition among suppliers. Since $c(q,0)$ decreases with quantity purchased, a buyer can minimize his cost of purchase by awarding the whole contract, $\alpha_1 = 1$, to a single supplier in any Period i, $i \geq 1$. Hence, in the absence of asset specificity, economies of scale considerations favor a single source strategy.

Proposition 3: In the absence of learning specificity effect, a single source strategy minimizes a buyer's cost of purchase, $P^{**} = P^* = c(q,0)$.

However, when asset specificity is present and the buyer follows a single source strategy in Period 1 $(\alpha_1 = 1)$, Lemma 2 implies that $P^{**} = P^* = c(q,0)$ and $\alpha_2 = 1$. Extending the argument to n periods, if $\alpha_1 \neq 0.5$, then $\alpha_{i+1} = 1, \forall \ i \geq 1$. This means if the buyer follows a single source strategy in Period 1, then he will be locked into the exchange relationship with the incumbent supplier as a result of learning specificity. What is more, the transaction cost faced by the buyer, $(P^{**} - c_{min}) = / c(q,0) - c(q,Q) /$, is maximized (Proposition 1), under a single source strategy, as the incumbent supplier appropriates all costs savings from learning specificity without passing any such savings to the buyer. Given that $P^{**} = P^{*} = c(q,0)$, the total cost of purchase to the buyer over the two periods is therefore $\pi_b (I) = 2Q[c(Q,0)]$, under the single source strategy. Proposition 4 thus follows.

Proposition 4: If the buyer follows a single source strategy in Period 1, $\alpha_1 = 1$,

(i) *He will be locked into the exchange relationship with the incumbent supplier in all future periods,* $\alpha_{i+1} = 1, \forall \; i \geq 1$.

(ii) *Transaction cost is maximized,* $(P^{**} - c_{min}) = / c(q,0) - c(q,Q) /$, *and* $\pi_b (I) = 2Q[c(Q,0)]$.

A single source strategy is optimal in the absence of asset specificity (Proposition 3). However, as Proposition 4 shows, when specific assets are present, a buyer following a single source strategy will be locked into the dyadic exchange relationship and transaction cost will also be maximized. Proposition q4 therefore confirms the central concern of TCE that, in dyadic exchange relationships, transaction specific assets gives rise to quasi-rents and hazards of opportunism (Klein et al., 1978; Williamson, 1979 and 1981).

Given that, the buyer and his single source supplier are locked into the exchange relationship, when specific assets are present, the dyadic exchange relationship is sustainable. However, the lop-sided sharing of the gains from learning specificity, with the supplier appropriating virtually all such gains, could result in conflicts in the exchange relationship. This is therefore consistent with Sriram and Mummalaneni's (1990) observation that economic gains can be so substantial that exchange relationship can be sustained, even though conflicts exist in the relationship.

When the buyer follows a multiple source strategy in Period 1 and splits the contract asymmetrically across the suppliers, he will be locked into the exchange relationship with the incumbent supplier who is awarded a larger portion of the contract in Period 1, as Lemma 2 implies. A multiple source strategy in which the buyer splits the contract asymmetrically across the suppliers is therefore not sustainable over the long run. However, a multiple source strategy of splitting the contract symmetrically across the suppliers in Period 1 is sustainable, as Lemma 2 implies also, and minimizes the transaction cost faced by the buyer (Proposition 2). Under such a strategy, $P^* = c(\frac{1}{2} Q, 0)$, $P^{**} = c(\frac{1}{2}Q, \frac{1}{2}Q)$ (Lemma 2), and hence, the buyer's cost of purchase $\pi_b (I)$ is equal to $Q[c(\frac{1}{2}Q,0)+ c(\frac{1}{2}Q, \frac{1}{2}Q)]$ over Periods 1 and 2, while the suppliers' payoffs $\pi_s(I) = 0$.

Proposition 5:

(i) *Under a multiple source strategy, if the contract is split asymmetrically across the suppliers in Period 1,* $\alpha_1 \neq 0.5$, *then the incumbent supplier who is awarded the larger contract will be able to secure the whole contract in all future periods,* $\alpha_{i+1} = 1, \ \forall \ i \geq 1$.

(ii) *A multiple source strategy is sustainable over the long run if and only if the contracts split symmetrically across the suppliers in all periods i,* $\alpha_i = 0.5, \ \forall i = 1, \ldots n$, *in which case* $\pi_b (I) = Q[c(\frac{1}{2}Q,0) - c(\frac{1}{2}Q, \frac{1}{2}Q)]$ *and* $\pi_s(I) = 0$.

It has been suggested that the introduction of competition among selected suppliers would provide for post-award cost control, only if multiple suppliers are chosen in the initial process (Seshadri, *et al.*,1991). Proposition 5 refine this condition for post-award cost control. Not only must multiple suppliers be chosen initially, the effect of learning specificity must also be equalized across the selected suppliers. This can be achieved through a symmetric split of the supply contract across the selected suppliers.

Although, a multiple source strategy of splitting the contract symmetrically between the suppliers minimize the transaction cost, the buyer's cost of purchase may not be minimized. This is because the efficiency gains from the economies of scale are reduced, as the production volume for each supplier becomes smaller. There is a tradeoff in production cost due to greater economies of scale by following a single source strategy, against transaction cost reduction by following a multiple source strategy. The use of a multiple source strategy to insure against hazard of opportunism in the outsourcing of supplies therefore carries a cost in reduced economies of scale. Proposition 6 states the equilibrium outsourcing strategy.

Proposition 6: A multiple source strategy of splitting the supply contract symmetrically across the suppliers minimizes the buyer's cost of purchase only if the condition that $[c(\frac{1}{2}Q, 0) + c(\frac{1}{2}Q, \frac{1}{2}Q)] < 2c(Q, 0)$ *is satisfied.*

Proposition 6 implies that a multiple source strategy is the dominant one in the long run, when transactions are recurring and efficiency gains due to specific knowledge are substantial. Under such situations, a multiple source strategy allows the buyer to appropriate the efficiency gains that result from learning specificity achieved by its suppliers, and also makes each of the suppliers more replaceable. As Heide and John (1988, p25) have suggested, "firms with high levels of specific assets can improve their performance by improving the replace ability of their exchange partners".

However, Proposition 6 seriously questions the suggestion that a long-term perspective favors a single source strategy, as this ignores the appropriation risks when transaction specific assets are present (Klein, 1978; Williamson, 1979). As Williamson (1979, p242) has also highlighted, in a bilateral monopoly, "Although both (buyer and seller) have a long term interest in effecting adaptations of a joint profit maximizing kind, each also has an interest in appropriating as much of the gains as he can on each occasion to adapt".

Proposition 6 also clarifies the role of production cost vis-à-vis transaction cost in governance decision (Rindfleisch and Heide, 1997). In particular, Proposition 6 implies that, if production is highly idiosyncratic in that the efficiency gains due to learning specificity is substantial, then over the long run, a multiple source strategy clearly dominates a single source strategy in terms of purchase cost minimization for the buyer. Conversely, a single source strategy is optimal when the effect of learning specificity is small, but the effect of economies of scale is large. However, when both the effects of the economies of scale and learning specificity are substantial, then internalization would be the optimal strategy. An internalization strategy maximizes on the benefits of both these effects, instead of having to trade-off the benefits of economies of scale vis- à-vis learning specificity when following a single source or a multiple source strategy. Hence, Williamson's (1985) suggestion that, production is more likely to be brought in-house to take advantage of the economies of scale if transactions are frequent, is conditional on high asset specificity characterizing the transactions. The corollary thus follows.

Corollary: An internalization strategy is optimal when both the effects of economies of scale and learning specificity are large.

DISCUSSION

The explicit consideration of the impact of both production and transaction costs on outsourcing strategy through a game theoretic analysis yields some novel insights. A single source strategy has the advantage of maximizing efficiency gains due to the economies of scale. However, as Table 1 shows, under a single source strategy, transaction cost is maximized and is higher than that under a multiple source strategy (Proposition 1). In addition, the efficiency gains that result from learning specificity are appropriate by the supplier, and the buyer will be locked into the exchange relationship with his sole supplier (Proposition 4). This occurs even if the supply market is competitive because the market is transformed from one large numbers interactions into one of dyadic interactions or bilateral monopoly on account of transaction specific assets (Williamson, 1979). Only by following a multiple source strategy of splitting the contract symmetrically across the selected suppliers will a buyer be able to appropriate the efficiency gains that are derived from learning specificity (Proposition 2). Such a strategy minimizes the transaction cost (Table 1) and is also sustainable over the long run (Proposition 5(ii)). However, a multiple source strategy of splitting the contract asymmetric across the selected suppliers is not sustainable in the long run (Proposition 5(i)).

(Insert Table 1 here)

Table 2 illustrates the impact of the effects of the economies of scale and learning specificity on governance decisions. As Table 2 shows, while economies of scale considerations favor a single source strategy (Proposition 3), learning specificity considerations favor a multiple source strategy (proposition 6). Hence, when both the effects of economies of scale and learning specificity are large, then internalization is the optimal strategy. Obviously, as Proposition 3 implies also, when both the effects of the economies of scale and learning specificity are low, then a single source strategy is optimal.

(Insert Table 2 here)

There are several implications to the theoretical propositions presented in this paper for empirical research on the impact of transaction cost on governance decision. It is important that the empirical studies take into explicit account both production and transaction costs in examining governance decisions. As Table 2 shows, under the low asset specificity condition, a single source strategy is optimal, as production cost considerations overwhelms transaction cost considerations in governance decisions. As Lyons (1995, p442) has also observed, “Economies of scale and scope are a significant motivation behind the decision to buy-in, but only in the absence of specific assets. Specific assets are the overriding influence when scale or scope economies exist”. This also explains Walker and Weber's (1984) result which shows that comparative production costs are the strongest predictor of make-buy decisions for components. For such products, the effect of learning specificity would be low, but that of the economies of scale would be high, therefore suggesting a buy (single source strategy) decision. Walker and Weber (1984) also reported that the effect of supplier market competition on the make-or-buy decision is low, but significant. This could also be attributed to the low learning specificity effect of the product chosen for investigation.

When conducting empirical research, it is also equally important to clearly distinguish between the single and multiple source strategies under the buy decision. This is because, as Proposition 3 and 6 imply, there is an interaction effect between economies of scale and asset specificity condition, in which case the equilibrium governance decision is to outsource by following a multiple source strategy if the effect of the economies of scale is small. Otherwise, internalization is the optimal strategy. The neglect of production cost considerations in governance decisions, when conducting empirical investigations, could therefore lead to potentially misleading conclusions.

Walker and Weber (1987) suggested that "Even when a buyer owns specialized assets and has low costs of switching suppliers, transaction costs can arise when the supplier is not constrained from behaving opportunistically by the presence of other firms competing for a buyer's business". In comparison, our analysis shows that, even when neither buyers nor suppliers have invested in any specific assets ex-ante, transaction cost can arise when suppliers acquire specific experience or learning ex-post and are not constrained from behaving opportunistically by competing suppliers who possess similar idiosyncratic knowledge. Hence, supply market competition by itself is not enough to safeguard against the hazards of opportunism, homogeneity of the suppliers' production capabilities post contract award is crucial for minimizing appropriable quasi rents. Finally, our analysis also confirms Monteverde and Teece's (1982) intuition that, "Even if the title to specialized equipment used by the supplier is held by the assembler, this need not provide protection against rent appropriation if transaction-specific know-how has been generated".

CONCLUSION

While this paper has provided a more precise understanding of the role of production cost in governance decisions under dyadic and triadic interactions, there are several limitations that are worth nothing. We have not included environmental uncertainty in our analysis at this stage (e.g. Walker and Weber, 1984 and 1987, Balakrishnan and Wernerfelt, 1986; Weiss and Anderson, 1992; Stump and Heide, 1996) as its inclusion will make the analysis less tractable. We have also not considered how product quality might influence governance decisions. Product quality improves with an increase in the acquisition of specific knowledge, which potentially increases the risk of opportunism in outsourcing. We have also not considered reputation effects, which may deter players from opportunistic behaviors (Klein and Leffler, 1981). An important assumption in our model is that the suppliers possess the same technology and learn at the same rate. However, if this is not true then the results may not hold. However, given that collusion is illegal in many countries, this seems to be a reasonable assumption.

The model presented can be extended in several ways. Of the many types of asset specificity identified (e.g., Klein *et al*., 1978; Williamson, 1981; Nooteboom, 1993a), we have focused only on one type of asset specificity, that is, human asset specificity. Future studies could investigate the impact of the various types of specific asset on governance decisions. Another logical extension would be to conduct an empirical verification of the theoretical propositions derived in this study.

REFERENCES

Anderson E, Weitz BA. 1986. Make-or-buy decisions: vertical integration and marketing productivity. *Sloan Management Review* **27**(3): 3-19.

Anderson E, Weitz BA. 1992. The use of pledges to build and sustain commitment in distribution channels. *Journal of Marketing Research* **29** (February): 18-34.

Balakrishnan S, Wernerfelt B. 1986. Technical change, competition and vertical integration. *Strategic Management Journal* **7** (July/August): 347-359.

Dutta S, Bergen M, Heidi JB, John G. 1995. Understanding dual distribution: the case of reps and house accounts. *Journal of Law, Economics, and Organization* **VII**(1): 189-204.

Dutta S, John G. 1995. Combining lab experiments and industry data in transaction cost analysis: The case of competition as a safeguard. *Journal of Law, Economics, and Organization*, **11**(1): 87-111.

Dwyer FR, Oh S. 1988. A transaction cost perspective on vertical contractual structure and interchannel competitive strategies. *Journal of Marketing* **52**(2): 21-34.

Farrel J, Gallini NT. 1988. Second-sourcing as a commitment: monopoly incentives to attract competition. *Quarterly Journal of Economics* (November): 673-694.

Grossman SJ, Hart OD. (1986). The costs and benefits of ownership: A theory of vertical and lateral integration. *Journal of Political Economy* **94**(4): 691-719.

Heide JB, John G. 1988. The role of dependence balancing in safeguarding transaction-specific assets in conventional channels. *Journal of Marketing* **52**(1): 20-35.

Heide JB, John G. 1990. Alliances in industrial purchasing: The determinants of joint action in buyer-supplier relationships. *Journal of Marketing Research* **27** (February): 24-36.

Irwin DA, Klenow PJ. 1994. Learning-by-doing spillovers in the semiconductor industry. *Journal of Political Economy* **102**: 1200-1227.

Joskow, PL 1987. Contract duration and relationship-specific investments: empirical evidence from coal markets. *American Economic Review* **77**(1): 168-185.

Kliendorfer P, Knieps G. 1982. Vertical integration and transaction-specific sunk costs. *European Economic Review* **19**: 71-87.

Klein B. 1988. Vertical integration as organized ownership: the fisher body – general motors relationship revisited. *Journal of Law, Economics, and Organization* **4**: 199-213.

Klein B, Crawford RG, Alchian AA. 1978. Vertical integration, appropriable rents and the competitive contracting process. *Journal of Law and Economics* **21** (2): 297-326.

Klein B, Leffler KB. 1981. The role of market forces in assuring contractual performance. *Journal of Political Economy* **89** (August): 615-641.

Leavy B. 1994. Two strategic perspectives on the buyer-supplier relationship. P*roduction and Inventory Management Journa*l **35**(2): 47-51.

Lee KS, Lim GH, Tan SJ. 1999. Dealing with resource disadvantage: generic strategies for SMEs. *Small Business Economics* **12**: 2299-2311.

Lim GH, Lee KS, Tan SJ. 2000. Gray marketing as an alternative market penetration strategy for entrepreneurs: conceptual model and case evidence. *Journal of Business Venturing*, (forthcoming).

Lyons, B.R. (1995), "Specific investment, economies of scale, and the make-or-buy decision: A test of transaction cost theory," *Journal of Economic Behavior and Organization,* **26** (3);431-443

Masten SE, Meethan Jr JW, Snyder EA. 1989. Vertical integration in the U.S. auto industry: a note on the influence of transaction specific assets. *Journal of Economic Behavior and Organization* **12**: 265-273.

McAfee RP, Schwartz M. 1994. Opportunism in multilateral vertical contracting: nondiscrimination, exclusivity, and uniformity. A*merican EconomicReview* **84**(1), 210-230.

Monteverde K, Treece D J. 1982. Supplier switching costs and vertical integration in the automobile industry. *Bell Journal of Economics* **13** (Spring): 206-213.

Moorthy KS. 1985. Using game theory to model competition. J*ournal of Marketing Research* **22** (August): 262-282.

Noordewier TG, John G, Nevin JR. 1990. Performance outcomes of purchasing arrangements in industrial buyer-vendor relationships. *Journal of Marketing* **54** (October): 80-93.

Nooteboom B. 1993a. Research note: an analysis of specificity in transaction cost. *Organization Studies* **14**: 443-451.

Nooteboom B. 1993b. Firm size effects on transaction costs. *Small Business Economics* **5**(4): 283-295.

Olsen T. 1996. Agency costs and the limits of integration. *RAND Journal of Economics* **27**(3): 479-501.

Parkhe A. 1993. Strategic alliance structuring: a game theoretic and transaction cost examination of interfirm competition. *Academy of Management Journal* **36** (August): 749-829.

Pisano GP. 1990.Using equity participation to support exchange: evidence from the biotechnology industry. *Journal of Law, Economics, and Organization* **5**(1): 109-126.

Presutti WD. 1992. The single source issue: U.S. and Japanese sourcing strategies. *International Journal of Purchasing and Materials Management* **28**(1): 2-10.

Rindfleisch A, Heide JB. 1997. Transaction cost analysis: past, present, and future applications. *Journal of Marketing* **61** (October): 30-54.

Segal MN. 1989. Implications of single vs. multiple buying sources. *Industrial Marketing Management* **18**(3): 163-178.

Seshadri S. 1995. Bidding for contest. *Management Science* **41**(4): 561-576.

Seshadri S, Chatterjee K, Lilien GL. 1991. Multiple source procurement competitions.

Marketing Science **10**(3), 246-263.

Shelanski HA, Klein PG. 1995. Empirical research in transaction cost economics. *Journal of Law, Economics, and Organization* **11**(2): 335-361.

Sriram V, Mummalaneni V. 1990. Determinants of source loyalty in buyer-seller relationships. *Journal of Purchasing and Materials Management* **26**(4): 21-26.

Stump RL, Heide JB. 1996. Controlling supplier opportunism in industrial relationships. *Journal of Marketing Research* **33**(4): 431-442.

Treleven M. 1987. Single sourcing: a management tool for the quality supplier. *International Journal of Purchasing and Materials Management,* **23**(1): 19-25.

Walker G, Weber D. 1984. A transaction cost approach to make-or-buy decisions. *Administrative Science Quarterly* **29**(3): 373-392.

Walker G, Weber D. 1987. Supplier competition, uncertainty, and make-or-buy decisions. *Academy of Management Journal* **30** (September): 589-596.

Weiss AM, Anderson E. 1992. Converting from independent to employee salesforces: the role of perceived switching costs. *Journal of Marketing Research* **29** (February): 101-115.

Williamson OE. 1979. Transaction cost economics: the governance of contractual relations. *Journal of Law and Economics* **22** (2):233-261.

Williamson OE. 1981. The economics of organization: the transaction cost approach. *American Journal of Sociology* **87** (November): 548-577.

Williamson OE. 1983. Credible commitments: using hostages to support exchange. *American Economic Review* **73** (September): 519-540.

Williamson OE. 1984. Credible commitments: further remarks. *American Economic Review* **74**(3): 488-490.

Williamson OE. 1985. *The Economic Institution of Capitalism*. The Free Press: New York.

Wilson EJ. 1994. The relative importance of supplier selection criteria: a review and update. *International Journal of Purchasing and Materials Management* **30**(3): 35-43.

APPENDIX

Proof of Lemma 1:

In Period 2, the unit cost of production are $c(q, \alpha_1 Q)$ *and* $c(q, (1-\alpha_1)Q)$ for the suppliers awarded the contract α_1 and $(1-\alpha_1)$ respectively, $\forall\ \alpha_1 : 0 \leq \alpha_1 \leq 1$. Hence, if $c(q, \alpha_1 Q) < c(q, (1-\alpha_1)Q)$, then $P_2 = P^{**} = [c(q, (1-\alpha_1)Q) - \varepsilon] = c(q, (1-\alpha_1)Q)$, as $\varepsilon \rightarrow 0$. Similarly, if $c(q, \alpha_1 Q) > c(q, (1-\alpha_1)Q)$, then $P_2 = P^{**} = c(q, \alpha_1 Q)$. Q.E.D.

Proof of Proposition 1:

From Lemma 1, $P_2 = P^{**} = Max. \{c(q, \alpha_1 Q), c(q, (1-\alpha_1)Q)\}$, while the unit cost of production for the supplier with the lowest cost is Min. $\{c(q, \alpha_1 Q), c(q, (1-\alpha_1)Q)\}$. Hence, $(P^{**} - c_{min}) = / c(q, \alpha_1 Q) - c(q, (1-\alpha_1)Q) /$. Q.E.D.

Proof of Lemma 2:

If $\alpha_1 \neq 0.5$, then $c(q, \alpha_1 Q) \neq c(q, (1-\alpha_1)Q)$, and $P^{**} = Max. \{c(q, \alpha_i Q), c(q, (1-\alpha_1)Q)\}$ from Lemma 1. The incumbent supplier with the cost advantage can charge a price that just undercuts that of the other incumbent supplier by an amount $\varepsilon \rightarrow 0$ to secure the whole contract, $\alpha_2 = 1$, in Period 2. However, if $\alpha_1 = 0.5$, then $c(q, \alpha_1 Q)$, and $P^{**} = c(q, \alpha_1 Q) = c(q, (1-\alpha_1)Q)$. The buyer is therefore indifferent in choosing α_2 in Period 2. Q.E.D.

Proof of Proposition 2:

From Lemma 2, if $\alpha_1 = (1-\alpha_1)$, $P^{**} = c(q, \alpha_1 Q) = c(q, (1-\alpha_1)Q)$, which implies that $\forall\ i, i = 1, \ldots n$ periods, if $\alpha_1 = (1-\alpha_1)$, then $P_{i-1} = c(q, \alpha_1 Q)\ c(q, (1-\alpha_1)Q)$, and $(P_{i+1} - c_{min}) = 0$. Q.E.D.

Proof of Proposition 3:

In the absence of specific knowledge effects, Lemma 1 implies $P^{**} = c(q,0) = P^*$. Since $c(q,0)$ is decreasing in q, the buyer's is thus minimized by maximizing q, choosing $q = Q$. Q.E.D.

Proof of Proposition 4:

Lemma 2 implies that, $P^{**} = P^{*} = c(q,0)$ and $\alpha_2 = 1$, given that $\alpha_1 = 1$. Hence, if $\alpha_1 \neq 0.5$, then $\alpha_{i+1} = 1$. $\forall i \geq 1$, and as Proposition 1 implies, $(P_{i-1} - c_{min}) = / c(q,0) - c(q,Q) /$ is maximized and $\pi_b (I) = 2Q[c(Q,0)]$. Q.E.D.

Proof of Proposition 5:

(i) Lemma 2 implies that, if the buyer splits the contract asymmetrically, $\alpha_1 \neq ½$, then $\alpha_{i+1} = 1$. $\forall i \geq 1$ (proof to Proposition 4).

(ii) If the buyer splits the contract symmetrically, $\alpha_1 = (1\text{-}\alpha_1) = ½$, then from Proposition 2, $P_{i+1} = c(q, ½ Q)$, and $(P_{i+1} - c_{min}) = 0$. *Since* $P^{*} = c(½ Q, 0)$ and $P^{**} = c(½Q, ½Q)$(Lemma 2), the buyer's cost of purchase $\pi_b (I) = Q[c(½ Q, 0) - c(½Q, ½Q)]$ over Periods 1 and 2, while the supplier's payoffs are given by $\pi_s(I) = 0$. Q.E.D.

Proof of Proposition 6:

If the buyer follows a single source strategy, $\pi_b (I) = 2Q[c(Q,0)]$ (Proposition 4). If the buyer follows a multiple source strategy, splitting the contract symmetrically, $\pi_b (I) = Q[c(½ Q, 0) - c(½Q, ½Q)]$ (Proposition 5(ii)). Hence, a multiple source strategy is superior if $Q[c(½ Q, 0) - c(½Q, ½Q)] < 2Q[c(Q,0)] \Rightarrow [c((½ Q, 0) - c(½Q, ½Q)] < 2c(Q,0)$. Q.E.D

Table 1:

Transaction Costs and Payoffs under Single and Multiple Source Strategies

Sourcing Strategy	Transaction Cost (P**-c)	Buyer's Cost of Purchase π_b (I)	Supplier's Profits π_s(I)
Single Source	*[c(Q,*0*) -c(Q,Q)]*	2*Q[c(Q,0)]*	Q*[c(Q,*0*) -c(Q,Q)]*
Multiple Source	0	Q*[c(½Q,* 0*) – c(½Q,½Q)*	0

Table 2:

Impact of Economy of Scale and Learning Specificity

on Equilibrium Governance Decision

Economy of Scale Effect

Learning Specificity Effect		*Low*	*High*
	Low	Single Source Strategy	
	High	Multiple Source Strategy	Internalization Strategy

Figure 1:

Game Theoretic Model of Sourcing Strategy