THE STRUCTURE OF VERTICAL RELATIONSHIPS AND TRANSACTION COSTS: EVIDENCE FROM JAPANESE AUTOMOBILE MANUFACTURING

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Abstract

This paper uses the transaction costs framework to provide a clearer understanding of the mechanisms used to govern the subcontracting relationships between Japanese automobile makers and their auto parts suppliers. We offer empirical support for the transaction costs proposition that suppliers of specialized automobile components are faced with higher switching costs than those of more standardized parts. Moreover, we present evidence that variations in supplier switching costs explain variations in the practices used by the auto makers in their dealings with parts suppliers. In particular, we find that the auto makers' ownership of supplier shares is positively related to the supplier's switching costs, which in turn supports the hypothesis that stock ownership facilitates the control and coordination of those suppliers of rather specialized parts. We encountered two major difficulties in trying to test these hypotheses. First, switching costs are not directly observable. To deal with this problem we show that supplier profits depend upon observable variables that vary systematically with changes in switching costs. Second, there are two types of suppliers: those that have a very close, long-term affiliation with a major auto maker and those that are independent. Thus, there is the potential problem the assignment of supplier type to these two regimes is correlated with the profits firms can earn in each regime. To correct for this type of selectivity bias, we estimate a switching regression model.

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1. Introduction

Recent empirical research has significantly improved the understanding of the use of various mechanisms in vertical production relationships. While the list of papers is quite extensive, the following examples should be sufficient to illustrate the nature of this research. Monteverde and Teece (1982) showed that problems of post contractual haggling and opportunism are more likely for automobile components which require specialized "know-how." Since these problems raise the transaction costs of contracting, automobile assemblers are more likely to vertically integrate the production of such components into their systems. This is, of course, what Coase (1934) had argued in his "Nature of the Firm" article, and what Williamson (1989) had subsequently formalized. Joscow (1987) showed that coal buyers and suppliers who were linked by relationship-specific investments, e.g., mine-mouth coal plants, were more likely to rely on long-term versus short-term contracts. His work lends support to another prediction of transaction costs theory that idiosyncratic investments raise the cost of discrete market transactions, so that other governance mechanisms, i.e., long-term contracts, would emerge. Masten and Synder (1993) used transaction costs theory to offer an efficiency explanation of United Shoe Machinery's leasing practices. In contrast to the more traditional explanation that United's leasing arrangement was designed to promote anticompetitive exclusion, they

showed that United's practices represented a "coherent and measured response to the incentive and governance problems encountered in these transactions." (Master and Snyder, 1993: 67)

In the spirit of this recent research, the present paper uses the transaction costs framework to explain certain distinctive governance mechanisms found in the Japanese automobile manufacturing industry. As is well-known, each major Japanese car maker has set up an association of auto parts suppliers, called a "kigyo" group, from which it purchases a substantial portion of auto parts and components. See Caves and Uekusa (1976), Asanuma (1984, 1985), Cusumano (1985, Ch. 4), Aoki (1987), Nakatani (1987), Kawasaki and McMillan (1987), Asanuma and Kikutani (1992), and Miwa (1994). The kigyo group members are given long-term supply assurances by the auto maker, or parent company, conditional on satisfactory performance with respect to such criteria as cost or price, service and quality. In the next section we discuss the kigyo group's specific governance mechanisms on which this study focuses. While these mechanisms are unique to Japanese manufacturing, nevertheless, we find that the same general principles of transaction costs theory used to explain other governance mechanisms, particularly in the US, can be applied to the kigyo group.

In particular, following Monteverde and Teece (1982), we find that asset specificity goes a long way towards explaining why suppliers of specialized auto parts are more likely to be inducted into a car maker's kigyo group, than suppliers of more standardized parts. This suggests that the same incentive that prompts an auto maker to vertically integrate into the production of certain parts also prompts them to induct the suppliers of these parts into its kigyo group.

Another principle of transaction costs theory holds that relationship-specific investments by the supplier will tend to raise the cost of terminating the buyer-seller relationship; namely, raise switching costs. We apply this principle to argue that suppliers of highly specific components with their higher switching costs, will tend to earn lower profits than those with lower switching costs, ceteris paribus. This result explains an apparent anomaly, first observed by Caves and Uekusa (1982), that kigyo suppliers tend to earn lower profits than their independent counterparts. We also use this principle to explain how certain governance practices established by the kigyo group's parent company tend to reflect suppliers' specific investments and hence the extent of their switching costs. Our switching cost approach enables use to devise a model with which to test hypotheses about the role of these practices within kigyo groups. In particular, our empirical results suggest that the practices of placing management personnel from the parent company to the kigyo suppliers and of owning member's common stock, while designed to control and coordinate the activities of the supplier, also reflects supplier switching costs.

Our work has two implications. First, observe that the auto maker may also be required to make specific investments associated with a supplier's component. Were this true, the auto maker would be vulnerable to supplier opportunism. But if supplier switching costs are high when specific investments are made by the auto maker, then the incentive for supplier opportunism is clearly less. However, if the auto maker's exercise of coordination and control tend to reflect its specific investment expenditures, then our results do indeed suggest a positive correlation between the auto maker's specific investments and the supplier's switching costs. Thus, our work suggests that the governance mechanisms of the kigyo group serve to reduce the vulnerability of the auto

maker to supplier opportunism. The second implication of our work suggests that while efficiency is undoubtedly a major aspect of the kigyo group governance mechanisms, it cannot be denied that the appropriation of quasi-rents must be another.

In the next section we describe the subcontracting relationships between the Japanese auto makers and the auto parts suppliers. In section 3, we formulate the basic model which we use to carry out the analysis of the subcontracting relationships and kigyo groups. We then explain the econometric methodology used to test our model and its hypotheses and develop the variables for the model. It turns out that because auto parts suppliers can belong to two regimes, kigyo groups or independents, the appropriate econometric methodology is the switching regression model. In section 4, we describe data for the study and present our empirical results. Section 5 concludes the paper with some thoughts on just what the study has accomplished.

2. Subcontracting and Corporate Groups

In the Japanese automobile manufacturing industry, parts and components that are not produced internally are purchased from two types of external suppliers. A substantial proportion of these external suppliers are members of a well-defined group of firms closely associated with one of the main automobile manufacturers.[1] The "kigyo" group refers to the arrangement wherein a major manufacturer surrounds itself with satellite suppliers bound together by long-term buyer-seller agreements. In the auto industry these supplier groups provide the manufacturer with a variety of auto parts, such as engines, carburetors, transmissions, steering assemblies, axles, wheels, and electrical components. The firms that

[1]Manufacturing groups are to be distinguished from the financial groups, which consist of firms surrounding a major financial company. For further descriptions of corporate groups, see Aoki (1987), and Nakatani (1984).

belong to the group clearly and openly identify themselves as members of the group, e.g., Toyota Group, and membership in a group usually excludes membership in any other group. The second type of external supplier are parts makers that do not belong to any kigyo group and clearly identify themselves as independents.

The relationships between the firms in a group are informal, but yet are clearly defined. For example, a typical member in one of the major groups sells a majority of its product to either the principal manufacturer or to another firm in the group. Although the group member is not precluded from selling to firms outside the group, selling to the group's main competitor, e.g. Toyota Group versus Nissan Group, is done very rarely. Usually, outside sales are to independent parts-makers or to one of the secondary groups, e.g. Honda, Isuzu, Mazda, Mitsubishi. In contrast, independent parts-makers sell to all types of buyers, irrespective of group affiliation.

The kigyo group is also characterized by interfirrn holdings of common stock. That is, Toyota holds shares of every firm in its group and the major suppliers in the Toyota Group often hold shares in the secondary parts-makers in the group. Interfirm shareholding tends to be asymmetric in the sense that the smaller firms rarely hold shares in the parent firm, although it can happen that the largest group members are corporate shareholders in the parent company.[2] On the other hand, inter-group holdings of common stock is virtually non-existent. This, of course, reflects the fact that group membership tends to be mutually exclusive. Interfirm shareholdings between independent firms and kigyo group firms is quite common, but tends to be quite small. For the parts suppliers

[2]In the sample of 91 parts suppliers in this study, none of the member firms held shares of common stock in the parent company. This is unlike the financial groups in which corporate shareholding is much more symmetric. See Nakatani, *supra* note 1 at 231.

that we sampled, the average percent of independent suppliers' common stock owned by a major auto maker was 2.8%, whereas for kigyo group suppliers, the corresponding percentage was 32.1%.

The parent firm tends to maintain close contact with the executives and management of its member firms. The presidents of the various companies have regular meetings. Often the boards of directors of the leading firms in the group are interlocked wherein a director of one company sits on the boards of several others. There are frequent exchanges of top executives and managers between the parent firm and its members. In our sample, the management staffs of 99% of the kigyo suppliers included managers from the parent company, whereas there was only one independent firm that had a manager on its staff who was previously employed by one of the main auto makers.

To explain why kigyo groups exist, several researches have focused on the efficiency gains obtained under this form of organization. It is said to improve the allocation of capital (Aoki, 1984). On the one hand, the parent firm's capital requirements are lower, because it is not producing as many components, in-house. On the other hand, the kigyo group serves as an internal capital market for its members and financial assistance is available to the members of the group. Technological innovation and "know-how" are disseminated within the group as a way of encouraging each firm to cut costs and improve efficiency (Aoki, 1987). Furthermore, long-term supply assurances by the auto makers have encouraged kigyo members to undertake efficiency enhancing investments (Miwa, 1994).

Masahiko Aoki (1987: 280-281) hypothesizes that inter-firm shareholding in non-zaibatsu groups is a substitute for risk diversification in the absence of perfect capital

markets. He also argues that mutual shareholding provides for and is an effective bond for interfirm relations that serves to reduce transactions costs. While his arguments have intuitive appeal, they do not explain the practice of interfirm shareholding between kigyo group firms and independent firms. Nor are his hypotheses consistent with the observation that kigyo suppliers tend to be less profitable than independent firms.[3] Using our approach, we reconcile this apparent anomaly between the common stock ownership by the parent firm and the profits of the kigyo members.

Much of what is known about subcontracting in the automobile industry is based upon the studies by Asanuma (1984, 1985).[4] He divides the negotiation process into two stages. In the first stage the basic contract is worked out for four years, the usual duration of an automobile model. During this first stage, the parts-maker examines the design specifications for the components and estimates the development and production costs. The manufacturer examines these estimates and determines the basic contract price in such a way that the estimated production costs are covered as well as a mark-up for the supplier's profit. In addition, the manufacturer agrees to pay for the specific investment needed to set up the production process, e.g. molds and casts. In the first stage the production target is agreed upon and presumably reflects the total number of units of the final product which the manufacturer expects to sell.

The second stage of the negotiation process occurs after production has begun. During this stage, a sequence of short-term agreements is struck in intervals of from one to six months. Here, minor adjustments are made to the basic contract to account for

[3]The celebrated study by Caves and Uekusa (1976, Ch. 4) established that independent firms are more profitable than those in a kigyo group. A subsequent study by Nakatani, *supra* note 1, substantiated these results.

changes in design, quantity, some costs, and efficiency. Increases in labor and energy costs are not permitted to be passed on in the form of higher contract prices. Furthermore, if the contract quantity has to be reduced in response to falling demand, the manufacturer nevertheless insures that the fixed development and set-up costs will be covered

3. Methodology

The theoretical framework for the ana1ysis is relatively straightforward. Consider a steady state, equilibrium relationship between the buyer and seller of an intermediate input, e.g., an automobile component. The buyer has complete information about the seller's attributes, such as its costs, capabilities of the supplier's engineering, management, and production staff, and the way in which management and production are organized. Likewise, the seller has complete information about the buyer. It knows the buyer's valuation of the part, the value of the buyer's product, the number of units the buyer plans to purchase, and the desired quality and specifications of the part.

Suppose the buyer offers the seller a long-term contract to continue the relationship between the agents. The seller can expect to earn the return V from the contract. In equilibrium the value of V is likely to be constrained by two factors. First, the seller could choose to reject the incumbent's offer and accept the highest bid from other buyers in the market. Let V* denote the returns the seller can expect to earn from these outside offers. It is determined, in part, by the price the seller can obtain from alternative buyers, typically on short-term spot markets. The second factor that is likely to constrain V consists of the costs the seller incurs if it switches to another buyer. For example, switching buyers may require the seller to redesign the part, modify the production

[4]Two other papers dealing with subcontracting are Sato (1984) and Uekusa (1987).

process, retrain workers, and even locate new prospective buyers. Let C denote these switching costs.

For simplicity, assume that both parties are risk neutral. If the buyer's offer were such that $V < V^* - C$, then the seller would surely terminate the relationship and switch to another buyer. On the other hand, if $V > V^* - C$, then the buyer would find it more profitable if it offered a different contract which obligated it to pay a slightly lower price for the part. Consequently, in equilibrium we would except to find that

(1): $V = V^* - C$.

Thus, our model suggests that switching costs create a wedge between the supplier's reservation and actual profits. Moreover, eq. (1) suggests that supplier profits are determined by two classes of variables. On the one hand are those variables that determine the supplier's reservation profits; the profits it can expect to earn if it auctions its part to outside bidders. On the other hand are those variables that determine the costs of switching from the incumbent buyer to another buyer. As it applies to Japanese automobile manufacturing, eq. (1) implies that parts suppliers with higher switching costs, ceteris paribus, will earn lower profits. We argue that in as much as kigyo group suppliers have higher switching costs than independents, then we should observe lower profits for kigyo group members. As we pointed out in the previous section, this has been observed by other studies Caves and Uekusa (1976), Nakatani (1984), as well as the present one.

In the rest of this section, we formulate the empirical specification for the model in eq.(1). Of the alternative measures of the dependent variable, V, the supplier's returns or profits, we find it convenient to use the ratio of before-tax operating profits to sales revenue. This ratio becomes a measure of the firm's profit margin, i.e., the ratio of price-

minus-cost to price, when unit costs are constant. Variables that are likely to reflect the supplier's reservation profits include the following: Equity or net assets measure the firm's financial strength and viability, and may affect its ability to negotiate profitable contracts with buyers. Variables that reflect the supplier's cost structure, for example labor costs or wages, are likely to affect the firm's reservation profits. A supplier's capital-to-labor ratio measures the relative size of the firm's physical plant or it may stand as a proxy for the firm's technological attributes. Finally, the firm's output, e.g., body components, engine parts, transmission, chassis assemblies, is likely to affect the firm's reservation profit margin.

We use two variables to measure of effects of switching costs on the supplier's profit margin. The first variable is the number of buyers of the supplier's part. Presumably, switching costs are expected to be lower if there are several potential buyers the seller can turn to if it seeks outside.

We maintain that the second determinant of switching costs arises when the part is highly specific to the incumbent auto maker, thereby intensifying its need to exercise control and coordination over the supplier. According to Monteverde and Teece's study of the US automobile industry (1982), components that are specifically engineered for the incumbent car maker must be modified in order to meet the specifications of another buyer. Making these modifications tends to raise the supplier's switching costs. Monteverde and Teece also argue that specific components are more likely to require close control and supervision in order to guard against supplier opportunism. Hence, they conclude that suppliers of highly specific components are more likely to be vertically integrated by the car maker.

We argue that the same forces operate within the Japanese auto industry, wherein the incentive of the parent car maker to induct suppliers into its kigyo group corresponds with the incentive for vertical integration by US auto makers. Thus, parts suppliers that require close control and supervision by the Japanese car maker correspond to those parts suppliers that the US auto maker would want to vertically integrate. But how might a Japanese auto maker exercise control and supervision over a parts supplier? Imagine that the parent company inducts the supplier into its kigyo group. Then the auto maker acquires sufficient shares of the supplier's common stock in order to place members of its own board of directors on the board of the member company. Moreover, with this influence over the supplier's shareholder votes and its board of directors, the parent company can secure even more control by placing some of its executives and managers within the satellite supplier. Thus, the governance mechanism of the kigyo group enables the parent company to exercise management control and coordination over the member suppliers.

We test this hypothesis with the following model:

(2): $M_i = a + bS_i + c' Z_i + \nu_i$, where Mi is the number of supplier *i*'s managers who were previously employed as managers in the parent company, S_i is the percent of supplier *i*'s common stock owned by the parent firm (*SHARES*), Z_i is a vector of attributes of supplier *i*, which includes the type of component the supplier produces, its capital-labor ratio, equity-sales ratio, and ν_i is the standard regression error term. In the next section, we provide the details of the empirical estimation of eq.(2). Suffice it to say here that our hypothesis is statistically supported: The degree of management control, M, is greater when the parent firm has larger holdings of common stock and when the part tends to be

specialized. In what follows, *SHARES* is the key variable we use to measure the effect of supplier switching costs. It reflects the auto maker's incentives to control the supplier, where control and coordination are desired over those parts makers for whom switching costs are high, namely those that supply highly specific parts.

Based on the above analysis, we assume that the empirical specification of the model in eq. (1) can be written in the following form:

(3): $V_i = \beta' X_i + \gamma' Y_i + u_i$

where X_i is a vector of attributes affecting the returns supplier *i* can expect to get from alternative buyers, Y_i is the vector of attributes that determine supplier *i*'s switching costs, u_i is the regression error term, and β, γ are the vectors of the parameters to be estimated.

However, eq.(3) cannot be estimated in its present form. As we stated in Section 2, there are two types or regimes of auto parts suppliers in Japan: Those that belong to one of the kigyo groups and those that are independent and not affiliated with any car maker group. Now if the assignment of the suppliers to these two regimes is correlated with the probits that firms in the respective regimes earn, then the correct specification of eq.(3)is a switching regression model. Following Maddala (1982: 223-228), the switching regression form for eq.(3) can be written as follows:

$$(4): V_i = \begin{cases} \beta_1 X_{i1} + \gamma_1 Y_{i1} + u_{i1} \text{ if } i \in G \\ \beta_2 X_{i2} + \gamma_1 Y_{i2} + u_{i2} \text{ if } i \in I \end{cases}$$

where the assignment of a supplier i to a kigyo group, *G*, or to the independent, *I*, occurs when

(5): $bZ_i > u_{i3}$ for $i \in G$; $bZ_i < u_{i3}$ for $i \in I$.

In this model, the vector of error terms, (u_{i1}, u_{i2}, u_{i3}) is assumed to be trivariate normal with zero mean vector and covariance matrix:

$$\Sigma = \begin{bmatrix} \sigma_1^2 & \sigma_{12}^2 & \sigma_{13}^2 \\ \sigma_{21}^2 & \sigma_2^2 & \sigma_{23}^2 \\ \sigma_{31}^2 & \sigma_{32}^2 & \sigma_3^2 \end{bmatrix}$$

where $\sigma_3^2 = 1$. Using Lee's two-stage procedure (Maddala, 1982: 223-228), we first estimate the probit assignment model, eq.(5) using Maximum Likelihood. Then we use the estimates from the first stage to construct the selectivity correction variables, *GROUPSELECT* and *INDEPSELECT*, that are appended to eq.(4). We then apply standard OLS regression to estimate the two appended regime equations in (4) and correct the standard errors for heteroscedasticity. We report the results of this estimation in the next section.

4. Empirical Results

The data for this study were obtained from a variety of sources for a sample of 91 automobile parts suppliers listed in the Tokyo, Nagoya, and Osaka stock exchanges (*Yuka Shokan Hokoku Sho*, 1987). Information about what each firm in the sample produced and its buyers was found in the Auto Parts Industry Yearbook (*Nihon No Jidosha Buhin Kogyo*, 1987). Financial data were collected from corporation annual reports. Information about kigyo group membership and shareholdings was obtained from *Kigyo Keiretsu Soran* for 1987. Because our interest centered on parts suppliers that sell directly to one of the main auto makers, the sample included only the larger, "first-tier" subcontractors. The

final sample with complete data consisted of 53 kigyo suppliers and 23 independent parts makers.

Table 1 presents the Ordinary Least Squares regression results for the management control model of equation (2) in section 3. As the table shows, the results support the hypothesis that stock ownership facilitates the attainment of management control over the kigyo supplier by the parent firm. Consistent with this hypothesis, the stock ownership by the parent company has a positive and significant effect in explaining the exchange of management personnel from the parent firm to its satellite suppliers. Since engine components must be integrated into a complex subassembly requiring significant engineering effort and coordination, we included a dummy variable for engine components, *ENGINE*. The coefficient on this variable is positive and significant. This result supports the transactions cost hypothesis that greater control is necessary for highly specific parts. Other subcomponents had no significant role in explaining management control. Two variables, the *Capital-Labor* (capital-labor ratio) and the *Equity-Sales* (equity-sales ratio), were included to control for differences in supplier attributes: Namely, differences in technology and financial stability, respectively. Neither of these two variables was statistically significant in explaining management control.

For the first stage of Lee's two-stage switching regression procedure, we estimated the probability of kigyo group affiliation. As shown in **Table 2**, the probit model appears to fit the data reasonably well with an average likelihood of 66.6%. The dummy variable, *SPECIFIC*, indicates whether the supplier produces a specialized component. Here we defined *SPECIFIC* to equal one if the supplier produces a component for one of the following subassemblies: body, engine, chassis, transmission. The positive and significant

effect of *SPECIFIC* on the probability of group affiliation is consistent with transactions cost theory. The variable, *ASSETS*, defined as the ratio of total assets to total sales revenue, is significant at 5% and has the expected negative sign. It is reasonable that, *ceteris paribus*, smaller suppliers tend to benefit more from the supply assurances of the parent auto manufacturer and hence have more incentive to join a kigyo group. In order to see if production technique might help to explain kigyo group affiliation, we tried various measures of capital as an independent variable, with similar results. For the case shown in Table 2, we used the capital-sales ratio, *CAPITAL*. While this variable has the expected sign, it is not significant at 5%. In summary, our results suggest that group affiliation is more likely for smaller suppliers that produce relationship-specific components parts.

The second stage of Lee's procedure provides estimates of the profit margin equation (4) for the two types of suppliers. The results shown in **Table 3** were obtained by constructing two selectivity correction variables, *GROUPSELECT* and *INDEPSELECT*, from the first stage probit estimates, and then appending these corrections to the respective profit margin equations in (4). The purpose of Lee's procedure is to eliminate selectivity bias when kigyo group affiliation is correlated with profit margins. As shown in Table 3, the significant coefficient on *GROUPSELECT* indicates the presence of selectivity bias. In order to demonstrate the extent of this bias, we estimated the two equations in (4) without correcting for selectivity. As **Table 4** shows, our results are substantially affected if we do not make these corrections.

Table 3 shows the contrasting results between independent suppliers and kigyo suppliers. Within the kigyo group regime all variables, except *BUYERS* (the number of buyers of the supplier's part), were significant with expected signs. On the other hand, for

independent suppliers, only one variable, *CAPITAL-LABOR* (capital-labor ratio), has a significant effect in explaining the profit margins. Overall, the model does a reasonably good job in explaining the data for both regimes, as indicated by the R-squares and the F statistics. Let us now consider the results for individual variables, and compare them across kigyo and independent supplier regimes.

We first consider the variables that are supposed to reflect the supplier's reservation profits. The variable *EQUITY* (equity-sales ratio) is significant and positive for kigyo-affiliated suppliers, but is not significant for independents. For kigyo suppliers who tend to be smaller and more specialized, greater financial strength is likely to enable them to win higher bids for their parts on the open market. On the other hand, for the non-affiliated suppliers, who tend to be larger and sell standardized parts, financial strength does not appear to influence the bids they can expect to receive from buyers. Labor cost per worker, *WAGE*, is significant and has the expected sign for the kigyo regime, but like *EQUITY*, is not significant in the other regime. As we pointed out in section 2, one advantage of belonging to a kigyo group is that the parent firm typically agrees to cover most cost increases which the supplier incurs, except for increases in labor and energy costs. Thus, if *WAGE* increases and the parent company makes no adjustments in payments, then the supplier's profit margin will fall. Our results suggest that independent suppliers are able to pass on increases in labor costs to the buyers, i.e., increases in *WAGE* do not affect profit margins. This interpretation is not unreasonable because independent suppliers, as rather large firms whose standardized part are needed by every auto maker in the industry, are likely to have considerable bargaining power. The capital-labor ratio (*CAPITAL-LABOR*) has the expected sign and is significant for both regimes. It not

surprising that capital intensity raises profitability for any firm, irrespective of group affiliation.

Of the two proxy variables for switching costs, *SHARES* and *BUYERS*, the former presents the more compelling support of our theory. As shown in Table 3, the percentage ownership of supplier common stock by an auto maker has the hypothesized effect on profit margins for both types of suppliers: negative for kigyo group suppliers and insignificant for independents. According to our theory, the parent firm acquires greater shareholdings (and hence control) of those suppliers whose parts are more specialized. Moreover, according to transactions cost theory, suppliers with more specialized parts have higher switching costs. Thus, the theory predicts that the presence of switching costs will be indicated by a negative coefficient on *SHARES* for kigyo suppliers, which is what the data shows. In contrast, independent suppliers, whose parts are standardized, are not expected to have significant switching costs, even though some of their common stock may have been acquired by a major auto maker. This is also supported by the result in Table 3. In addition as we pointed out in section 2, the auto makers only held 2.8% of the independent suppliers' common stock, suggesting that the incentives for owning these shares must be low indeed.

In conclusion, the empirical results reported in Table 3 are consistent with the theory proposed in the previous section. Of particular interest is the empirical support for the hypothesis that the negative effect of parent firm share holdings on supplier profit margins reflects higher switching costs for kigyo suppliers that produce specialized components. This result provides a plausible explanation for why kigyo suppliers' profits tend to be less than those of independents. In our sample, a t-test shows that the average

profit margin of 2.6% for kigyo suppliers is significantly less than the 4.9% average for independents at the 5% level.

5. Conclusions

Within the framework of transaction cost theory, we have argued that the profits which an auto parts supplier can expect to earn from the auto maker with whom it has been dealing for some time, will equal the profits the supplier could expect to earn if it switches to another buyer, minus the costs it would incur in order to effect the switch. The reason is that profits above the equilibrium will provide the auto maker with the incentive to lower the price it is willing to pay for the part, thereby diminishing the profits going to the supplier. Profits below the equilibrium will provide the supplier with the incentive to seek out outside offers, which by definition, exist and will provide the supplier higher incomes, even after accounting for switching costs. Thus, transaction costs theory implies that switching costs create a wedge between the amount the supplier actually earns and the amount it could earn from alternative buyers.

This provides a way to empirically test some of the propositions of the theory. To this end, we developed hypotheses about the determinants of this wedge and about the way in which it is likely to vary with changes in certain transaction-specific variables. To carry out the empirical tests, we obtained data from a sample of Japanese automobile parts suppliers. The Japanese auto parts industry is especially interesting because of the unique subcontracting relationships between the major auto makers and the suppliers. Here suppliers tend to fall into two different regimes. In one regime, the suppliers are closely affiliated with one of the major auto makers in what are known as "kigyo" groups. The

other regime consists of suppliers that are independent of any group affiliation. We argued that suppliers of specialized components requiring greater coordination and control by the auto maker are more likely to be inducted into the auto maker's kigyo group. In addition, smaller suppliers are more likely to be found in a kigyo group because the benefits of long term supply assurances, technical assistance, and other services offered to group affiliates are likely to be greater for smaller firms. A probit model of the assignment of suppliers to kigyo groups was estimated, and strong support of our hypotheses was found.

A major conclusion of transaction cost theory is that suppliers of specialized components are more likely to have higher switching costs than those that produce standardized parts. As a corollary it follows that since suppliers of specialized components require greater coordination and control by the auto maker, then switching costs should be positively related to these efforts of auto makers. Our empirical findings were consistent with these conclusions. First, we found evidence that our measure of switching costs, the wedge between reservation profits and actual profits, was greater for kigyo suppliers than independents. Second, we found that higher levels of auto maker's coordination and control, measured by their holdings of supplier common stock, were consistent with higher switching costs.

In conclusion, we believe that using the transaction cost framework has provided a clearer understanding of the subcontracting relationships between the Japanese auto makers and the auto parts suppliers. In particular, the concept of switching costs has not only facilitated the derivation of testable hypotheses, but it has also led to the construction of an empirical model.

TABLE 1
OLS Regression of Management Control of Kigyo Group Suppliers

INDEPENDENT VARIABLE	COEFFICIENT
CONSTANT	2.7396 (1.5063)
SHARES	10.7018 (2.8658)
CAPITAL-LABOR	- 2636.5183 (- 1.4983)
EQUITY-SALES	- 3.9671 (- 1.0232)
ENGINE	1.7474 (2.0415)

t-statistics in parentheses
Adjusted R^2: 0.2808
F-value: F(4, 49) = 6.1751
Sample Size: N = 54

TABLE 2
Probit Estimates of Kigyo Group Membership

INDEPENDENT VARIABLE	COEFFICIENT
CONSTANT	2.6597 (3.1441)
SPECIFIC	0.9227 (2.4847)
ASSETS	- 2.3916 (- 2.3930)
CAPITAL	- 3.1836 (- 1.2120)

t-statistics in parentheses
Average Likelihood: 0.6660
Sample Size: N = 77

TABLE 3
Switching Regressions of Profit Margin:
Kigyo Group Suppliers and Independent Suppliers

INDEPENDENT VARIABLES	COEFFICIENTS	
	KIGYO GROUP	**INDEPENDENTS**
CONSTANT	0.0188 (1.2776)	0.0391 (1.2360)
EQUITY	0.1462 (4.5009)	- 0.0030 (- 0.2795)
WAGE	- 0.6014 (- 2.0583)	- 1.3804 (- 1.2145)
CAPITAL-LABOR	33.5312 (2.5667)	94.4577 (3.1978)
SHARES	- 0.0544 (- 0.3687)	- 0.2604 (- 1.2747)
BUYERS	- 0.0004 (- 0.3687)	0.0020 (0.6221)
GROUPSELECT	0.024845 (2.3155)	
INDEPSELECT		- 0.0174 (- 1.0326)

t-statistics in parentheses
Adjusted R^2: Kigyo Group = 0.3970; Independents = 0.4027
F-value: Kigyo Group = F(6, 47) = 6.8168, significance 0.00003;
Independents = F(6,16) = 3.4724, significance 0.0216
Sample Size: N = 54 for Kigyo Group; N = 23 for Independents

TABLE 4
OLS Regression of Profit Margins:
Kigyo Group Suppliers and Independent Suppliers
Without Sensitivity Corrections

INDEPENDENT VARIABLES	COEFFICIENTS	
	KIGYO GROUP	**INDEPENDENTS**
CONSTANT	0.0152 (1.0087)	0.0156 (0.6677)
EQUITY	0.1077 (3.3118)	- 0.0055 (- 0.4937)
WAGE	- 0.5934 (- 1.5595)	- 1.7800 (- 1.5097)
CAPITAL-LABOR	18.2385 (1.2965)	105.8501 (3.6647)
SHARES	- 0.0444 (- 1.5833)	- 0.2854 (- 1.3420)
BUYERS	0.0004 (0.3150)	0.0037 (1.2971)

t-statistics in parentheses
Adjusted R^2: Kigyo Group = 0.3530; Independents = 0.4046
F-value: Kigyo Group = F(5, 48) = 6.7838, significance 0.00007;
Independents = F(5,17) = 3.9894, significance 0.0141
Sample Size: N = 54 for Kigyo Group; N = 23 for Independents

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