An Application of Extended Transfer-Pricing Model to the *Kigyo Keiretsu* System in the Japanese Automobile Manufacturing Industry*1

日本の自動車産業における系列取引の研究――トランスファー・プライス・モデルの応用

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Abstract:

This paper focuses on the following issues. First, it is concerned with a problem of pricing auto-parts that are exchanged between the automaker and its parts-suppliers within the *kigyo keiretsu* group. Second, it illustrates how these prices should be set in order to induce each parts-supplier to maximize its profit as a whole. Third, we test whether the *kigyo keiretsu* system is a stable quasi-vertical organization. If so, what is the optimal level of holding parts-suppliers' shares by the automaker in order to maximize parts-suppliers' total sales and profits?

キーワード：*Kigyo Keiretsu*（企業系列）、Japanese Automobile Industry（日本の自動車産業）、Transfer-Pricing（移転価格）、Quasi-Vertical Integration (準垂直的統合)、Auto-Parts-Supplier (自動車部品サプライヤー)

Ⅰ. Introduction

The structure of the Japanese automobile manufacturing industry is a set of pyramids, with the product flows from the bottom to the top. Automakers, such as Toyota, Nissan, and Honda are at the top of each of their pyramids.*2 The parts for each automaker are supplied by its affiliated group member firms, and primary independent parts-suppliers. Above all, a conspicuous feature of the Japanese automobile manufacturing industry in Japan is that Japanese firms are less vertically integrated than their American counterparts. Rather than adopt fully vertical integration, a Japanese automaker surrounds itself with a group of parts-suppliers that are bound to the automaker through shareholdings, exchange of directorates or management, and technological and financial assistance. These parts-suppliers in a *kigyo keiretsu* group tend to be vertically related in the production chain and produce most of their parts for their respective automaker or other firms within the group.

This paper focuses on the following issues. First, it is concerned with problem of pricing auto-parts that are exchanged between the automaker and its parts-suppliers within the *kigyo keiretsu* group.*3 Second, it illustrates how these prices should be set in order to induce to each parts-supplier to maximize its profit as a whole. Third, we test whether the *kigyo keiretsu* system is a stable quasi-vertical organization. If so, what is the optimal level of holding parts-suppliers' shares by the automaker in order to maximize parts-suppliers' total sales and profits?

Ⅱ. Characteristics of the *Kigyo Keirestu* System in the Japanese Automobile Manufacturing Industry

There are several distinguishing features to the Japanese automobile manufacturing industry. First, most of the parts and sub-assemblies are purchased from "external" suppliers under long-term contracting arrangements. According to some studies, comparing the US and Japanese automobile industries, US manufacturers, including their fully-owned subsidiaries, produce about 45 % of the purchased value attributable to outside suppliers. In contrast, Japanese auto manufacturers and their fully owned subsidiaries contribute only 25 % of the final product's market value as the in-house production (Aoki, 1986). Second, a substantial proportion of these external subsidiaries is closely affiliated with the main automakers in the name of buhin-*kyoryokukai*, or corporate association. For instance, In the mid-90s, Toyota Motors organizes three associations, named *Tokai Kyohokai*, *Kanto Kyohokai*, and *Kansai Kyohokai*,*4 on a regional basis. Nissan used to organize *Takarakai and Shohokai*.*5 In addition, the automakers tend to purchase parts and components from firms which are members of respective *kigyo keiretsu* group. According to Asanuma (1992), Toyota purchased about 90 % (by monetary value) from the *Kyohokai* member firms in 1986. In 1983, Nissan bought about 90 % from the member firms in *Takarakai* and *Shohokai*. The term, "*kigyo keiretsu*" refers to the vertical arrangement wherein a major manufacturer surrounds itself with a group of suppliers bound together by a set of long-term buyer-supplier's agreements.*6 Third, each major manufacturer tends to deal with a small number of parts suppliers per parts purchased, and is usually dealing with two to three parts suppliers per unit of parts (Itami, 1988 and Fair Trade Commission, 1993).

In the automobile manufacturing industry, these limited numbers of suppliers provide the auto-assembler with variety of parts, such as engines, carburetors, transmissions, steering components, clutches, axles, wheels and electrical components (See Table 1). Except other parts, such as standardized parts or raw materials, the Japanese automakers deal with two to three parts-suppliers per parts.

Table 1. Number of Parts-Suppliers per Parts

	Engine Component	Body Component	Transmission and Clutch	Chassis and Brake	Electric Component	Other
Toyota	2.00	2.58	2.13	2.57	1.90	3.67
Nissan	1.88	2.42	2.13	2.86	2.50	4.33
Honda	1.92	1.75	1.27	2.07	1.95	3.67
Mazda	2.21	2.33	2.07	2.14	2.55	4.33
Mitsubishi	2.50	2.792	2.53	2.57	2.35	4.00
Mean	2.08	2.38	2.03	2.44	2.35	4.00

Data Source: IRC 1987. "*Jidosha Buhin 160 Hinmoku No Seisan Ryutsu Chosa*," English translation: Survey of Product Distributions of 160 Auto Parts.

The firm that belongs to the manufacturing *kigyo keiretsu* group clearly and openly identifies itself as a member of the group; for instance, Toyota group, Nissan group, Honda group, and so on. Membership in a group usually excludes membership in any other groups if suppliers in the group produce highly specific parts, such as engines, and body-assemblies. However, not all parts' manufacturers belong to a group, and these firms clearly identify themselves as "independent" firms.

A typical parts-supplier in one of the major *kigyo keiretsu* group sells most of its products to either the principal automaker or other firms in the same group. Although the group member firm is not precluded from selling to other firms outside the group, selling to its main competitor is rare. For instance, the parts-suppliers in the Nissan group rarely deal with Toyota. Usually, outside sales are independent parts-suppliers or to one of the secondary automakers, such as Honda, Mazda, and Mitsubishi. In return, firms in one of the secondary groups also sell their parts to the dominant groups, such as Toyota and Nissan. For instance, Keihin Seiki Mfg. Co., Ltd., joining the Honda group, sells carburetors, injectors, and engine valves to Nissan. In this sense, firms in the secondary group are not tightly linked with their respective parent automaker. However, this helped these parts-suppliers in a secondary automaker group to obtain technological "know-how" and skills in developing parts in cooperation with these two dominant automakers. In contrast, independent parts-suppliers sell all types of buyers, irrespective of group affiliation. These suppliers are quite heterogeneous. While some suppliers produce standardized parts such as tires, batteries, and raw materials, others produce more specialized products, such as brakes, piston rings, gaskets, shock absorbers and oil pumps.

The *kigyo keiretsu* is also characterized by interfirm holdings of stock. Namely, Toyota holds shares of every supplier within its group. The major suppliers in Toyota group often hold shares in the secondary parts-suppliers, or the second layer of their parts-suppliers in the group. This generates sub-subcontractors. Interfirm shareholding tends to be asymmetric in the sense that the smaller suppliers rarely hold shares of the parent automaker, although it can happen that the largest suppliers in the *kigyo keiretsu* group are corporate shareholders of the parent automaker.*7 Another aspect of the *kigyo keiretsu* structure is that intergroup holdings of common stock are virtually non-existent. This, of course, reflects the fact that group membership tends to be mutually exclusive. Interfirm shareholding between independent suppliers and firms in a *kigyo keiretsu* is quite common. For example, Nissan, Toyota, and Bendix respectively hold 15.1%, 14.9%, and 14.8% of an independent parts-supplier, Akebono Brake Industry in 1987.

The parent automaker tends to maintain close contact with the leaders of it 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 director of one company sits on the boards of others. There are exchanges of top executives and managers between the automaker and its member firms in the group. In manufacturing, the engineers are also exchanged among group member firms as technological assistants or consultants. This implies that technological innovation and "know-how" are disseminated within the group as a way of encouraging each parts-supplier to cut costs and improve efficiency. This appears to benefit the automakers. One of the benefits is that dissemination of technological innovation and "know-how" within a *kigyo keiretsu* group serves to reduce the parent firm's costs of switching suppliers.*8 Another benefit is that better communication between the automaker and its suppliers in the *kigyo keiretsu* group reduces the monitoring costs as well as other transaction costs. Moreover, closing the gap of asymmetric information between the buyer and the seller appears to help the automakers to mitigate opportunism by the parts-suppliers in its group.*9

The quasi-vertically integrated group system, so-called, the *kigyo keiretsu* system works like an inter-market-pricing system.*10 Therefore, we have applied a transfer-pricing model to such Japanese *kigyo keiretsu* system; namely, transfer-pricing models with technologically independent and dependent cases are developed.*11 In the following section, we first overview the Hirshleifer's transfer-pricing model and extend his model to analyze how the parts-suppliers charge their prices of parts to the automaker in a *kigyo keiretsu* group.

Ⅲ. Basic Models

1. Overview of the Hirshleifer's Transfer Pricing Model*12

Assume that the units of the final product can be expressed in units of the intermediate product. More specifically, one automobile corresponds to one carburetor or one radiator in this case. The determination of the joint level of output is shown in Figure 1.

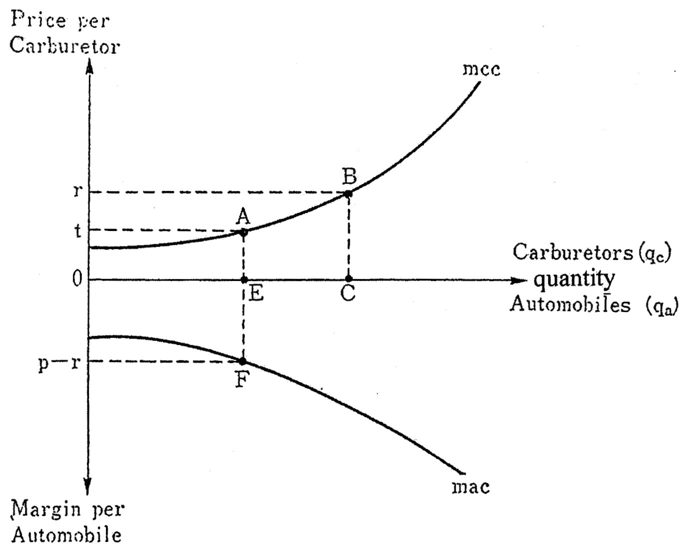

Figure 1

The curves respectively denoted as mcc and mac represent the marginal cost of producing the carburetor and of the automobile. Given this information, Hirshleifer's proposed solution is for the parts-supplier to produce OC units of carburetors. OE units of carburetors are sold to the parent firm and EC units to the external market. The automaker produces OE units of automobiles, and hence requires OE units of carburetors from its subsidiary.

The optimal transfer-price of carburetor is the market price, r, that is, r = mcc. Under the technological independence, the automaker will produce its automobiles up to the point where p = mac + mcc. The sum of the marginal costs embodies the assumption that the operating costs are independent.

In the following discussion, imperfectly competitive intermediate market is assumed. First, consider the auto-manufacturing firm. For each of automobile it sells, the revenue is given by MR. The extra cost it occurs is the sum of its own mac plus that of the carburetor, mcc. The reason for regarding total manufacturing costs as the sum, mac + mcc, is the assumption of technological independence wherein the operating costs of each firm are independent of the level of operations being carried on by the other.

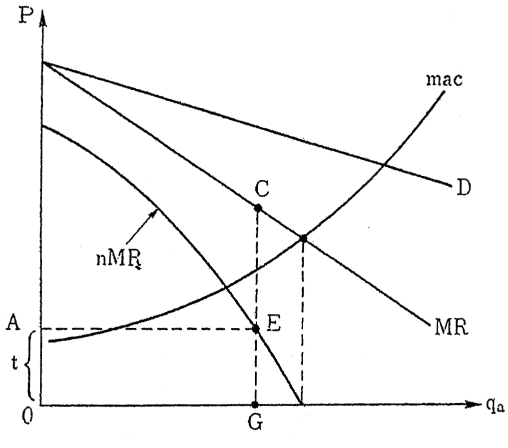

Figure 2

In Figure 2, the "net marginal revenue" curve (denoted as nMR) is obtained by subtracting mac from MR; that is, nMR = MR − mac. The net marginal revenue, nMR, shows the amount that the automaker is willing to pay for each successive carburetor. Hence, nMR represents the automaker's demand curve for its auto-parts.

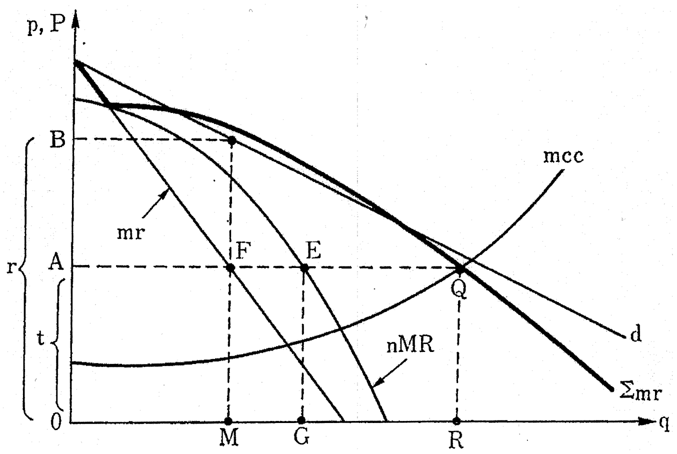

Figure 3

Next consider the auto-parts-supplier. In Figure 3, Hirshleifer argues that parts-supplier must be instructed to take the nMR curve as given, and not to use the curve marginal to it. This is to prevent monopolistic exploitation by the parts-supplier. Hirshleifer's solution is to horizontal sum of mr and nMR.to get Σmr. The parts-supplier then produces up to the point where Σmr = mcc. The transfer price is t = OA whereas the price charged to external buyer is r = OB. Total parts output is OR, which consists of OM units to external buyers and OG units to the parent automaker. Note that the parts-supplier's behavior is analogous to discriminating monopolist. Note also that if OG units of carburetors are sold to the automaker at the transfer price OA = mcc, then, as is in Figure 2, the automaker produces OG units of automobiles where GE + EC = MR but GE = mcc and EC = mac. Therefore, Hirshleifer's solution implies that the automaker produces up to the point, MR = mac + mcc, which, we see, is precisely the condition for the profit-maximization. This verifies that the profit-maximizing-transfer-price should be equal to mcc.

Hirshleifer's analysis, thus, tells us that for a vertically integrated firm, the optimal transfer-price for the intermediate product should be its marginal cost. Then both the final assembler and its subsidiary will maximize their profits. This is equivalent to maximizing joint profits of vertically integrated firm. More specifically, if $c(q_a+q_c)$ and $z(q_a)$ are cost functions of producing parts and of producing automobiles, respectively, then we obtain the following equation:

$$\max_{q_a,\, q_c} \; p(q_a)q_a + r(q_c)q_c - z(q_c) - c(q_a+q_c) \; : (1)$$

Where q_a and q_c are quantities of automobiles and of carburetors sold to the parent firm. The first order conditions are obtained as:

$MR(q_a) - mac(q_c) = mcc(q_a+q_c)$: (2)

$mr(q_c) = mcc(q_a+q_c)$: (3)

As is shown in Figure 4, the parts-supplier charges the price of parts to the parent firm, t, and r to the external market (non-*kigyo-keiretsu*-member firm).

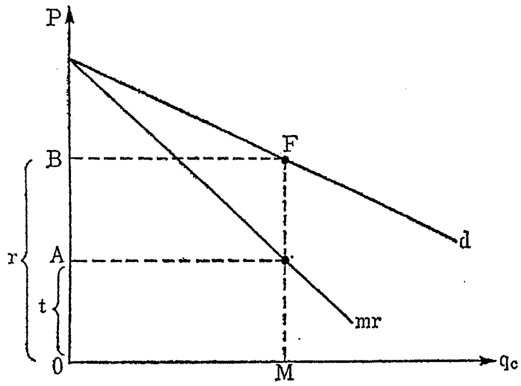

Figure 4

2. Extension of the Hirshleifer's Transfer-pricing Model

In the following two cases, the joint profit-maximization of quasi-vertically integrated firms is implicitly assumed.

A. Case of Technologically Independent Parts-supplier:

Suppose that the degree of vertical ownership, λ, is measured as the percentage of stock ownership of parts-supplier by the parent firm,*[13] and that administrative or monitoring cost is described as $A(\lambda)$. Since the administrative cost becomes larger as the firm grows larger. Namely, the firm size is large enough to show diseconomies of scale due to x-inefficiency), $A' < (\lambda) < 0$, and $A''(\lambda) > 0$ are assumed.*[14] Then we have to solve the following equations:

$$\max_{q_a,\, q_c} p(q_a)q_a - z(q_a) + \lambda\{r(q_c)qc - c(q_a+q_c)\} - A(\lambda) \quad : (4)$$

The first order conditions are obtained as:

$$MR(q_a) - mac(q_a) - \lambda\, mcc(q_a+q_c) = 0: (5)$$

$$\lambda\{mr(q_c) - mcc(q_a+q_c)\} = 0: (6)$$

These agree with the joint-profit-maximization of the quasi-vertical integrated firm.

Now, consider operating each firm independently. The automaker informs the subsidiary parts supplier of the parts demand curve, nMR, such that

$nMR(q_a) = \{MR(q_a) - mac(q_a)\} / \lambda$.*15

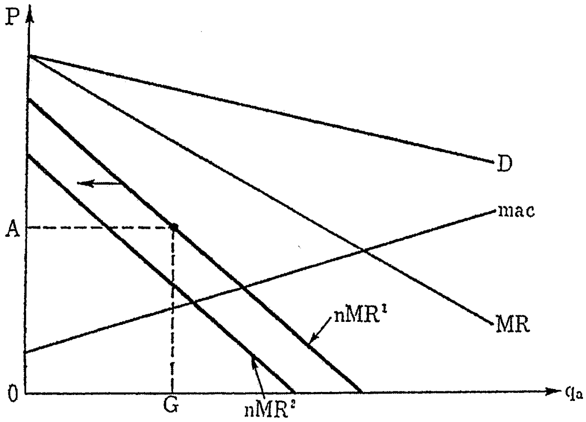

Figure 5

In Figure 5, this tells us that the parts demand curve will shift to the right from nMR[1] to nMR[2] if the degree of vertical integration, λ increases.

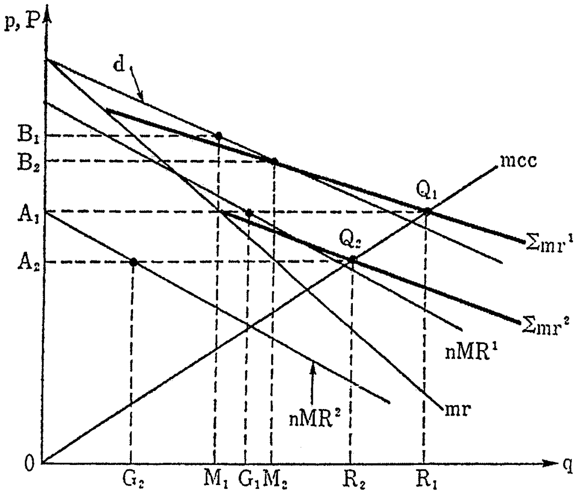

Figure 6

In Figure 6, for a given value of λ, the parts-supplier initially produces up to the point where $mcc(q_a+q_c) = nMR\ (q_a) + mr(q_c) = \Sigma mr^1$ at the level of output, OR_1. It then sells OM_1 to the external market at the price, OB_1, and sells OG_1 to the automaker at the transfer price, $OA_1 = mcc(q_a+q_c)$. However, the sales OG_1 to the automaker occurs where $mcc(q_a+q_c)) = nMR\ (q_a) \equiv \{MR(q_a) - mac(q_a)\} / \lambda$.

As is shown in Figure 6, it is interesting to compare the solution of the quasi-vertically integrated firm, $\lambda < 1$, with the fully vertically integrated firm, $\lambda = 1$. The solution of the latter case is shown as nMR^2. Resulting from the leftward shift of nMR from nMR^1 to nMR^2 due to the increase of λ, the Σmr curve will also shift from Σmr^1 to Σmr^2. Sales to the parent automaker, OG_1 drops toOG_2 when $\lambda = 1$, but sales to the external rises from OM_1 to OM_2. The transfer price will then drop to OA_2, while the price to the external market slightly drops to OB_2.

To determine the optimal degree of vertical integration, differentiate the firm's maximum profit with respect to λ. This yields $A'(\lambda) = rq_c - c(q_a+q_c) \equiv \pi_c$, where π_c is the economic profit of the parts-supplier and it is independent of the degree of vertical integration, λ. As is shown in Figure 7, the optimal degree of vertical integration, λ^* is obtained by finding the intersection of π_c and $A'(\lambda)$.*16

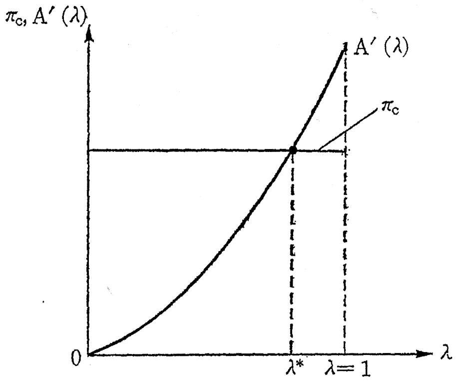

Figure 7

B. Case of Technologically Dependent Parts-supplier:

Similar to the discussion above, but this time, the cost function of producing parts includes the degree of stock ownership of the parts-supplier by the parent automaker, λ. Because the more the parent automaker owns its parts-supplier's stock, the more information to produce parts are obtained from the parts-supplier. More specifically, under the *kigyo keiretsu* system, better communication between the automaker and its parts-suppliers in the group will help the parts-supplier to reduce its production costs as well as other transaction costs. Thus, it is quite plausible that the cost function includes the variable, λ as a cost saving factor due to vertical integration, and set the cost function as $c(q_a+q_c, \lambda)$. As the amount of the automaker's partial stockholdings of its parts-supplier increases better coordination between the automaker and its parts-supplier. Hence, $c(q_a+q_c, \lambda)$ is assumed to be a monotonously decreasing function of λ.*[17] To obtain the optimal degree of vertical integration, λ, differentiate the following equation with respect to λ.

$$\max_{\lambda} p(q_a)q_a - z(q_a) + \lambda\{r(q_c)q_c - c(q_a+q_c, \lambda)\} - A(\lambda) \quad : (8)$$

The first order condition is obtained as

$$\pi_c - \lambda c(q_a+q_c, \lambda) = A'(\lambda) : (9)$$

where $\pi_c \equiv rq_c - c(q_a+q_c, \lambda)$, the economic profit of the parts-supplier. The optimal degree of vertical integration, λ^* is finally obtained by solving the equation (9) with respect to λ (See Figure 8).*[18]

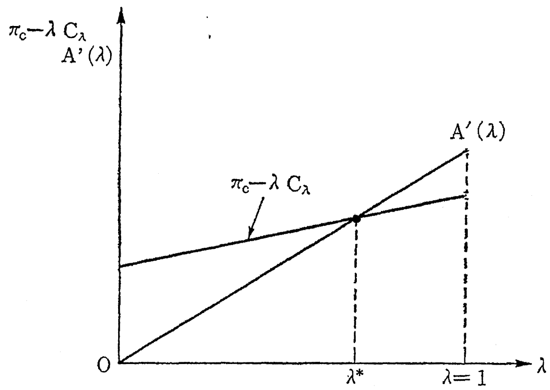

Figure 8

In sum, extended Hirshleifer's models show us how the prices of parts to the parent automaker and to the external intermediate market, or to the non-*kigyo-keiretsu* member firms are charged. Namely, the transfer-price is set lower than the market price. This result gives us an answer to the question, why the automaker organizes the *kigyo keiretsu* system. By organizing such a quasi-vertically integrated form, the parent automaker could purchase a lower price of parts from its member parts-supplier.

Another result is that the sales amount to the external market, or sales to non-*kigyo-keiretsu* member firms will be increased as the degree of vertical integration, (increases, whereas the sales amount to the parent automaker declines. In addition to this result, the more the degree of vertical integration brought out, the fewer amount of total sales is expected (As is illustrated in Figure 6, total sales decreases from OR_1 to OR_2 as the degree of vertical integration, λ increases).

This result could be apparently a paradox of vertical integration. However, this is the pint where the full-vertical integration (or fully in-house production of parts) is not dominant in a real business. Rather, the quasi-vertical organization is often preferred, and is often observed.

Ⅳ. Hypothesis and Empirical Results

In section Ⅲ, we expect that parts-suppliers' total sales might decrease as the degree of vertical integration increases. To empirically test this hypothesis, a simple regression model is used:

$$ln\ (Total\ Revenue) = a + b\lambda + c\lambda^2 : (10)$$

where λ is the percentage of stock ownership of parts-supplier by the parent automaker, and the variable, revenue as a proxy of parts-supplier's total sales. Expected signs of each coefficient are $c < 0$, and $b > 0$ if the *kigyo keiretsu* system works as a stable quasi-vertical organization. In other words, as is shown in Figure 9, the optimal degree of the automaker's shareholding of their parts-suppliers should be bounded between zero and one (i.e., $0 < \lambda < 1$).

From equation (10), to maximize the parts-supplier's total sales, the optimal degree of automaker's shareholdings to the parts-supplier is estimated as

$$\lambda = -b / (2c): (11).$$

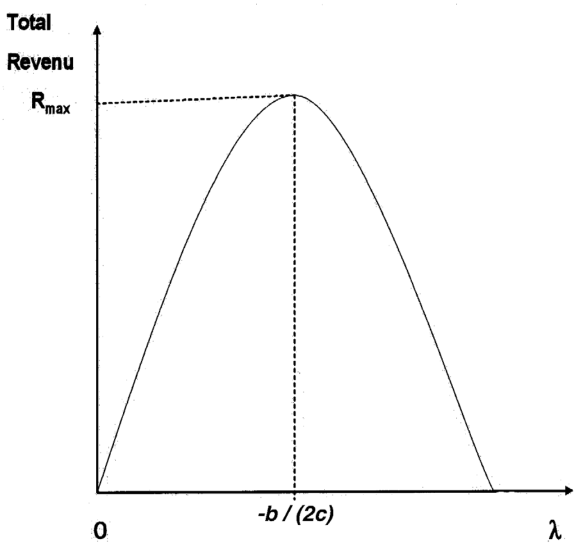

Figure 9

Data Sources

The Kaisha Zaimu Karute (i.e., Corporation Financial Report) in 1988 and 2000, *the Auto Parts Industry in Japan, 1988 and The Structure of the Japanese Auto Parts Industry,* 6th ed (1997) are used as the main data sources for this empirical research.*19 The sample consists of 64 parts-suppliers in 1987 and 66 parts-suppliers in 1999, including auto-body assemblers, which are joining *kigyo keiretsu* groups, and are listed in Tokyo, Nagoya, and Osaka Stock Exchanges, Section 1 and 2. Note that the sample mainly includes the larger first-tier subcontractors with three thousand employees on average, since small- and medium-sized firms belong most likely to the second layer of the core subcontractors.*20 In this study, my main interest is to analyze relationship between automakers and primary parts- suppliers, which belong to a *kigyo keiretsu* group.

Descriptive statistics of overall data are summarized in Table 2. The automaker's shareholdings to its parts-suppliers on average declined from 1987 to 1999.

Table 2. Overall Data of Parts-Suppliers Joining a *Kigyo Keirestu* Group in 1987 and 1999

	1987			1990		
	Mean	Max.	Min.	**Mean**	Max.	Min.
Shareholdings by the Automaker [%] (λ)	25.87 (15.42)	64.27	1.37	22.73 (14.08)	58.06	.017
Total Asset (TA) [million yen]	68605 (111185)	808293	5595	117538 (206851)	1556363	9492
Total Revenue (Rev) [million yen]	103866 (144306)	964762	8364	124960 (191125)	1329003	6978
Total Employment (TEM)	3061 (4687)	36109	198	3103 (5106)	39549	176
Ordinary Profit over Total Asset (π / TA)	.0420 (.0350)	.1332	-.0699	.0125 (.0324)	.0965	-.0921
Ordinary Profit over Total Revenue (π / TR)	.0420 (.0379)	.2533	-.0559	.0101 (.0316)	.0772	-.0886
Sample Size	**N=65**			**N=67**		

Note: Standard deviations (SD's) are shown in (   ); Units are shown in [   ].

Table 3 presents descriptive statistics of *kigyo keiretsu* member firms in 1987 and in 1999. For the two dominant manufacturers, Toyota and Nissan Motors, stock ownership is very substantial, whereas for the smaller automakers, Honda, Isuzu, Mazda and Mitsubishi, stock ownership is substantial but lower than that held by the dominant automakers, Toyota and Nisan. Note that the Toyota and Nissan's shareholdings to its parts-suppliers on average declined from 1987 to 1999.

Table 3. *Kigyo Keiretsu* Member Firms in 1987 and in 1999

	***Kigyo Keiretsu* Member Firms**	
Sub Classification	**Toyota & Nissan Groups**	**Other Auto Groups**
Variables		
Shareholdings in 1987 [%] (λ)	29.40 (14.17)	14.09 (13.82)
Total Revenue (TR) [million yen]	117610 (159532)	58052 (56537)
Ordinary Profit over Total Asset in 1987 (π / TA)	.0460 (.0358)	.0290 (.0297)
Ordinary Profit over Total Revenue in 1987 (π / TR)	.0279 (.0246)	.0374 (.0659)
Sample size in 1987	**50**	**15**
Shareholdings in 1999 (λ_{99})	25.87 (12.74)	12.71 (13.80)
Total Revenue (TR) [million yen]	141969 (214647)	70744 (55058)
Ordinary Profit over Total Asset in 1999 (π / TA)	.0141 (.0285)	.0076 (.00433)
Ordinary Profit over Total Revenue in 1999 (π / TR)	.0123 (.0277)	.0028 (.0419)
Sample size in 1999	**51**	**16**

Note: The variable, λ is defined as the percent of a supplier's common stock that is owned by the primary automaker in a group.

Table 4 and Table 5 present the results of five regressions of equation (10). Note that the statistical software, SPSS, version 11.5J is used to obtain the results.

Table 4. OLS Estimation of Equation (10) : All *Kigyo Keiretsu* Parts-Suppliers

Dependent Variable: *ln (Total Revenue)*

	1987	1999
a	17.060*** (.349)	10.422*** (.341)
b	6.961** (2.740)	5.441* (3.126)
c	- 11.164** (4.861)	-7.717 (6.244)
Adjusted R^2	.067	.044
F-value	3.296	2.536
Sample Size	65	67
Optimal Degree of Shareholdings by the Automaker: $\lambda = -b/(2c)$	31.18 [%]	35.25 [%]

Note: Numbers in ( ) indicates the standard error. * indicates significance at the 10 % level. ** indicates significance at the 5 % level. *** indicates significance at the 1 % level.

In Table 4, the parameter estimates are generally consistent with the hypothesis developed from the model; that is, $c < 0$, and $b > 0$. From equation (11), the optimal degree of shareholdings by the automaker is estimated as 31.38 % in 1987, and 35.25 in 1999, respectively. In other words, total sales of parts-suppliers in a *kigyo keiretsu* group become maximum when $\lambda = 31.18$ in 1987, and 35.25 in 1999, respectively. Note that somewhat lower adjusted R^2 values in both years are due to missing explanatory variables. In 1987 and 1999, F-values are 3.296 and 2.536, respectively. These values suggest that the null-hypothesis H_0: $b = c = 0$ is rejected at the 5 % in the case of 1987, and it is also rejected at the 10% levels of significance in the case of 1999. In sum, these results support the hypothesis that the *kigyo keiretsu* system works as a stable quasi-vertical organization.

Note that by using the Chow test (Gujarati, 2003: 275-279) in estimating equations (10), we fail to reject the structural changes between these two periods (i.e., 1987 and 1999) at the 5 % level of significance, nevertheless the Japanese subcontracting system is reported to be changed after the mid-90s (Fujiki, 2002). This is an interesting result.

Table 5. OLS Estimation of Equation (10) : Toyota and Nissan *Kigyo Keiretsu* Group Parts-Suppliers

Dependent Variable: *ln (Total Revenue)*

	1987	**1999**
a	16.938*** (.542)	10.293*** (.542)
b	8.129** (3.671)	6.601 (4.213)
c	- 12.792** (- 1.013)	-9.675 (7.652)
Adjusted R^2	.057	.021
F-value	2.477	1.541
Sample Size	65	67
Optimal Degree of Shareholdings by the Automaker: λ =-*b*/(2*c*)	31.77 [%]	34.11 [%]

Note: Numbers in ( ) indicates the standard error. * indicates significance at the 10 % level. ** indicates significance at the 5 % level. *** indicates significance at the 1 % level.

In Table 5, the parameter estimates are generally consistent with the hypothesis developed from the model; that is, $c < 0$, and $b > 0$. This result seems to support the hypothesis that the *kigyo keiretsu* system, more specifically, Toyota or Nissan *kigyo keiretsu* system keeps a stable quasi-vertical organization. From equation (11), the optimal degree of either Toyota's or Nissan's shareholdings to their parts-suppliers is estimated as 31.77 % in 1987, and 34.11 in 1999, respectively. In other words, total sales of parts-suppliers' in either Toyota's or Nissan's *kigyo keiretsu* group become maximum when λ = 31.77 % in 1987, and 34.11 % in 1999. Note that somewhat lower adjusted R^2 values in both years are due to missing explanatory variables. In 1987 and 1999 F-values are respectively 2.477 and 1.541. These values suggest that the null-hypothesis H_0: $b = c = 0$ is rejected at the 10 % in 1987, while it fails to reject the null hypothesis at the 10% levels of significance in 1999. In a sense, these results weakly support the hypothesis that the either Toyota's or Nissan's *kigyo keiretsu* system works as a stable quasi-vertical organization.

Note that by using the Chow test (Gujarati, 2003: 275-279) in estimating equations (10), we fail to reject the structural changes between these two periods (i.e., 1987 and 1999) at the 5 % level of significance, nevertheless the Japanese subcontracting system is reported to be changed after the mid-90s (Fujiki, 2002). This is an interesting result.

Ⅴ. Conclusion

First of all, this transfer-pricing model shows us how the prices of parts to the parent automaker and to the external intermediate market (i.e., the non-keiretsu member firms) are charged. Namely, the transfer-price is set lower than the market price. This gives us the answer the question why the automaker (i.e., final assembler) has an incentive to organize the quasi-vertical organization, so-called, "*kigyo keiretsu*" system-the automaker could purchase a lower price of parts from its member parts-suppliers. Another result from the model analysis is that the sales amount to the external market will be increased as the degree of the automaker's stockholdings of its parts-suppliers increase, while the sales to the parent automaker are declined. This result is somewhat surprising: the more the degree of vertical integration is brought out, the fewer amounts of the total sales is expected (ie., sales decrease from OR_1 to OR_2 in Figure 6). However, this is the point where the fully vertical integration is not dominant. Rather, the automaker's partial stockholdings of its parts-suppliers or quasi-vertically integrated organization, so-called *kigyo keiretsu* organization is observed in the real business.

If the quasi-vertically integrated organization takes place in the Japanese automobile manufacturing industry, then one may ask the question of whether the quasi-vertical organization is stable. If so, is there any optimal degree of the automaker's shareholdings to its parts-suppliers to maximize the parts-supplier's total sales. In our simple regression analyses, we obtain the correct signs of coefficients in equation (10). More specifically, the *kigyo keiretsu* system works as a stable quasi-vertical organization, and the optimal degree of the automaker's shareholding of their parts-suppliers should be bounded between zero and one (i.e., $0 < \lambda < 1$). Furthermore, the optimal degree of automaker's shareholdings is 31.18 % in 1987 and 35.25 % in 1999, respectively. In the case of Toyota and Nissan parts-suppliers, the optimal degree of automaker's shareholdings is 31.77 % in 1987, and 34.11 % in 1999, respectively. In the case of 1997, it is interesting to note that the automaker could possess the power of veto in its parts-supplier's board of director's meeting if the optimal degree of shareholdings is greater than 25 %. Furthermore, the automaker could practically control the board of directors if it owns more than 33.3 % (or holding 1 / 3 of total shares) of the parts-supplier's shares, since 2 / 3 of votes are required to change any rules in the board meeting. Thus, it is plausible that the optimal degree of shareholdings is somewhere between 25 % and 34 %.

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*1 It is my great honor to be published in the first issue of this journal, and this paper is dedicated to the late professor, Keiji Kasuya, who closed his seventy years of life two years ago—he contributed a lot of establishing School of Asia 21, and the Asia-Japan Research Center.

*2 On the Japanese Automobile Manufacturing Industry, refer to Cusmano (1985) for detailed illustration.

*3 "Vertically" integrated manufacturing groups, so-called "*kigyo keirestu*" groups are to be distinguished from "horizontally" integrated financial groups, so-called "*kigyo shudan*," which consist of firms surrounding a major financial company. For further descriptions of corporate groups, see Aoki (1987), Nakatani (1984), Shimokawa (1985), Fujiki (2002) and Kobayashi and Ohno (2005).

*4 They are now called *Kyohokai*.

*5 *Takarakai* and *Shohokai* become *Nisshokai*, now. Mitsubishi Motors also organizes *Kyoryokukai*.

*6 Manufacturing groups or *kigyo keiretsu* groups are distinguished from financial groups, which consist of firms surrounding a major financial company; for example, "ex-zaibatsu" groups such as Mitsui, Mitsubishi, Sumitomo and Yasuda. In general, the Japanese term, "*keirestu* (noun)," simply refer to a "hierarchical" grouping of firms, "*keiretsu-ka*" is an adjective form of "*keiretsu*." However, in a narrow definition, "*keiretsu*" refer to these ex-zaibatsu groups, or financial groups. Thus, to avoid semantic confusion, some Japanese economists use the term, "*kigyo shudan*" for these six ex-zaibatsu groups. In contrast, the term, "*kigyo grupu* (group)" is used for manufacturing (i.e., non-financial") groups. See K. Yamamura and Y. Yasuba, eds. (1987), *The Political Economy in Japan*, and M. Aoki, ed. (1984), *The Economic Analysis of the Japanese Firm*. In this paper, the author uses the "kigyo keiretsu" and "kigyo group" interchangeably for such vertically integrated Japanese manufacturing group.

*7 In our sample, only a few parts-suppliers, such as Toyota Boshoku, and Denso, held shares of their parent automaker's common stock. In fact, Toyoda Boshoku was a former parent firm of Toyota Motors before the World War Ⅱ.

*8 On supplier-switching-costs and vertical integration in the automobile manufacturing industry, refer to K. Monteverde, and D. J. Teece (1982), N. Tabeta (2003, 2004).

*9 Refer to O. Williamson (1975).

*10 In the usual definition of vertical integration, a manufacturer fully owns a production process or a capital good and retains control over the production process or the capital good to initially produce a final good. All quasi-rents are retained by the manufacturer. On the other hand, quasi-vertical integration means that the monopolist retains ownership of a production process or a capital good and then contracts with other firms to use this process or the capital good. Quasi-vertical integration gives up control of the production process of producing parts and leases it out via a contract to external firms which produce the parts for the down stream final assembler. See Blois (1972) on vertical quasi-integration.

*11 From opportunistic point of view, see Inaba and Tabeta (1995), Tabeta (1998), and Tabeta (2004). From risk-sharing point of view, see Tabeta and Rahaman (1999).

*12 On Hirshleifer's original transfer pricing model, refer to "On the Economics of Transfer Pricing," *Journal of Business*, pp.172-184, July 1956.

*13 In other words, λ is the degree of parent ownership of the subsidiary parts supplier, used as an index for measuring the degree of vertical integration? $0< \lambda < 1$ simply means less than full ownership and control, so that subcontracting is required.

*14 Note that $A(\lambda)$ is regarded as a sort of quasi-fixed cost.

*15 Note that the parts demand curve is obtained from equation (5):

$$nMR(q_a) \equiv \{MR(q_a) - mac(q_a)\} / \lambda = mcc.$$

*16 Note that this result is consistent with the one that I discussed in my article, Tabeta (1991).

*17 It is possible to combine the cost function, $c(q_a+q_c, \lambda)$ and the administrative cost function., $A(\lambda)$.
Let the combined cost function of producing parts as $\theta(q_a+q_c, \lambda)$. Then $\theta(q_a+q_c, \lambda)$ could be a quadratic function of λ. However, in this paper, I conceptually separate these two cost curves to make a clear argument.

*18 Note that this result is also consistent with the one that I discussed in my article, Tabeta (1991).

*19 We also refer to Ministry of Finance, ed. (1987), *Yuka Shoken Hokokusho Soran* [English translation: Annual Corporation Reports (Various Companies)], and Toyo Keizai Shinpo Sha, ed. (1987and 2000), *kigyo keiretsu Soran* [English translation: Survey of Corporate Groups].

*20 In fact, data are not available for these small parts-companies.