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WHAT FACTORS DETERMINE THE NUMBER OF TRADING PARTNERS?

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What factors determine the number of trading partners?*

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Abstract

The purpose of the paper is to provide a simple model explaining buyer-supplier relationships and show what factors determine the number of trading partners. We show that when the supplier is able to determine the number of trading partners, the optimal number is small if the supplier's bargaining power with them is *weak*, the economy of scope in the supplier's variable costs is *significant*, and that in its sunk investment is *weak*. Investment may be greater when the number of trading partners is small. The results may be consistent with the formation of Japanese buyer-supplier relations.

Keywords: buyer, supplier, investment, economies of scope

JEL Classification codes: L14, M11

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I Introduction

Manufacturers have sought the optimal number of buyers, which affects revenues from customers and manufacturers' fixed/variable costs including labor, material, and investment. For instance, in the context of patent licensing, licensors determine the number of licensees (Kamien and Tauman (1986) and Kamien et al. (1992)).[1] In the context of buyer-suppler relations, suppliers consider whether strategies with broader customer scope lead to superior performance (Nobeoka et al. (2002)). In fact, in the Toyota *keiretsu* group (recognized as among the tightest), 41.7 percent of its affiliated firms (defined here as those that are more than 20 percent owned by Toyota) sold 40–80 percent of their products to outsiders (Sato (1988, p. 121) and Nishiguchi (1994, p. 115)). This fact implies that some suppliers choose a broader customer scope, while others choose a narrower scope. In other words, taking into account their technological environments, including the values of their products, production efficiencies, and investment capabilities, suppliers choose their optimal number of customers. We therefore investigate what factors determine the number of trading partners (the customer scope).

We provide a simple model to explain the strategies of suppliers. The setting is as follows. Consider a situation in which there is one supplier and two buyers. The supplier can provide a good that is used by the two buyers. However, the buyers cannot produce the good on their own. In this situation, the supplier first decides with whom to negotiate. Second, the supplier invests to improve the value of the good for the buyer(s) and at this stage decides the amount of investment. The investment cost is sunk before the next stage. The (additional) sunk investment cost for the second buyer (the second unit of the good) is smaller than that for the first buyer. Third, there are negotiations between the supplier and the buyer(s) who were designated by the supplier in the first stage. In this stage, we apply a simple Nash bargaining approach used by Chipty and Snyder (1999) and Raskovich

[1] Kamien and Tauman (1986) and Kamien et al. (1992) and subsequent researchers investigate how a (monopolistic) patent holder determines the number of licensees that compete in final product markets. Downstream competition is an essential factor in the adoption of exclusive licensing offers for the licensees in those papers.

(2003).[2] The characteristic of this approach is that if the supplier chooses to bargain with two buyers in the first stage, the supplier and each buyer conduct simultaneously and separately the Nash bargaining. The supplier only provides and sells the good to the buyer if its variable production cost is covered as a result of the bargaining. When the supplier produces the good for the buyer(s), it incurs a variable production cost. The (additional) variable production cost for the second buyer is smaller than that for the first buyer.

We show several results that may be consistent with the formation of Japanese buyer–supplier relations.[3] When the supplier is able to determine the number of trading partners—one or two—the optimal number is one for the supplier if the supplier's bargaining power with its trading partners is *weak*, and the supplier's additional sunk investment cost is relatively large. The supplier prefers to trade with one buyer if the variable production cost is neither large nor small relative to the value of the good. In other words, when the supplier's variable production cost is small, it should have broader relationships with partners. As the product efficiency of the supplier improves, the performance (payoff) of the supplier becomes higher because of the higher investment level caused by the broader customer scope. This seems consistent with the finding in Nobeoka et al. (2002): a broader customer scope strategy should result in superior performance, primarily because of superior learning opportunities. We also show that the equilibrium investment level when the supplier trades with one buyer can be larger than with two buyers if the sunk investment cost is large relative to the value of the good, the supplier's bargaining power with its trading partners is weak, and the variable production cost is large.[4] This may

[2] For theoretical discussions of bargaining solutions, see, for instance, Binmore et al. (1986), Chae and Yang (1994), Krishna and Serrano (1996), and Okada (1996, 2010).

[3] Konishi *et al.* (1996) formulate a bargaining model of buyer–seller relationships from the buyer's viewpoint. Their purpose is to provide an alternative solution for the hold-up problems, in contrast to the vertical integration approach advocated by Grossman and Hart (1986) and Hart and Moore (1990). Although their model provides a plausible explanation why typical auto assemblers in Japan do not vertically integrate with a single part supplier but transact with two potentially competitive suppliers, they do not explain suppliers' decisions concerning the number of buyers.

[4] The outcome in this paper (a narrower customer scope) may evoke the term "exclusive dealing,"

also be consistent with the following finding. Japanese automakers and their suppliers are more specialized than their US counterparts, and there is a high correlation between supplier specialization and automaker profitability (Dyer (1996)). Although this statement is based on the viewpoint of buyers (automakers), the correlation may be because the higher investment levels caused by the narrower customer scope of suppliers leads to higher profitability of the automakers.

This paper is closely related to those of Chipty and Snyder (1999) and Raskovich (2003).[5] However, to analyze a buyer–supplier relation with cooperative investments, we add two new elements to these papers. One is the supplier's decision regarding the number of buyers, and the other is the supplier's investment to improve the quality of the buyers' products. Inderst and Wey's (2003) study is also closely related to ours. They discuss how the equilibrium market structure is determined in a bilateral oligopoly with choice of technology. Although they comprehensively discuss bargaining, mergers, and technology choice in simple bilateral oligopolistic markets, they do not discuss the relation between bargaining power and equilibrium market structure (the number of trading partners) as our paper does.

This paper is also related to literature on the source of buyer power.[6] The model structure in this paper is related to those in Battigalli et al. (2007) and Inderst and Wey (2007, 2010). Those papers discuss situations in which a monopoly upstream supplier sells an input to downstream firms (buyers) and engages in quality-enhancing/cost-reducing investments. The number of buyers is exogenously fixed in those papers.

This paper is relevant to the literature on the hold-up problem because in our model the supplier's investment is not fully compensated by the buyers (a classic form of "hold-

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although the main concern is quite different from those in the literature on exclusive dealing. Several papers discuss whether exclusive contracts foster relationship-specific investment by an incumbent supplier (e.g., Segal and Whinston (2000) and de Meza and Selvaggi (2007)). They discuss whether the exclusion of potential suppliers enhances the incentive of the incumbent supplier to invest.

[5] Stole and Zwiebel's (1996a, b) study is also relevant to the discussion in Chipty and Snyder (1999).

[6] Inderst and Mazzarotto (2008) and Inderst and Shaffer (2007) provide surveys in discussions of buyer power. Rey and Tirole (2007) provide a comprehensive survey of vertical relations.

up"). The literature mainly discusses ways to overcome the hold-up problem (e.g., Klein *et al.* (1978) and Williamson (1979)) and examines a pair of buyers and sellers in isolation, whereas this paper considers the hold-up problem in a situation with multiple buyers.[7]

This study is also relevant to studies of buyer and seller networks. While there are many papers discussing buyer–seller networks (e.g., Kranton and Minehart (2000, 2001)) that compare vertically integrated firms and networks of manufacturers and suppliers, the purpose of this paper is different.[8] Although in most of these papers product quality is exogenously given, we discuss quality investment by the upstream supplier who anticipates subsequent negotiations between the buyers.

The remainder of this paper is organized as follows. Section 2 presents the basic model. Section 3 presents the result of the basic model. Section 4 incorporates the investment decision of the supplier into the basic model. Section 5 discusses the buyers' incentive for a horizontal merger. Section 6 investigates whether an exclusive incumbent buyer allows a monopoly supplier to expand the customer scope of the supplier when the incumbent buyer contracts exclusively with the monopoly supplier. Section 7 concludes.

II A simple model

We consider a situation in which there is one supplier and two potential buyers (buyers 1 and 2). For example, in the case of the automobile industry, the supplier corresponds to an auto parts manufacturer and the buyers correspond to automotive manufacturers. The supplier can produce a good and sell it to the buyers. Although the buyers need one

[7] The other methods are changing ownership structure (*e.g.*, Grossman and Hart (1986), Hart and Moore (1990), and Aghion and Bolton (1992)) and contractual solutions (*e.g.*, Chung (1991) and Aghion *et al.* (1994)). Che and Hausch (1999), however, showed that when investments have a cooperative nature (*e.g.*, the seller's investment improves the buyer's valuation of the good), contracting has no value if the contract must remain subject to renegotiation (see also Hart and Moore (1999) and Segal (1999)). This paper also concerns cooperation, because the supplier's investment improves the quality of buyers' products.

[8] Jackson and Wolinsky (1996) and Bala and Goyal (2000) provided formal models of network formation. Belleflamme and Bloch (2004), Billand and Bravard (2004), Goyal and Joshi (2006), and Furusawa and Konishi (2007) applied the theory to the models of oligopoly.

unit of the good, they cannot produce it on their own, and therefore must buy it from the supplier.

We model the negotiation between the supplier and the buyers as the following two-stage game. In the first stage, the supplier decides with whom to negotiate. In the second stage, the supplier and the buyers designated in the first stage negotiate. If the negotiation is successful, the supplier produces the good and sells it to the buyer. Otherwise, the good is not provided and the buyer obtains nothing.

We now explain the details of the two stages. In the first stage, if there is one negotiation partner, the cost of the investments for production is F, and if there are two, this cost is dF where $d \in [1, 2]$. This investment cost is assumed to be sunk; that is, the supplier cannot recover the cost in the second stage. This assumption means that the per-buyer (sunk) investment cost is smaller when the supplier trades with two partners than with only one, and that the investment cost is related to several kinds of sunk set-up costs; for instance, designing a large plant to manufacture the inputs of partners, conducting basic surveys to build it and building firm-specific facilities to make the inputs.

In the second stage, we consider a form of bilateral and simultaneous negotiation. If the supplier negotiates with two buyers, then it enters into simultaneous bargaining with each of the two buyers separately.[9] Bargaining determines whether one unit of the good is provided and the amount of money the buyer transfers to the supplier. Each bargaining session, if successful, provides one unit of the good. The cost of providing the good is c if one unit of the good is produced, and $(a + 1)c$ if two are produced, where $a \in [0, 1]$ and this cost is not sunk. These assumptions mean that the per-buyer production cost is smaller when the supplier trades with two partners than with only one, and is related to

[9] We have to mention two remarks about the assumption. First, this assumption implies that each pair of the supplier and a buyer *bilaterally* negotiate the amount of payment after the product characteristic is determined. In the Japanese buyer-supplier relationships, Asanuma (1985) observes that parts prices are revised at regular intervals, by *bilateral* negotiation, incorporating both risk and incentives for innovation and effort. We think that the assumptions about the timing structure and the negotiation procedure capture this stylized fact in Asanuma (1985). Second, some may assume that our results depend on the simultaneous bargaining procedure. Fortunately, the results of sequential bargaining are similar to those of simultaneous bargaining and are available in Appendix 2.

several variable costs, such as material, labor, and natural resources.[10]

Payoffs to the supplier and the two buyers are determined as follows. Let v denote the (gross) value of each buyer for the good. If buyer i obtains the good and pays T_i, then it receives the payoff $v - T_i$. Otherwise, its payoff is zero.[11] When the supplier negotiates with the two buyers, the supplier's payoff is $T_1 + T_2 - (a+1)c - dF$ if it successfully negotiates with buyers 1 and 2, $T_i - c - dF$ if it succeeds only in the negotiation with buyer i $(i = 1, 2)$, and $-dF$ if none of the bargaining is successful. When the supplier negotiates with one buyer, the supplier's payoff is $T_i - c - F$ if bargaining is successful and $-F$ otherwise.

We assume that the outcome of the second stage is determined as follows.[12]

1. The outcome of each negotiation is given by the Nash bargaining solution in the belief that the outcome of bargaining with the other party is determined in the same way.

2. The joint surplus is divided between the buyer and the supplier in the proportion of $1 - \beta$ to β, in which $\beta \in (0, 1)$ represents the bargaining power of the supplier, and the supplier has the advantage over the buyer if and only if $\beta > 1/2$.

In this model, there is an externality in bargaining. Although each bargaining session decides whether one unit of the good is produced so as to maximize joint surplus, the cost of providing the good depends on the outcome of the bargaining with the other party. The cost of the good is ac if the other negotiation is successful, and c otherwise. Thus, the

[10] If prices of some widgets needed to produce the buyer's inputs depend on the following functional form, the assumption that $a \in [0, 1]$ is reasonable: $F/Q + w$, where $F(> 0)$ and $w(> 0)$ are exogenous parameters and Q is the quantity demanded by the supplier. That price schedule is often called quantity discount (Jeuland and Shugan (1983)). The price schedule is equivalent to the case in which the total payment for widgets is equal to $F + wQ$ $(= Q \times (F/Q + w))$, the so-called "two-part tariff."

[11] This payoff form of buyers implicitly assumes that the buyers' demand for the good is inelastic. This assumption is to simplify the analysis.

[12] We follow the bargaining procedures in Raskovich (2003). A different approach, building on the Shapley value, has been used, for instance, in Inderst and Wey (2003) and de Fontenay and Gans (2005, 2007).

joint surplus of each bargaining session varies according to the belief about the bargaining with the other firm. Note that according to this assumption, the two participants in each bargaining session (the supplier and one buyer) believe that the other bargaining session is conducted efficiently, and this belief is justified in equilibrium.[13]

Remarks We have implicitly assumed that the supplier cannot supply more than two buyers. This constraint reflects technological difficulties of the suppliers. For instance, using a common platform, Nissan (a major Japanese automobile manufacturer) produces two brands of cars (CUBE and MARCH). It is not easy, however, for Nissan to make a new type of car under the common platform because it restricts the car's design, size, drivability, and so on.[14] Therefore, we consider that the implicit assumption is reasonable. We have also implicitly assumed that only two buyers exist. This assumption implies that the supplier would have difficulty in finding a new buyer. Small suppliers often face such a difficulty due to a shortage of information about potential buyers. Moreover, trade frictions can cause thin trade networks among buyers and suppliers (Mahoney (2001) and Chatain and Zemsky (2009)). We have also assumed that the supplier does not trade with new buyers when it has decided to trade with only one. Once the supplier incurs a sunk investment cost of production for one buyer, it has difficulty changing production factors, such as size, design, and process. Moreover, the supplier faces a time constraint that impedes the expansion of its production capacity. For instance, small and medium-sized technology-based enterprises can hardly compete in volume, because they may not have sufficient resources to expand production capacity swiftly (Qian and Li (2003)). We implicitly assume that the supplier forgoes the opportunity to sell the right to obtain the good. This implies that a buyer cannot buy out the supplier. Small firms are often

[13] The assumption that each participant in a bargaining session believes that bargaining with the other party is conducted efficiently is essential to our result. In another bargaining procedure, such as the Shapley bargaining, we may not obtain the same results. This is available in Appendix 3.

[14] Some researchers also point out that this kind of component sharing has a trade-off: the benefit is a reduction in the cost of designing and purchasing additional components, but the cost is an increase in mismatch costs associated with using existing components with excess capability (Fisher *et al.* (1999), Ramdas and Sawhney (2001), Ramdas and Randall (2008)).

organized by owners who have specific skills in production. In other words, technicians manage their own firms. Those self-managing technicians may have an intrinsic motivation to operate their firms. They may also like the privilege of determining when they work and what they produce. Those factors would discourage the suppliers/technicians from selling their firms.

III Analysis

We solve the two-stage model using backward induction. First, we calculate the Nash bargaining outcomes of the second stage. Second, we consider the first stage and examine the number of buyers with whom it is optimal for the supplier to negotiate.

III(i) The second stage

We need to consider the following two cases: the supplier negotiating with only one buyer, and with two buyers.

III(i).1 Negotiation with one supplier and one buyer

If the supplier decided to negotiate with one buyer, then the surplus of this negotiation is $v-c$. Let T denote a payment from the buyer to the supplier. The buyer and the supplier split the surplus in a way that satisfies $v-T : T-c = 1-\beta : \beta$. Therefore, we obtain

$$\beta[v-T] = (1-\beta)(T-c) \quad \text{or} \quad T_o := \beta v + (1-\beta)c.$$

Then, the profit of the supplier is

$$\pi_1^* = T_o - c - F = \beta(v-c) - F. \tag{1}$$

As the value of β increases, the positive/negative effect of an increase in v/c on π_1^* gets stronger. The significance of each effect is β ($|\partial\pi_1^*/\partial v| = |\partial\pi_1^*/\partial c| = \beta$).

The profit of the buyer is

$$\pi_1^B = v - T_o = (1-\beta)(v-c). \tag{2}$$

III(i).2 Negotiation with one supplier and two buyers

Let us consider a case in which the supplier negotiates with two buyers. In this case, we need to consider two possibilities. One is that each buyer pays not less than c, and the other is that each buyer pays less than c and the sum of the payments of the two buyers is greater than $(1+a)c$. In the first case, one unit of the good can be provided and the buyer in the successful negotiation can obtain the good even if the other negotiation breaks down. In this situation, the buyer is *nonpivotal* to the production of two units of the good. In the other case, if one of the buyers withdraws from the negotiation, then none of the goods are provided. In this situation, each buyer is *pivotal* to the provision of the two units of the good (the term "pivotal" is used in Raskovich (2003)).

Nonpivotal buyers First, we consider a situation in which the two buyers are nonpivotal to production; production is successful even if one of the buyers withdraws from the negotiation. In this situation, the buyer and the supplier split the surplus $v - ac$, where the first (*resp.* the second) term is the additional benefit (*resp.* cost) from the trade given that one trade will be executed. The buyer pays T to the supplier in a way that satisfies

$$\beta(v-T) = (1-\beta)(T-ac) \quad \text{or} \quad T_{2n} := \beta v + (1-\beta)ac.$$

The profit of the supplier is

$$\pi_{2n} = 2T_{2n} - (1+a)c - dF = 2\beta v - (1-(1-2\beta)a)c - dF. \tag{3}$$

As the value of β increases, the positive/negative effect of an increase in v/c on π_{2n} becomes stronger. The significance of the positive effect is 2β and that of the negative effect is $1-(1-2\beta)a$ ($|\partial\pi_{2n}/\partial v| = 2\beta$ and $|\partial\pi_{2n}/\partial c| = 1-(1-2\beta)a$).

The profit of each buyer is

$$\pi_{2n}^B = v - T_{2n} = (1-\beta)(v-ac). \tag{4}$$

Because the buyers are nonpivotal, we must have $T_{2n} - c > 0$. This is given as

$$\beta v > (1-(1-\beta)a)c.$$

Pivotal buyers Second, we consider a case in which every buyer is pivotal to production. In this case, the production fails if one of the two buyers withdraws from the negotiation.

If T_1 and T_2 designate payments from buyers 1 and 2, respectively, the surplus of the negotiation with buyer 1 is $(v - T_1) + (T_1 + T_2 - (1+a)c) = v + T_2 - (1+a)c$ and that of the negotiation with buyer 2 is $(v - T_2) + (T_1 + T_2 - (1+a)c) = v + T_1 - (1+a)c$. In each equation, the terms in the first set of parentheses are the buyer's benefit from the trade and those in the second set are the supplier's benefit from the trade, given that the other trade will be executed. The buyers and the supplier split the surplus in a way that satisfies the following conditions:

$$\begin{aligned} \beta(v - T_1) &= (1-\beta)(T_1 + T_2 - (1+a)c), \text{ and} \\ \beta(v - T_2) &= (1-\beta)(T_1 + T_2 - (1+a)c). \end{aligned}$$

The simultaneous equations have only one solution: we obtain

$$T_1 = T_2 = T_{2p} := \frac{\beta v + (1-\beta)(1+a)c}{2-\beta}.$$

In the two negotiations, they take into account the total sum of the three players' bargaining positions, $\beta + 2(1-\beta) = 2 - \beta$. The share of the supplier's bargaining position is $\beta/(2-\beta)$. The coefficient of v reflects the share of the supplier.

The profit of the supplier is

$$\pi_{2p} = 2T_{2p} - (1+a)c - dF = \frac{\beta(2v - (1+a)c)}{2-\beta} - dF. \tag{5}$$

As the value of β increases, the positive/negative effect of an increase in v/c on π_{2p} becomes stronger. The significance of the positive effect is $2\beta/(2-\beta)$, and that of the negative effect is $(1+a)\beta/(2-\beta)$ ($|\partial\pi_{2p}/\partial v| = 2\beta/(2-\beta)$ and $|\partial\pi_{2p}/\partial c| = (1+a)\beta/(2-\beta)$).

The profit of each buyer is

$$\pi_{2p}^B = v - T_{2p} = \frac{(1-\beta)(2v - (1+a)c)}{2-\beta}. \tag{6}$$

Summary The profits of the supplier and each buyer are summarized as follows:

$$(7)\qquad \pi_2^* = \begin{cases} \pi_{2n} = 2\beta v - (1-(1-2\beta)a)c - dF & \text{if } c \leq \dfrac{\beta v}{1-(1-\beta)a}, \\ \pi_{2p} = \dfrac{\beta(2v-(1+a)c)}{2-\beta} - dF & \text{if } c \geq \dfrac{\beta v}{1-(1-\beta)a}. \end{cases}$$

$$(8)\qquad \pi_2^B = \begin{cases} \pi_{2n}^B = (1-\beta)(v-ac) & \text{if } c \leq \dfrac{\beta v}{1-(1-\beta)a}, \\ \pi_{2p}^B = \dfrac{(1-\beta)(2v-(1+a)c)}{2-\beta} & \text{if } c \geq \dfrac{\beta v}{1-(1-\beta)a}. \end{cases}$$

Note that when $c = \beta v/(1-(1-\beta)a)$,

$$\pi_{2n} = \pi_{2p} = \frac{\beta v(1-a)}{1-(1-\beta)a} - dF \quad and \quad \pi_{2n}^B = \pi_{2p}^B = \frac{(1-\beta)v(1-a)}{1-(1-\beta)a}.$$

III(ii) The first stage

We now consider the supplier's choice concerning the number of buyers. Suppose that the supplier chooses the number to maximize its own profit. Then, the supplier negotiates with one buyer if and only if $\pi_1^* > \pi_2^*$. ¿From (1) and (7), the difference between π_1^* and π_2^* is given as

$$(9)\quad \Delta\pi^* \equiv \pi_1^* - \pi_2^* = \begin{cases} (d-1)F - \beta v + (1-\beta-(1-2\beta)a)c & \text{if } c \leq \dfrac{\beta v}{1-(1-\beta)a}, \\ (d-1)F - \dfrac{\beta^2 v + \beta(1-\beta-a)c}{(2-\beta)} & \text{if } c \geq \dfrac{\beta v}{1-(1-\beta)a}. \end{cases}$$

Before we ascertain the properties of $\Delta\pi^*$, we must first ascertain whether there exists F such that $\pi_1^* > 0$ and $\Delta\pi^* > 0$.[15] A simple rearrangement of (1) and (9) leads to the following condition by which the supplier trades with only one buyer:

$$(10)\quad \begin{aligned} &\frac{\beta v - (1-\beta-(1-2\beta)a)c}{d-1} < F < \beta(v-c) && \text{if } c \leq \frac{\beta v}{1-(1-\beta)a}, \\ &\frac{\beta^2 v + \beta(1-\beta-a)c}{(2-\beta)(d-1)} < F < \beta(v-c) && \text{if } c \geq \frac{\beta v}{1-(1-\beta)a}. \end{aligned}$$

In (10), when the right-hand-side value of the second inequality is larger than the left-hand-side value of the first inequality, there exists F such that $\pi_1^* > 0$ and $\Delta\pi^* > 0$. This

[15] If $\pi_1^* \leq 0$, the optimal number of buyers is not 1 even though $\Delta\pi^* > 0$.

condition is given as

$$
(11) \qquad d > \underline{d} \equiv \begin{cases} \dfrac{2\beta v - (1-(1-2\beta)a)c}{\beta(v-c)} & \text{if } c \le \dfrac{\beta v}{1-(1-\beta)a}, \\ \dfrac{2v-(1+a)c}{(2-\beta)(v-c)} & \text{if } c \ge \dfrac{\beta v}{1-(1-\beta)a}. \end{cases}
$$

We summarize this in the following proposition:

Proposition 1 *If F satisfies (10), then $\pi_1^* > 0$ and $\Delta\pi^* > 0$. That is, the supplier prefers trading with one buyer to trading with two buyers if F satisfies (10).*

We first exclude the case in which $\beta > 1/2$ and concentrate our discussion on the case in which $\beta \le 1/2$. This is because the inequality $d > \underline{d}$ in (11) is satisfied only if $d > 2$ when $\beta > 1/2$.[16]

We now check the property of $\Delta\pi^*$. When $\beta \le 1/2$, the relations between $\Delta\pi^*$ and the exogenous parameters are given as (the mathematical procedure is available in Appendix 1)

$$
(12) \qquad \begin{array}{llll} \dfrac{\partial \Delta\pi^*}{\partial a} < 0, & \dfrac{\partial \Delta\pi^*}{\partial c} > 0, & \dfrac{\partial \Delta\pi^*}{\partial \beta} < 0, & \text{if } c \le \dfrac{\beta v}{1-(1-\beta)a}, \\ \dfrac{\partial \Delta\pi^*}{\partial a} > 0, & \dfrac{\partial \Delta\pi^*}{\partial c} < 0 \text{ iff } 1 > a+\beta, & \dfrac{\partial \Delta\pi^*}{\partial \beta} < 0, & \text{if } c \ge \dfrac{\beta v}{1-(1-\beta)a}. \end{array}
$$

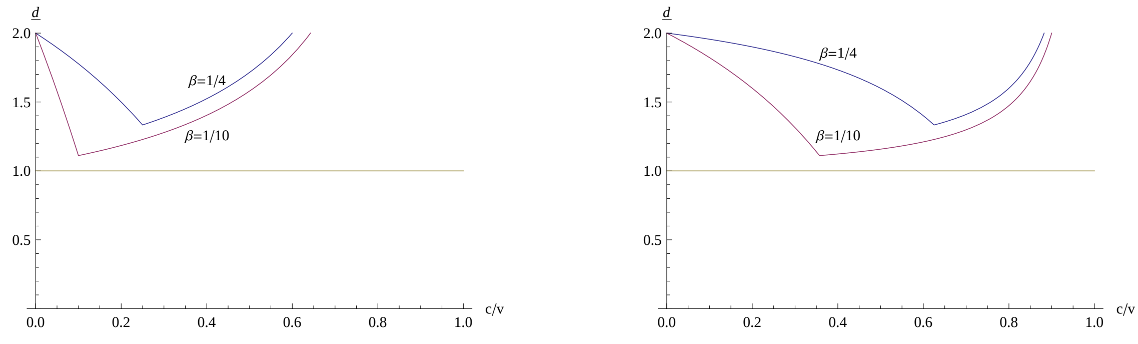
When the buyers are nonpivotal (c is small), an increase in a decreases $\Delta\pi^*$. As the additional cost generated by the second production increases, the supplier tends to trade with two buyers. This is because the supplier and one buyer take into account only the additional cost ac, even though the supplier incurs the variable production cost $(1+a)c$. This means that the "uncompensated" production cost of the supplier is $(1+a)c - 2ac = (1-a)c$. Because the uncompensated cost decreases as the value of a increases, the supplier tends to trade with two buyers when the value of a is large. This tendency does not hold when the buyers are pivotal (c is large). The buyers take into account the full cost $(1+a)c$ when they negotiate with the supplier. An increase in a only increases the *additional* production cost when the supplier trades with the second buyer. Thus, the supplier tends to trade with one buyer when the value of a is large.

[16] When $c = 0$, $\underline{d} = 2$. $\partial \underline{d}/\partial c > 0$ for all c when $\beta > 1/2$.

When the buyers are nonpivotal (c is small), an increase in c increases $\Delta\pi^*$. The "uncompensated" production cost of the supplier $(1-a)c$ increases as the value of c increases. This effect induces the supplier to trade with only one buyer.[17] When the buyers are pivotal (c is large), the effect of an increase in c on $\Delta\pi^*$ depends on the exogenous values. We have already shown that $|\partial\pi_1^*/\partial c| = \beta$ and $|\partial\pi_{2p}^*/\partial c| = (1+a)\beta/(2-\beta)$. An increase in a increases the total production cost where the supplier trades with two buyers, $(1+a)c$. Moreover, in general, a stronger bargaining position of the supplier leads to greater gain and cost of the supplier from trade. In this context, the negative effect of an increase in c strengthens with the bargaining position of the supplier. Because the total production cost when the supplier trades with two buyers is larger than that when it trades with one, the negative effect in the two-buyer case is also stronger than that with one buyer. Because of those two effects, the sign of $\partial\Delta\pi^*/\partial c$ can be positive when β and a are sufficiently large ($a+\beta>1$).

An increase in β decreases $\Delta\pi^*$. As the bargaining power of the supplier increases, the supplier tends to trade with two buyers. The bargaining power is positively correlated with the gross gain of the supplier in the negotiation stage. A stronger bargaining power of the supplier weakens the relative importance of the additional investment costs, $(d-1)F$.

We briefly discuss the relation between $\underline{d}$ and c. This is summarized in Figure 1.



($a = 0$) ($a = 3/4$)

Figure 1: The optimal number of buyers can be one

Note: horizontal axis, c/v; vertical axis, $\underline{d}$.

[17] If $a = 1$, $\underline{d}$ in (11) is 2 for any $c \le v$. That is, this effect disappears if $a = 1$.

$\underline{d}$ is minimized when $c = \beta v/(1-(1-\beta)a)$, which is the threshold value regardless of whether the buyers are pivotal. As mentioned above, the cost of the investments for production is F (dF) if the number of its negotiation partners is one (two), respectively, where $d \in [1, 2]$. The additional investment cost of the second round of production is $(d-1)F$ ($\leq F$). This means that trading with two buyers is more profitable when d is smaller.

This figure shows an interesting property: nonmonotonicity of the relation between the optimal number of buyers and c. This means that the supplier with a lower or higher c prefers trading with two buyers, whereas one with an intermediate value of c prefers trading with one buyer. The reason for this concerns the relation between $\Delta\pi^*$ and c, which has been discussed above.

IV Quality choice

We incorporate quality investments into the basic setting. Between the first and the second stages, the supplier invests to improve the (gross) value of each buyer for the good. In this stage, if the supplier invests $q \geq 0$ and has one (two) negotiation partners, the gross value of each buyer becomes q and the cost of the investments is fq^2 (dfq^2), respectively, where $d \in [1, 2]$ and f is a positive constant. That is, the supplier endogenously determines the value for the good. Note that in the basic model, the supplier incurs the investment costs F (dF) when it trades with one buyer (two buyers), respectively. This investment cost is assumed to be sunk; that is, the supplier cannot recover the cost in the second stage. We employ this assumption in this section. The rest of the model assumptions are the same as in the basic model.[18]

[18] To simplify the analysis, we assume that product quality is common to both buyers. We only have to consider two cases concerning buyers' positions: (i) they are pivotal; (ii) neither is pivotal. If we allow heterogeneity of product quality, we have to consider the third case: (iii) one of the buyers is pivotal. The additional case complicates the comparison of the three cases.

IV(i) The negotiation stage

We use the same general mathematical procedures with the basic model. We replace the gross value of each buyer by q and the investment cost by fq^2 (dfq^2) if the number of its negotiation partners is one (two), respectively.

If the supplier decided to negotiate with one buyer, the profit of the supplier is (see (1))

$$\pi_1(q) = \beta(q - c) - fq^2. \tag{13}$$

If the supplier decided to negotiate with two buyers, two situations can occur: (i) the two buyers are nonpivotal to production; (ii) they are pivotal to production. If the buyers are nonpivotal to production ($\beta q > (1 - (1 - \beta)a)c$), the profit of the supplier is (see (3))

$$\pi_{2n}(q) = 2\beta q - (1 - (1 - 2\beta)a)c - dfq^2. \tag{14}$$

If both buyers are pivotal to production ($\beta q \leq (1 - (1 - \beta)a)c$), the profit of the supplier is (see (5))

$$\pi_{2p}(q) = \frac{\beta(2q - (1 + a)c)}{2 - \beta} - dfq^2. \tag{15}$$

IV(ii) The investment stage

We derive the optimal investment level q in the three situations.

If the supplier decided to negotiate with one buyer, the optimal q is given as (see (13))

$$q_1^* = \arg\max_q \ \pi_1(q) = \frac{\beta}{2f}. \tag{16}$$

The optimal q_1^* leads to

$$\pi_1(q_1^*) = \beta\left(\frac{\beta}{4f} - c\right). \tag{17}$$

The profit of the buyer is (see (2))

$$\pi_1^B(q_1^*) = (1 - \beta)(q_1^* - c) = (1 - \beta)\left(\frac{\beta}{2f} - c\right). \tag{18}$$

If the supplier decides to negotiate with two buyers and they are nonpivotal to production ($\beta q > (1 - (1 - \beta)a)c$), the optimal q is given as (see (14))

$$q_{2n}^* = \arg\max_q \ \pi_{2n}(q) = \frac{\beta}{df}. \tag{19}$$

The optimal q_{2n}^* leads to

$$\pi_{2n}(q_{2n}^*) = \frac{\beta^2}{df} - (1-(1-2\beta)a)c. \tag{20}$$

The profit of each buyer is (see (4))

$$\pi_{2n}^B(q_{2n}^*) = (1-\beta)(q_{2n}^* - ac) = (1-\beta)\left(\frac{\beta}{df} - ac\right). \tag{21}$$

q_{2n}^* is an interior solution if and only if $f < \beta^2/(d(1-(1-\beta)a)c)$.

If the supplier decides to negotiate with two buyers and both are pivotal to production ($\beta q \leq (1-(1-\beta)a)c$), the optimal q is given as (see (15))

$$q_{2p}^* = \arg\max_q \ \pi_{2p}(q) = \frac{\beta}{df(2-\beta)}. \tag{22}$$

The optimal q_{2p}^* leads to

$$\pi_{2p}(q_{2p}^*) = \frac{\beta}{2-\beta}\left(\frac{\beta}{df(2-\beta)} - (1+a)c\right). \tag{23}$$

The profit of each buyer is (see (6))

$$\pi_{2p}^B(q_{2p}^*) = \frac{(1-\beta)(2q_{2p}^* - (1+a)c)}{2-\beta} = \frac{1-\beta}{2-\beta}\left(\frac{2\beta}{df(2-\beta)} - (1+a)c\right). \tag{24}$$

q_{2p}^* is an interior solution if and only if $f \geq \beta^2/(d(2-\beta)(1-(1-\beta)a)c)$.

Nonpivotal or pivotal For $f \in [\beta^2/(d(2-\beta)(1-(1-\beta)a)c), \beta^2/(d(1-(1-\beta)a)c))$, the two cases in which the supplier trades with two buyers have interior solutions. In other words, q_{2n}^* and q_{2p}^* are local optimal solutions for this range of f. q_{2p}^* (q_{2n}^*) is the global optimum if and only if $\pi_{2p}(q_{2p}^*) \geq \pi_{2n}(q_{2n}^*)$ ($\pi_{2p}(q_{2p}^*) \leq \pi_{2n}(q_{2n}^*)$), respectively. $\pi_{2p}(q_{2p}^*) \geq \pi_{2n}(q_{2n}^*)$ if and only if

$$f \geq \frac{\beta^2(3-\beta)}{2cd(2-\beta)(1-a+a\beta)} \in \left[\frac{\beta^2}{d(2-\beta)(1-(1-\beta)a)c}, \frac{\beta^2}{d(1-(1-\beta)a)c}\right).$$

¿From (20) and (23), if the supplier decides to negotiate with two buyers, the optimal investment level q_2^* and the profit of the supplier $\pi_2(q_2^*)$ are

$$q_2^* = \begin{cases} q_{2n}^* = \dfrac{\beta}{df} & \text{if } f < \dfrac{\beta^2(3-\beta)}{2cd(2-\beta)(1-a+a\beta)}, \\ q_{2p}^* = \dfrac{\beta}{df(2-\beta)} & \text{if } f \geq \dfrac{\beta^2(3-\beta)}{2cd(2-\beta)(1-a+a\beta)}, \end{cases} \tag{25}$$

$$
(26) \quad \pi_2(q_2^*) = \begin{cases} \dfrac{\beta^2}{df} - (1-(1-2\beta)a)c & \text{if } f < \dfrac{\beta^2(3-\beta)}{2cd(2-\beta)(1-a+a\beta)}, \\ \dfrac{\beta}{2-\beta}\left(\dfrac{\beta}{df(2-\beta)} - (1+a)c\right) & \text{if } f \geq \dfrac{\beta^2(3-\beta)}{2cd(2-\beta)(1-a+a\beta)}. \end{cases}
$$

¿From (16) and (25), we find how the number of buyers affects the equilibrium investment level.

Proposition 2 *The investment level in the case of one buyer, q_1^*, is larger than that in the case of two buyers, q_2^*, if and only if*

$$
d > 2/(2-\beta) \quad \textit{and} \quad cdf \geq \frac{\beta^2(3-\beta)}{2(2-\beta)(1-a+a\beta)}.
$$

Now suppose that the supplier trades with two buyers that are pivotal. When the investment level is q, following their bargaining positions, they split the total gain from trade, $2q$. A supplier and buyer pair i consider the gain from another trade between the supplier and buyer j, T_j ($i = 1, 2,\ j \neq i$). As mentioned above, in the two negotiations they consider the sum of the three players' bargaining positions, $\beta + 2(1-\beta) = 2-\beta$. The share of the supplier's bargaining position is $\beta/(2-\beta)$. $\pi_{2p}(q)$ in (15) reflects the share of the supplier's bargaining position, and the total gross gain of the supplier from the trades is $2q\beta/(2-\beta)$ (see (15)). Note that this is smaller than that in which each buyer is nonpivotal, $2\beta q$ (see (14)). The smaller gross gain in the pivotal case diminishes the incentive of the supplier to invest.

Proposition 2 implies that a narrow buyer-supplier relationship intensifies the supplier's incentive to invest if the supplier's investment cost parameters c, d, and f are large. As mentioned in the introduction, Japanese automakers and their suppliers are more specialized than their US counterparts and there is a high correlation between supplier specialization and automaker profitability (Dyer (1996)). Although this statement is based on the viewpoint of buyers (automakers), this correlation may occur because the higher investment level caused by the narrower customer scope of suppliers leads to greater profitability of the automakers.

IV(iii) The first stage

We need to find the highest value of f such that both $\pi_1(q_1^*)$ and $\pi_2(q_2^*)$ are positive. We now impose the following assumption:

Assumption 1 We assume that $a = 0$ and $f < \beta/4c$.

We impose Assumption 1 to simplify the exposition and the analysis. The inequality in Assumption 1 ensures that $\pi_1(q_1^*)$ and $\pi_2(q_2^*)$ are positive for the exogenous parameters (β, c, d, and f). ¿From (17) and (26), the difference between $\pi_1(q_1^*)$ and $\pi_2(q_2^*)$ is given as[19]

$$\begin{aligned}\Delta\pi(q^*) &\equiv \pi_1(q_1^*) - \pi_2(q_2^*)\\ &= \begin{cases} \dfrac{4cd(1-\beta)f - \beta^2(4-d)}{4df} & \text{if } f < \dfrac{\beta^2(3-\beta)}{2cd(2-\beta)},\\ \dfrac{\beta(\beta((2-\beta)^2 d - 4) - 4cd(2-\beta)(1-\beta)f)}{4(2-\beta)^2 df} & \text{if } f \geq \dfrac{\beta^2(3-\beta)}{2cd(2-\beta)}.\end{cases}\end{aligned}$$

If the following condition holds, $\Delta\pi(q^*) > 0$:

$$\frac{\beta^2(4-d)}{4cd(1-\beta)} < f < \frac{\beta((2-\beta)^2 d - 4)}{4cd(2-\beta)(1-\beta)}. \tag{27}$$

Depending on the exogenous parameters, f can be empty. If the right-hand-side value in the latter inequality is larger than the left-hand-side value in the former inequality, there exists f such that $\Delta\pi(q^*) > 0$. The following inequality shows the condition in which the optimal number of buyers may be one. The right-hand side is increasing in β.

$$d > \frac{2(1 + 2\beta - \beta^2)}{2 - \beta}. \tag{28}$$

We summarize the above discussion in the following proposition:

Proposition 3 *Under Assumption 1, if f satisfies (27), then $\pi_1(q_1^*) > 0$ and $\Delta\pi(q^*) > 0$. That is, the supplier prefers trading with one buyer to trading with two buyers if f satisfies (27).*

[19] Note that $\beta^2(3-\beta)/2cd(2-\beta)$ is not always smaller than $\beta/4c$ in Assumption 1. That is, in some cases, only the nonpivotal case appears.

The relations between $\Delta\pi(q^*)$ and the exogenous parameters are given as (the mathematical procedure is available in Appendix 1)

$$\begin{aligned}
&\frac{\partial \Delta\pi(q^*)}{\partial c} > 0, \quad \frac{\partial \Delta\pi(q^*)}{\partial \beta} < 0, \qquad\qquad \text{if } f \leq \frac{\beta^2(3-\beta)}{2cd(2-\beta)}, \\
&\frac{\partial \Delta\pi(q^*)}{\partial c} < 0, \quad \frac{\partial \Delta\pi(q^*)}{\partial \beta} \gtrless 0 \ \text{ if } d \gtrless \tilde{d} \ \text{ if } f \geq \frac{\beta^2(3-\beta)}{2cd(2-\beta)},
\end{aligned} \tag{29}$$

where $\tilde{d} \equiv 8\beta/((2-\beta)(\beta(2-\beta)^2 - 2(2-4\beta+\beta^2)cf))$.[20] Essentially, $\Delta\pi(q^*)$ has a similar property to $\Delta\pi^*$. The property of $\partial\Delta\pi(q^*)/\partial\beta$ is different from that of $\partial\Delta\pi^*/\partial\beta$ when the buyers are pivotal. In particular, when $d > 16/((2-\beta)(6-4\beta+\beta^2))$ and the buyers are pivotal, $\partial\Delta\pi(q^*)/\partial\beta > 0$ for any f under Assumption 1. As in Proposition 2, when d and f are large, the equilibrium investment level is larger when the supplier trades with one buyer ($q_1^* > q_2^*$). This property is quite different from that in the case where the quality of goods is exogenous. When d and f are large, the stronger bargaining position of the supplier generates a greater gross gain from trade when it trades with one buyer rather than two. Because a larger value of d enhances the difference between the equilibrium investment levels $q_1^* - q_2^*$, a stronger bargaining position for the supplier can encourage it to decrease the number of buyers when d is large.

V Buyer merger

We briefly discuss whether the buyers have an incentive to merge.

If the supplier decides to negotiate with a merged buyer, then the surplus of this negotiation is $2v - (1+a)c$. Let T denote a payment from the buyer to the supplier. The buyer and the supplier split the surplus in a way that satisfies $2v - T : T - (1+a)c = 1 - \beta : \beta$. Therefore, we obtain

$$\beta[2v - T] = (1-\beta)(T - (1+a)c) \ \text{ or } \ T_m := 2\beta v + (1-\beta)(1+a)c.$$

Then, the profit of the supplier is

$$\pi_m^* = T_m - (1+a)c - dF = \beta(2v - (1+a)c) - dF. \tag{30}$$

[20] The denominator is positive under Assumption 1.

The profit of the buyer is

$$\pi_m^B = 2v - T_m = (1-\beta)(2v - (1+a)c). \tag{31}$$

If π_m^B is larger than $2\pi_2^B$ (see (8) and (31)), the buyers merge. We easily find that the buyers merge if and only if they are pivotal. The difference between π_m^* and π_1^* is positive.[21]

When the supplier invests to improve its product quality, q, the profit of the supplier is

$$\pi_m(q) = \beta(2q - (1+a)c) - dfq^2. \tag{32}$$

¿From (32), the investment level is given as

$$q_m^* = \arg\max_q \ \pi_m(q) = \frac{\beta}{df}. \tag{33}$$

The optimal investment level q_m^* leads to

$$\pi_m(q_m^*) = \frac{\beta^2}{df} - \beta(1+a)c. \tag{34}$$

The profit of the merged buyer is

$$\pi_m^B(q_m^*) = (1-\beta)(2q_m^* - (1+a)c) = (1-\beta)\left(\frac{2\beta}{df} - (1+a)c\right). \tag{35}$$

If $\pi_m^B(q_m^*)$ is larger than $2\pi_2^B(q_2^*)$ (see (26) and (35)), the buyers merge. We easily find that the buyers merge if and only if they are pivotal. The difference between $\pi_m(q_m^*)$ and $\pi_1(q_1^*)$ is positive.[22]

[21] The difference is given by

$$\begin{aligned}
\pi_1^* - \pi_m^* &= (d-1)F - \beta(v - ac) < (d-1)\beta(v-c) - \beta(v-ac) \\
&= -\beta(2v - (1+a)c - (v-c)d) \le -\beta(2v - (1+a)c - 2(v-c)) \\
&= -\beta(1-a)c \le 0.
\end{aligned}$$

[22] The difference is given by

$$\begin{aligned}
\pi_1(q_1^*) - \pi_m(q_m^*) &= \beta\left(ac - \frac{\beta(4-d)}{4df}\right) \le \beta\left(c - \frac{\beta(4-d)}{4df}\right) \\
&< \beta\left(\frac{\beta}{4f} - \frac{\beta(4-d)}{4df}\right) = \frac{\beta^2(2d-4)}{4df} \le 0.
\end{aligned}$$

Based on the model in Raskovich (2003), Adilov and Alexander (2006) and Clark et al. (2008) also discuss buyer mergers. They clarify how being a pivotal merged buyer affects the payoffs of the players. Adilov and Alexander (2006) focus on heterogeneity of bargaining power among buyers, and Clark et al. (2008) consider several cases in which players sequentially bargain as in Stole and Zwiebel (1996a). Their basic results are consistent with ours.

VI Decision on the number of trading partners: Buyer's decision

So far, we have considered several cases in which the supplier determines the number of buyers. We now consider two cases in which a buyer determines the number of buyers. The only difference between the analysis in this section and that in the previous section is the structure of the first stage. The number of trading partners is determined by the current buyer in this section. The discussion is motivated by the following situation. A potential buyer emerges when a buyer and a supplier trade exclusively with each other. It is not obvious whether or not expanding the number of buyers benefits the incumbent buyer. If the expansion harms the incumbent buyer and if the contract between the pair allows this buyer to prevent the supplier from increasing the number of buyers, the incumbent buyer does not allow the supplier to do so.[23]

The model setting in this section is related to Nobeoka (1996). Focusing on the sourcing concentration and the sharing of common suppliers with competitors, he examines the component sourcing strategy of the Japanese automobile manufacturers. In his paper, he proposes two strategic dimensions in component sourcing. One of the dimensions is the degree of supplier sharing with competing assemblers. Some assemblers may buy a certain type of component from a supplier that exclusively sells it to the manufacturer, while others

[23] In the introduction, we mention the case in which affiliated firms in the Toyota *keiretsu* group sold a portion of their products to outsiders. This case may be taken as an example of the buyer deciding the number of trading partners served by the supplier. If Toyota has an exclusive contract with its affiliated firms, then the affiliated firms cannot trade with a new partner without its permission. In that situation, Toyota's permission implies that the affiliated firms can expand their number of trading partners.

may rely on a supplier that sells the same type of component to other manufacturers as well.[24]

We now consider the buyer's choice concerning the number of buyers. Suppose that the buyer chooses the number to maximize its own profit. From (2) and (8), the number is one if and only if

$$\pi_1^B = (1-\beta)(v-c) \geq \pi_2^B = \begin{cases} (1-\beta)(v-ac) & \text{if } c \leq \dfrac{\beta v}{1-(1-\beta)a}. \\ \dfrac{(1-\beta)(2v-(1+a)c)}{2-\beta} & \text{if } c \geq \dfrac{\beta v}{1-(1-\beta)a}. \end{cases}$$

We easily find that the inequality does not hold for all exogenous parameters (note that $c \leq v$). That is, the current buyer always prefers to expand the customer scope of the supplier. We next show that this result changes when we incorporate quality investments into the basic model.

We now consider the case with quality investments. The only difference between the analysis in this and the previous part is the structure of the first stage. To simplify the analysis, we impose Assumption 1 in this case.

First, we easily find that $\pi_{2n}^B(q_{2n}^*) > \pi_1^B(q_1^*)$ (see (18) and (21)). This means that the optimal number of buyers is two for the current buyer when $f < \beta^2(3-\beta)/(2cd(2-\beta))$.

Second, the difference between $\pi_1^B(q_1^*)$ and $\pi_{2p}^B(q_{2p}^*)$ is given as (see (18) and (24))

$$\Delta\pi^B(q^*) \equiv \pi_1^B(q_1^*) - \pi_{2p}^B(q_{2p}^*) = \frac{(1-\beta)(\beta((2-\beta)^2 d - 4) - 2cd(2-\beta)(1-\beta)f)}{2df(2-\beta)^2}.$$

This is positive if and only if

$$\frac{\beta^2(3-\beta)}{2cd(2-\beta)} \leq f < \frac{\beta((2-\beta)^2 d - 4)}{2cd(2-\beta)(1-\beta)}. \tag{36}$$

Note that the first inequality is the condition under which the supplier chooses q_{2p}^* in the investment stage. Depending on the exogenous parameters, f can be empty. If the right-hand-side value in the second inequality is larger than the left-hand-side value in the

[24] The other dimension is the sourcing concentration that determines the degree of reliance on a small number of suppliers such as on a single supplier. This dimension is similar in concept to the number of suppliers from which a firm procure a certain type of components.

first inequality, there exists f such that $\pi_1^B(q_1^*) > \pi_{2p}^B(q_{2p}^*)$. The following inequality shows the condition under which the optimal number of buyers can be one. The right-hand side is increasing in β.

$$d > \frac{4 + 3\beta - 4\beta^2 + \beta^3}{(2-\beta)^2}. \tag{37}$$

We summarize the above discussion in the following proposition:

Proposition 4 *Suppose that the supplier engages in quality investment. Under Assumption 1, when a current buyer determines the number of buyers, the optimal number of buyers is one for the current buyer if f satisfies (36).*

This result is also related to Proposition 2. When the supplier trades with two buyers, the equilibrium quality becomes lower, although per-unit production cost is reduced. A broad customer scope strategy is not preferable for the supplier and the current buyer if the investment technology of the supplier is not good (f and d are large).

Our result may have a potential to explain the difference among the sourcing strategies of major Japanese automobile assemblers. Nobeoka (1996) investigates the sourcing strategy of six Japanese car assemblers (Toyota, Nissan, Honda, Mitsubishi, Mazda, and Suzuki) regarding 95 components. He classifies two types of sourcing strategy into the quasi-market strategy and the quasi-hierarchy strategy. The former is related to an expansion of the supplier's customer scope and the latter is related to an exclusive trade relation. He shows that Nissan and Honda employ the quasi-hierarchy strategy while Toyota, Mitsubishi, and Suzuki do the quasi-market strategy. He also shows that firms using a broad manufacturer-supplier network tend to be more profitable. Our result clarifies the condition that firms using a broad manufacturer-supplier network are more profitable. Our result implies that a broad customer scope strategy is employed by the supplier and the current buyer when the supplier has a good investment technology (f and d are small). As a result, in our model, a broad manufacturer-supplier network leads to superior performance. Our result may be consistent with the finding in Nobeoka (1996).

VII Concluding remarks

We provide a simple model and investigate what factors determine the number of trading partners. We show several results that may be consistent with the formation of Japanese buyer-supplier relations. When the supplier is able to determine the number of trading partners, one or two, the optimal number is one for the supplier if the supplier's bargaining power with its trading partners is *weak* and the supplier's additional sunk investment cost is relatively large. The supplier prefers to trade with one buyer if the variable production cost is neither large nor small for the value of the good. That is, there is nonmonotonicity in the relation between the optimal number of buyers and the variable production cost. This means that a supplier with a lower or higher cost prefers trading with two buyers, whereas one with an intermediate level of variable production cost prefers trading with one buyer. We also show that the equilibrium investment level when the supplier trades with one buyer can be larger than that with two buyers if the sunk investment cost is large relative to the value of the good, the supplier's bargaining power with its trading partners is weak, and the variable production cost is large. This may be related to the following finding. Japanese automakers and their suppliers are more specialized than their US counterparts and there is a high correlation between supplier specialization and automaker profitability (Dyer (1996)). Although this statement is based on the viewpoint of buyers (automakers), this correlation may occur because the higher investment level caused by the narrower customer scope of suppliers leads to greater profitability of the automakers.

Our model may be applicable to the cable television industry. As mentioned in Chipty and Snyder (1999), a program service provider (supplier) has bilateral relationships with cable operators (buyers). Those operators tend to be regional monopolists and do not compete with each other. To make TV programs, such a program service company must incur higher (sunk) costs. In some cases, the program service company may have to pay per-buyer copyright fees for artists who participate in these TV programs (this is related to variable costs of the supplier). In other cases, this company would not have to do so because its own staff members make its programs. When we apply our results to this industry, we can say that a program service provider (supplier) that has to incur higher fixed costs and relatively higher variable costs should have a narrow relationship with cable operators.

In our model, buyers are independent in their final product markets. As discussed in Matsushima (2004, 2009), competition among buyers is an important research topic. To simplify the analysis of our model, we consider the transactions of only one supplier. Markets with multiple suppliers are also an important research topic. The wider investigation allows us to discuss competition among suppliers, although this complicates the analysis. Moreover, the topic of repeated interactions between suppliers and buyers is important. This would arise in examining the reason why technological improvements induce the gradual decrease of trading prices over time in Japanese buyer–supplier relationships. These are significant topics for future research.

Appendix 1: comparative statics

We now explain the results concerning the comparative statics of $\Delta\pi^*$ and $\Delta\pi(q^*)$.

When $\beta < 1/2$ and $c \leq \beta v/(1-(1-\beta)a)$ (the buyers are non-pivotal), we have the following result:

$$\begin{aligned}
\frac{\partial \Delta\pi^*}{\partial a} &= -(1-2\beta)c < 0, \\
\frac{\partial \Delta\pi^*}{\partial c} &= (1-\beta-(1-2\beta)a) > 0, \\
\frac{\partial \Delta\pi^*}{\partial \beta} &= -v-(1-2a)c \leq 0.
\end{aligned}$$

Note that $(1-\beta-(1-2\beta)a) = 1-\beta > 0$ when $a = 0$ and $(1-\beta-(1-2\beta)a) = \beta > 0$ when $a = 1$. Therefore, for any $a \in [0,1]$, $(1-\beta-(1-2\beta)a)$ is positive. Note also that $-v-(1-2a)c = -v < 0$ when $c = 0$ and $-v-(1-2a)c = -(1+\beta)(1-a)v/(1-(1-\beta)a) \leq 0$ when $c = \beta v/(1-(1-\beta)a)$. Therefore, for any $c \in [0, \beta v/(1-(1-\beta)a)]$, $-v-(1-2a)c$ is non positive.

When $\beta < 1/2$ and $c \geq \beta v/(1-(1-\beta)a)$ (the buyers are pivotal), we have the following result:

$$
\begin{aligned}
\frac{\partial \Delta \pi^*}{\partial a} &= \frac{\beta c}{2-\beta} > 0, \\
\frac{\partial \Delta \pi^*}{\partial c} &= -\frac{1-\beta-a}{2-\beta} < 0 \text{ iff } 1 > a+\beta, \\
\frac{\partial \Delta \pi^*}{\partial \beta} &= -\frac{2(1-a)c+\beta(4-\beta)(v-c)}{(2-\beta)^2} < 0.
\end{aligned}
$$

When $\beta < 1/2$ and $f \leq \beta^2(3-\beta)/(2cd(2-\beta))$ (the buyers are non-pivotal), we have the following result:

$$
\begin{aligned}
\frac{\partial \Delta \pi^*}{\partial c} &= \frac{4d(1-\beta)f}{4df} > 0, \\
\frac{\partial \Delta \pi^*}{\partial \beta} &= -\frac{2cdf+\beta(4-d)}{2df} < 0.
\end{aligned}
$$

When $\beta < 1/2$ and $f \geq \beta^2(3-\beta)/(2cd(2-\beta))$ (the buyers are pivotal), we have the following result:

$$
\begin{aligned}
\frac{\partial \Delta \pi^*}{\partial c} &= -\frac{4d(2-\beta)(1-\beta)f}{4(2-\beta)^2 df} < 0, \\
\frac{\partial \Delta \pi^*}{\partial \beta} &= \frac{\beta(d(2-\beta)^3-8)-2cd(2-\beta)(2-4\beta+\beta^2)f}{2(2-\beta)^2 df}.
\end{aligned}
$$

Appendix 2: sequential bargaining

We present two sorts of sequential bargaining models. In the first model, the supplier negotiates with buyers bilaterally and sequentially. In the second model, the supplier and the buyers participate in the bargaining modeled through the Shapley value.

A sequential bilateral bargaining

We first consider the following sequential bargaining (see Stole and Zwiebel (1996a, b)): First, the first buyer negotiates with the supplier. If the negotiation reaches an agreement, the buyer's payment T_1 is determined; otherwise, no transfer occurs and the buyer exits the game. Observing the outcome of the negotiation, the second buyer negotiates with the supplier. If the negotiation reaches an agreement, the buyer's payment T_2 is determined; otherwise, no transfer occurs and the buyer exits the game.[25]

We first analyze bargaining between the second buyer and the supplier. Given the outcome of the bargaining, we then examine the bargaining among the first buyer and the supplier.

Given that the first buyer's payment T_1 is determined, we consider the negotiation between the second buyer and the supplier. We need to consider the following two cases: one is the case of $T_1 > c$ (the second buyer is non-pivotal) and the other is the case of $T_1 \leq c$ (the second buyer is pivotal).

Case 1. $T_1 > c$**.** When $T_1 > c$, the second buyer is non-pivotal. The additional surplus of the trade with the second buyer is $v - ac$. The second buyer pays T_2 to the supplier in a way that satisfies

$$\beta(v - T_2) = (1 - \beta)(T_2 - ac) \text{ or } T_2 = \beta v + (1 - \beta)ac.$$

Assuming that the second negotiation reaches the agreement mentioned above, the first buyer negotiates with the supplier. It is worth noting that $T_2 > c$ holds if and only if the first buyer is also non-pivotal.[26] Because $T_2 > c$ implies $\beta v > (1 - (1 - \beta)a)c$, $\beta v > (1 - (1 - \beta)a)c$ must be satisfied for the first buyer to be non-pivotal.

(1.1) If $\beta v > (1-(1-\beta)a)c$, the first buyer is non-pivotal and then the additional surplus of the trade with the first buyer is $v - ac$. The first buyer pays T_1 to the supplier in a way that satisfies

$$\beta(v - T_1) = (1 - \beta)T_1 - ac \text{ or } T_1 = T_2 = \beta v + (1 - \beta)ac.$$

This satisfies the condition that $T_1 > c$ if and only if

$$\beta v > (1 - (1 - \beta)a)c.$$

[25] The order of bargaining does not affect our result.

[26] If $T_2 \leq c$, then it depends on the value of T_1 whether two units of input are supplied by the supplier.

(1.2) If $\beta v \leq (1-(1-\beta)a)c$, then the first buyer is pivotal and the additional surplus of the trade with the first buyer is $(v - T_1) + (T_1 + T_2 - (1+a)c) = v + T_2 - (1+a)c$. The first buyer pays T_1 to the supplier in a way that satisfies

$$\beta(v - T_1) = (1-\beta)(T_1 + T_2 - (1+a)c) \quad \text{or} \quad T_1 = \beta^2 v + (1-\beta)(1+a\beta)c.$$

This satisfies the condition that $T_1 > c$ if and only if

$$\beta v > (1-(1-\beta)a)c.$$

However, since we now consider the case in $\beta v \leq (1-(1-\beta)a)c$, case (1.2) does not appear in equilibrium.

If $\beta v > (1-(1-\beta)a)c$, then $T_1 > c$ is supported as an equilibrium and then $T_1 = T_2 = \beta v + (1-\beta)ac$.

Case 2. $T_1 \leq c$**.** When $T_1 \leq c$, the second buyer is pivotal. The additional surplus of the trade with the second buyer is $(v - T_2) + (T_1 + T_2 - (a+1)c) = v + T_1 - (a+1)c$. The second buyer pays T_2 to the supplier in a way that satisfies

$$\beta(v - T_2) = (1-\beta)(T_1 + T_2 - (a+1)c) \quad \text{or} \quad T_2 = \beta v + (1-\beta)(a+1)c - (1-\beta)T_1. \tag{38}$$

Assuming that the second negotiation reaches the agreement mentioned above, the first buyer negotiates with the supplier.

(2.1) If $T_2 > c$, then the first buyer is non-pivotal and the additional surplus of the trade with the first buyer is $v - ac$. The first buyer pays T_1 to the supplier in a way that satisfies

$$\beta(v - T_1) = (1-\beta)(T_1 - ac) \quad \text{or} \quad T_1 = \beta v + (1-\beta)ac.$$

Substituting it into T_2 in (38), we obtain

$$T_1 = \beta v + (1-\beta)ac, \quad T_2 = \beta^2 v + (1-\beta)(1+\beta a)c.$$

This satisfies the condition that $T_1 \leq c$ if and only if

$$\beta v \leq (1-(1-\beta)a)c. \tag{39}$$

We obtain $T_2 > c$ if and only if

$$\beta v > (1-(1-\beta)a)c. \tag{40}$$

There is no exogenous values that satisfy the two inequalities. Therefore, case (2.1) does not appear in equilibrium.

(2.2) If $T_2 \leq c$, then the first buyer is pivotal and the additional surplus of the trade with the first buyer is $(v-T_1)+(T_1+T_2-(a+1)c) = v+T_2-(a+1)c$. The first buyer pays T_1 to the supplier in a way that satisfies (we substitute T_2 in (38) into the following equation)

$$\beta(v-T_1) = (1-\beta)(T_1+T_2-(a+1)c) = \beta(1-\beta)(v+T_1-(a+1)c).$$

The equation leads to

$$T_1 = T_2 = \frac{\beta v + (1-\beta)(a+1)c}{2-\beta}.$$

This satisfies the condition that $T_1 \leq c$ if and only if $\beta v \leq (1-(1-\beta)a)c$ and $T_2 \leq c$ if and only if $\beta v \leq (1-(1-\beta)a)c$.

If $\beta v \leq (1-(1-\beta)a)c$, then $T_1 \leq c$ is supported as an equilibrium and then $T_1 = T_2 = (\beta v + (1-\beta)(a+1)c)/(2-\beta)$.

We can summarize the results mentioned above as follows:

$$T_1 = T_2 = \begin{cases} \beta v + (1-\beta)ac & \text{if } \beta v > (1-(1-\beta)a)c, \\ \dfrac{\beta v + (1-\beta)(a+1)c}{2-\beta} & \text{if } \beta v \leq (1-(1-\beta)a)c. \end{cases} \tag{41}$$

These transfer payments by the buyers are equal to those derived in the main text.

Appendix 3: a sequential bargaining modeled through the Shapley value

We consider the bargaining modeled through the Shapley value. Each player comes to negotiate in a given order and receives the marginal surplus from his/her arrival. The marginal surplus of the arrival may depend on the order of arrival, which is stochastically determined. We assume that the probability of each arrival order is the same. The Shapley value of each player is their expected marginal surplus. By applying the Shapley value, we calculate each player's share of the bargaining surplus.

We first examine the case in which the supplier negotiates with two buyers. Because there are three players (the supplier, buyer 1, and buyer 2), there are $3! = 6$ orders. Each order occurs with probability $1/6$. The bargaining surplus is calculated from a characteristic function. A *natural* characteristic function of our model, denoted by $V^2 : \{S, B1, B2\} \to \mathbb{R}_+$, in which S, $B1$, and $B2$ represent the supplier, buyer 1, and buyer 2, respectively, is as follows. We normalize $V^2(\emptyset) = 0$. No one can gain by him/herself; hence, $V^2(i) = 0$ for each $i \in \{S, B1, B2\}$. $B1$ and $B2$ can earn nothing; hence, $V^2(B1, B2) = 0$. Groups of the supplier and at least one buyer generate a surplus; $V^2(S, B1) = V^2(S, B2) = v - c$ and $V^2(S, B1, B2) = 2v - (1 + a)c$. The marginal contribution of player i to a set of arrived players, S', such that $i \notin S'$ is given by $V^2(S' \cup \{i\}) - V^2(S')$.

The expected contribution of player i constitutes the Shapley value, SV_i^2 ($i \in \{S, B1, B2\}$). Buyer 1's expected contribution, SV_{B1}^2, is

$$\begin{aligned}
SV_{B1}^2 &= \frac{V^2(B1) - V^2(\emptyset)}{6} + \frac{V^2(B1) - V^2(\emptyset)}{6} \\
&+ \frac{V^2(B1, B2) - V^2(B2)}{6} + \frac{V^2(S, B1) - V^2(S)}{6} \\
&+ \frac{V^2(S, B1, B2) - V^2(S, B2)}{6} + \frac{V^2(S, B1, B2) - V^2(S, B2)}{6} \\
&= \frac{3v - c - 2ac}{6}.
\end{aligned}$$

By a similar calculation, the expected contribution of $B2$, SV_{B2}^2, and that of S, SV_S^2, are $SV_{B2}^2 = (3v - c - 2ac)/6$ and $SV_S^2 = (3v - (1 + a)c - c)/3$, respectively.[27]

Second, we examine the case in which the supplier negotiates with one buyer. Consider a situation in which the supplier negotiates with buyer Bi ($i = 1, 2$). We can similarly

[27] Note that $SV_S^2 + SV_{B1}^2 + SV_{B2}^2 = V^2(S, B1, B2)$.

introduce a characteristic function $V^1 : \{S, Bi\} \to \mathbb{R}_+$: $V^1(\emptyset) = 0$, $V^1(j) = 0$ for each $j \in \{S, Bi\}$, and $V^1(S, Bi) = v - c$. The expected contribution of S, SV_S^1, and that of Bi, SV_{Bi}^1, are $SV_S^1 = (v-c)/2$ and $SV_{Bi}^1 = (v-c)/2$, respectively.

Based on these analyses, we examine the optimal number of buyers with whom the supplier negotiates. When the supplier negotiates with one buyer, his/her payoff is

$$\pi_1^* \equiv SV_S^1 - F = \frac{v-c}{2} - F. \tag{42}$$

When he/she trades with two buyers, his/her payoff is

$$\pi_2^* \equiv SV_S^2 - dF = \frac{3v - (1+a)c - c}{3} - dF. \tag{43}$$

Subtracting (43) from (42) yields

$$\pi_1^* - \pi_2^* = \frac{-3v - c + 2(1+a)c}{6} + (d-1)F. \tag{44}$$

We examine whether there is an exogenous parameter in which the supplier chooses to trade with one buyer. The supplier chooses to trade with one buyer if and only if $\pi_1^* - \pi_2^* \geq 0$ and $\pi_1^* \geq 0$. We have

$$\pi_1^* - \pi_2^* \geq 0 \text{ if and only if } F \geq \frac{3v + c - 2(1+a)}{6(d-1)}$$

and

$$\pi_1^* \geq 0 \text{ if and only if } \frac{v-c}{2} \geq F.$$

Thus,

$$\frac{v-c}{2} \geq F \geq \frac{3v + c - 2(1+a)c}{6(d-1)}. \tag{45}$$

We show that there exists an exogenous parameter that satisfies (45).

Lemma 1 *Condition (45) holds if and only if $a = 1$ and $d = 2$.*

Proof. Sufficiency is trivial. We show its necessity. We suppose that either $a \neq 1$ or $d \neq 2$. The left-hand side of (45) minus the right-hand side of (45) is equal to

$$\frac{3(d-2)v - (3d-2)c + 2(1+a)c}{6(d-1)}. \tag{46}$$

Because $v > c$, we can describe $v = \gamma c$ for some $\gamma > 1$. Substituting $v = \gamma c$ into (46), we obtain

$$\frac{(3(d-2)\gamma - (3d-2) + 2(1+a))c}{6(d-1)}. \tag{47}$$

Because $\gamma > 1$ and $d \leq 2$,

$$\frac{(3(d-2)\gamma - (3d-2) + 2(1+a))c}{6(d-1)} \leq \frac{(3(d-2) - (3d-2) + 2(1+a))c}{6(d-1)}. \tag{48}$$

If $d = 2$ but not $a = 1$, the right-hand side of (48) is $(a-1)c/3$, which is negative. If $a = 1$ but not $d = 2$, then (48) holds with strict inequality and the right-hand side of (48) is zero. Thus, there is no exogenous parameter that satisfies (45) in either case. ■

By Lemma 1, if there exists an exogenous parameter at which the supplier chooses to trade with one buyer, then $a = 1$ and $d = 2$. However, when $a = 1$ and $d = 2$, the supplier is indifferent between trade with two buyers and trade with one buyer. No parameter supports the supplier (strictly) preferring trade with one buyer to trade with two buyers. Therefore, in bargaining based on the Shapley value, the supplier rarely trades with one buyer.

We examine the merger incentive of buyers. Suppose that $B1$ and $B2$ merge. The merged buyer is denoted by $B12$. In this situation, a characteristic function $V^m : \{S, B12\} \to \mathbb{R}_+$ is as follows: $V^m(\emptyset) = V^m(S) = V^m(B12) = 0$ and $V^m(S, B12) = 2v - (1+a)c$. In the Shapley value, S receives $SV_S^m = (2v - (1+a)c)/2$ and $B12$ receives $SV_{B12}^m = (2v - (1+a)c)/2$. The buyers merge if and only if $SV_{B12}^m \geq SV_{B1}^2 + SV_{B2}^2$. We obtain $SV_{B12}^m - (SV_{B1}^2 + SV_{B2}^2) = c(a-1)/6 \leq 0$. Thus, in bargaining modeled by the Shapley value, the merger does not benefit the buyers.

In the Shapley value, the probability of each order is the same. This reflects the fact that the supplier and the buyers are treated symmetrically and the players have the same bargaining power.[28] One of the ways to investigate the effect of asymmetric bargaining power, introduced in simultaneous bargaining, is to assign different probabilities to the

[28] There are similarities between the Shapley value analysis and the simultaneous bargaining analysis with $\beta = 1/2$. In the case of the simultaneous bargaining analysis with $\beta = 1/2$, $\underline{d} \geq 2$. This means that a trade with one buyer rarely occurs in equilibrium.

order of the three players. In our game, as you can see in the characteristics functions, the marginal contribution of a player increases as he/she comes to the negotiation later. If we interpret this to mean that a higher marginal contribution entails greater bargaining power, then we can represent bargaining power by order of players. If the supplier has relatively strong bargaining power, the probability that the supplier arrives in the third place is relatively high and vice versa. If the supplier arrives in third place, he/she can extract the entire surplus. Thus, if the supplier negotiates with two buyers and if the probability that the supplier is the third arriver is sufficiently low, the supplier's payoff in the case of one buyer may be greater than his/her payoff in the case of two buyers. Asymmetric treatment of the order may create the possibility that the supplier benefits from trading with two buyers and that the buyers benefit from merging.

Stole and Zwiebel (1996a, b) introduce a sequential and bilateral bargaining model. They examine intrafirm wage bargaining between an employer and employees. They do not examine a buyer–supplier network. Unlike our sequential bargaining model, Stole and Zwiebel (1996a, b) assume that contracts between players are nonbinding and players can renegotiate contract details. They show that the equilibrium outcome of the sequential bargaining with renegotiation coincides with the Shapley value. Clarke et al. (2008) and Jeon (2006) apply the Shapley value to the buyer–supplier network and analyze the merger incentive of players. They do not examine the optimal number of buyers. Shapley (1953) and Kalai and Samet (1987) introduce a generalization of the Shapley value. In the generalized Shapley value, the order of players' arrival is treated asymmetrically. Application of the generalized Shapley value may change our result above.

References

Adilov, N. and Alexander, P.J., 2006, 'Horizontal merger: Pivotal buyers and bargaining power,' *Economics Letters*, 91, pp. 307–311.

Aghion, P. and Bolton, P., 1992, 'An Incomplete Contracts Approach to Financial Contracting,' *Review of Economic Studies*, 59, pp. 473–494.

Aghion, P., Dewatripont, M. and Rey, P., 1994, 'Renegotiation Design with Unverifiable Information,' *Econometrica*, 62, pp. 257–282.

Asanuma, B., 1985, 'The Organization of Parts Purchases in the Japanese Automotive Industry,' *Japanese Economy*, 13, pp. 32–53.

Bala, V. and Goyal, S., 2000, 'A Non-cooperative Model of Network Formation,' *Econometrica*, 68, pp. 1181–1229.

Battigalli, P., Fumagalli, C., and Polo, M., 2007, 'Buyer Power and Quality Improvements,' *Research in Economics*, 61, pp. 45–61.

Belleflamme, P. and Bloch F., 2004, 'Market Sharing Agreements and Collusive Networks,' *International Economic Review*, 45, pp. 387–411.

Bernheim, B.D. and Whinston, M.D., 1998, 'Exclusive Dealing,' *Journal of Political Economy*, 106, pp. 64–103.

Billand, P. and Bravard, C., 2004, 'Non-cooperative Networks in Oligopolies,' *International Journal of Industrial Organization*, 22, pp. 593–609.

Binmore, K.G., Rubinstein, A., and Wolinsky, A., 1986, 'The Nash Bargaining Solution in Economic Modeling,' *RAND Journal of Economics*, 17, pp. 176–188.

Chae, S. and Yang, J., 1994, 'An n-Person Pure Bargaining Game,' *Journal of Economic Theory*, 62, pp. 86–102.

Chatain, O. and Zemsky, P., 2009, 'Value Creation and Value Capture with Frictions,' INSEAD Working Paper No. 2009/35/ST/ACGRE.

Che, Y.-K. and Hausch, D., 1999, 'Cooperative Investments and the Value of Contracting,' *American Economic Review*, 89, pp. 125–147.

Chipty, T. and Snyder, C.M., 1999, 'The Role of Firm Size in Bilateral Bargaining: A Study of the Cable Television Industry,' *Review of Economics and Statistics*, 81, pp. 326–340.

Chung, T.-Y. 1991, 'Incomplete Contracts, Specific Investment and Risk Sharing,' *Review of Economic Studies* 58, pp. 1031–1042.

Clark, D.J., Musy, O. and Pereau, J.C., 2008, 'Merger and Bilateral Bargaining: A Note,' Working paper, University of Tromsø. Available at: http://www.ub.uit.no/munin/handle/10037/1814

de Fontenay, C.C. and Gans, J.S., 2005, 'Vertical Integration in the Presence of Upstream Competition,' *RAND Journal of Economics*, 36, pp. 544–572.

de Fontenay, C.C. and Gans, J.S., 2007, 'Bilateral Bargaining with Externalities,' The selected works of Joshua S. Gans. Available at: http://works.bepress.com/joshuagans/14

de Meza, D. and Selvaggi, M., 2007, 'Exclusive Contracts Foster Relationship-Specific Investment,' *RAND Journal of Economics*, 38, pp. 85–97.

Dyer, J.H., 1996, 'Specialized Supplier Networks as a Source of Competitive Advantage: Evidence from the Auto Industry,' *Strategic Management Journal*, 17, pp. 271–292.

Fisher, M.L., Ramdas, K., and Ulrich, K.T., 1999, 'Component Sharing in the Management of Product Variety: A Study of Automotive Braking Systems,' *Management Science* 45, pp. 297–315.

Furusawa, T. and Konishi, H., 2007, 'Free Trade Networks,' *Journal of International Economics* 72, pp. 310–335.

Grossman, S. and Hart, O., 1986, 'The Costs and Benefits of Ownership: A Theory of Lateral and Vertical Integration,' *Journal of Political Economy* 94, pp. 691–719.

Goyal, S. and Joshi, S., 2006, 'Bilateralism and Free Trade,' *International Economic Review* 47, pp. 749–778.

Hart, O. and Moore, J., 1990, 'Property Rights and the Nature of the Firm,' *Journal of Political Economy* 98, pp. 1119–1158.

Hart, O. and Moore, J. 1999, 'Foundations of Incomplete Contracts,' *Review of Economic Studies* 66, pp. 115–138.

Inderst, R., Mazzarotto, N., 2008. 'Buyer Power in Distribution,' *Issues in Competition Law and Policy Volume 3 (ABA Section of Antitrust Law)*, ed. W.D. Collins, American Bar Association, 2008.

Inderst, R. and Shaffer, G., 2007, 'Retail Mergers, Buyer Power, and Product Variety,' *Economic Journal* 117, pp. 45–67.

Inderst, R. and Wey, C., 2003, 'Bargaining, mergers, and technology choice in bilateral oligopolistic industries,' *RAND Journal of Economics* 34, pp. 1–19.

Inderst, R. and Wey, C., 2007, 'Buyer Power and Supplier Incentives,' *European Economic Review* 51, pp. 647–667.

Inderst, R. and Wey, C., 2010, 'Countervailing Power and Dynamic Efficiency,' *Journal of the European Economic Association*, forthcoming.

Jackson, M.O. and Wolinsky, A., 1996, 'A Strategic Model of Social and Economic Networks,' *Journal of Economic Theory* 71, pp. 44–74.

Jeuland, A.P. and Shugan, S.M., 1983, 'Managing Channel Profits,' *Marketing Science* 2, pp. 239–272.

Jeon, S., 2006, 'Shapley Bargaining and Merger Incentives in Network Industries with Essential Facilities,' *Hitotsubashi Journal of Economics* 47, pp. 229–248.

Kalai, E. and Samet, D., 1987, 'On Weighted Shapley Value,' *International Journal of Game Theory*, 16, pp. 205–222.

Kamien, M.I, Oren, S.S, and Tauman, Y., 1992, 'Optimal licensing of cost-reducing innovation,' *Journal of Mathematical Economics* 21, pp. 483–508.

Kamien, M.I and Tauman, Y., 1986, 'Fees versus Royalties and the Private Value of a Patent,' *Quarterly Journal of Economics* 101, pp. 471–491.

Klein, B., Crawford, R. and Alchian, A., 1978, 'Vertical Integration, Appropriable Rents, and the Competitive Contracting Process,' *Journal of Law and Economics* 21, pp. 297–326.

Konishi, H., Okuno-Fujiwara, M. and Suzuki, Y., 1996, 'Competition through Endogenized Tournaments: An Interpretation of "Face-to-Face" Competition,' *Journal of the Japanese and International Economies* 10, pp. 199–232.

Kranton, R.E. and Minehart, D.F., 2000, 'Networks Versus Vertical Integration,' *RAND Journal of Economics* 31, pp. 570–601.

Kranton, R.E. and Minehart, D.F., 2001, 'A Theory of Buyer-Seller Networks,' *American Economic Review* 91, pp. 485–508.

Krishna, V. and Serrano, R., 1996, 'Multilateral Bargaining,' *Review of Economic Studies* 63, pp. 61–80.

Mahoney, J.T., 2001, 'A Resource-Based Theory of Sustainable Rents,' *Journal of Management*, 27, pp. 651–660.

Matsushima, N., 2004, 'Technology of Upstream Firms and Equilibrium Product Differentiation', *International Journal of Industrial Organization*, 22, pp. 1091–1114.

Matsushima, N., 2009, 'Vertical Mergers and Product Differentiation,' *Journal of Industrial Economics*, 57, pp. 812–834.

Nishiguchi, T., 1994, *Strategic Industrial Sourcing: The Japanese Advantage*, New York: Oxford University Press.

Nobeoka, K., 1996, 'Alternative Component Sourcing Strategies within the Manufacturer-Supplier Network: Benefits of Quasi-Market Strategy in the Japanese Automobile Industry,' *Kobe Economic and Business Review*, 41, pp. 69–99.

Nobeoka, K., Dyer, J.H, and Madhok, A., 2002, 'The Influence of Customer Scope on Supplier Learning and Performance in the Japanese Automobile Industry,' *Journal of International Business Studies*, 33, pp. 717–736.

Okada, A., 1996, 'A Noncooperative Coalitional Bargaining Game with Random Proposers,' *Games and Economic Behavior* 16, pp. 97–108.

Okada, A., 2010, 'The Nash Bargaining Solution in General n-Person Cooperative Games,' *Journal of Economic Theory* 145, pp. 2356–2379.

Qian, G. and Li, L., 2003, 'Profitability of Small- and Medium-Sized Enterprises in High-Tech Industries: The Case of the Biotechnology Industry,' *Strategic Management Journal* 24, pp. 881–887.

Ramdas, K. and Randall, T., 2008, 'Does Component Sharing Help or Hurt Reliability? An Empirical Study in the Automotive Industry,' *Management Science* 54, pp. 922–938.

Ramdas, K. and Sawhney, M.S., 2001, 'A Cross-Functional Approach to Evaluating Multiple Line Extensions for Assembled Products,' *Management Science* 47, pp. 22–36.

Raskovich, A., 2003, 'Pivotal Buyers and Bargaining Position,' *Journal of Industrial Economics*, 51, pp. 405-426.

Rey, P. and Tirole, J., 2007, 'A Primer on Foreclosure,' M. Armstrong and R. Porter (eds.), *Handbook of Industrial Organization*, Vol. 3, Ch. 33, pp. 2145-2220, Elsevier.

Sato, Y., 1988, *Toyota gurupu no senryaku to jissho bunseki* (Strategy and Empirical Analysis of the Toyota Group), Tokyo: Hakuto Shobo.

Segal, I. 1999, 'Complexity and Renegotiation: A Foundation for Incomplete Contracts,' *Review of Economic Studies* 66, pp. 57–82.

Segal, I. and Whinston, M.D., 2000, 'Exclusive Contracts and Protection of Investments,' *RAND Journal of Economics* 31, pp. 603–633.

Shapley, L.S., 1953, 'Additive and Non-additive Set Functions,' Ph.D. thesis, Princeton University, Princeton, 1953.

Stole, L.A. and Zwiebel, J., 1996a, 'Intra-firm Bargaining under Non-binding Contracts,' *Review of Economic Studies*, 63, pp. 375–410.

Stole, L.A. and Zwiebel, J., 1996b, 'Organizational Design and Technology Choice under Intrafirm Bargaining,' *American Economic Review*, 86, pp. 195–222.

Williamson, O. 1979, 'Transaction-Cost Economics: the Governance of Contractual Relations,' *Journal of Law and Economics* 22, pp. 233–262.