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COORDINATION AND COMMUNICATION IN VERTICAL RELATIONSHIPS

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I. Introduction

In recent years there has been a renewal of interest in vertical relationships. One group of studies is from the literature of industrial organisation (see, for example, Mathewson and Winter [1984] [1986], Tirole [1988], Katz [1989], and Vickers and Waterson [1991]), and a second group is in the theoretical research in marketing (see, for example, Lilien, Kotler, and Moorthy [1992]). The former sheds lights on vertical integration and vertical restraints, and the latter on the strategic interactions both within a marketing channel and between channels. These recent works are in different fields of research, however, they treat similar issues in vertical relationships: especially the vertical coordination problem in pricing.

Among the motives of coordination in vertical pricing, it is widely known that the problem of double marginalization calls for vertical integration and vertical restraints (see, for example, Spengler [1950], Machlup and Taber [1960], and Tirole [1988]). Such a problem of vertical coordination has been addressed also in the marketing literature from the viewpoint of strategic interaction in a marketing channel (see, for example, Jeuland and Shugan [1983 a] [1983 b], Moorthy [1987], and Moorthy and Fader [1989]).

Recent papers treat vertical coordination in a stochastic environment. Rey and Tirole [1986] compared various forms of vertical restraints when the retailer is privately informed about demand. They show that vertical restraints may be insufficient to achieve the outcome of vertical integration. Gal-Or [1991] treats the same problem in a model where contingent contracts are possible between a manufacturer and a retailer. When there is uncertainty about demand and retailing cost, even contingent contracting cannot achieve the outcome of vertical integration.

This paper treats the problem of coordination in vertical relationships

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from the aspect of communication between a manufacturer and a retailer. We consider the vertical relationship between a manufacturer and a retailer, with emphasis on the vertical cooperation in pricing that arises from asymmetric information about demand. In contrast to the papers by Rey and Tirole [1986] and Gal-Or [1991], the aspect of communication between a manufacturer and a retailer is treated explicitly. Although many articles in marketing stress the importance of vertical coordination from the aspect of channel communication (see, for example, O'Hara [1983]), there is little attempt to formulate the problem in analytical models. We will explore the vertical relationship under several information conditions by using a game with imperfect information. When the retailer is privately informed, it can be shown that the retailer does not want to reveal information even if information sharing is beneficial for the manufacturer. This result indicates the need for vertical coordination from the aspect of communication. We will show that the vertical integration is an equilibrium outcome of a sequential game with asymmetric information. Vertical integration can be seen as the first best outcome from the social welfare point of view.

Furthermore we will also examine the attainability of the outcome of vertical integration in an alternative actual way. In Japan the *tatene* vertical pricing system can be seen in many vertical relationships. The Japanese manufacturer sets a suggested retail price of its own product and presents *kakeritsu* (the ratio to the suggested retail price) for the resale price in each distribution stage. A sample survey of the manufacturer's *tatene* vertical pricing system was carried out by *Kosei Torihiki Iinkai* (The Fair Trade Commission), and the edited report was published (Tajima [1988]). This sample survey includes the industries of home electrical appliances, cameras, watches, cosmetics, sporting goods, automobiles, and processed foods. Indeed, 85.5 percent of manufacturers in the sample respond as employing a *tatene* pricing system. As for the manufacturer's suggested retail price, 78.9 percent of manufacturers employ it for all their own products, and 21.1 percent of manufacturers employ it for more than half of their product line, from which we can see the *tatene* vertical pricing is extensively prevalent in Japan.

The sample survey undertook questionnaire analysis about the manufacture's suggested retail price not only for manufacturers, but also for retailers and consumers. The manufacturers explained the purposes of the suggested retail price, and retailers and consumers expressed their opinion

Table 1 The purposes of the suggested retail price (Manufacturers) (%)

(1)	To provide information for consumers' choice	93.4
(2)	To indicate the quality and the level of perfomance of its own products	64.5
(3)	To provide a reference for retailers' pricing behaviors	51.3

Source: Tajima [1988]

Table 2 The reasons for support of the suggested retail price (Retailers) (%)

(1)	To provide information for consumers' choice	66.7
(2)	To have a reference point for retail pricing	41.7
(3)	To emphasise the retailer's cut rate in compared with the suggested retail price	34.4
(4)	To recognise the upper bound of retail price	31.5

Source: Tajima [1988]

Table 3 The reasons for support of the suggested retail price (Consumers) (%)

(1)	To be easy to compare prices among similar products	74.1
(2)	To recognise the retailer's cut rate of retail prices	59.8
(3)	To estimate the quality and the perfomance of the goods	58.2
(4)	To check retailers setting higher prices than the suggested retail prices	34.8

Source: Tajima [1988]

and gave reasons. The results are summarised in the following tables.

Among the purposes of manufacturer's suggested retail price the third answer can be recognised as a motive for vertical coordination in pricing. In the sample survey it is interesting that 85.6 percent of retailers and 88.7 percent of consumers support the suggested retail price in principle.

The suggested retail price of the manufacturer is only a suggestion. Resale price maintenance (RPM) is prohibited by the Anti-Monopoly Act in Japan. The *tatene* vertical pricing system is controversial and questioned when it restricts the price competition in retail level. In this paper we will show that the *tatene* pricing system can be viewed as an alternative way to achieve the first best outcome of vertical integration so that it has a beneficial aspect from the social welfare point of view.

The paper is organised as follows. The next section sets up the model of vertical relationships between a manufacturer and a single retailer. Section III derives the equilibria of vertical relationships under

several information conditions. In Section IV we show the incentive of vertical coordination. Sequential game is used to derive vertical integration as an equilibrium outcome, and to assess the attainability of the first best outcome by a tatene vertical pricing system. Section V provides a summary of the analysis and further extensions.

II. The Model

Consider the simplest possible vertical relationship between a manufacturer and a single retailer. We examine the pricing behavior of a manufacturer and a retailer under a demand uncertainty. Let $q = D(p, \varepsilon)$ denote the retail demand at price p and a demand parameter ε, where ε is a stochastic variable with mean μ and variance σ^2. We suppose that both of the manufacturer and the retailer only know the probability distribution of parameter ε, but depending on whether the agent can recognise the *ex post* value of the demand parameter or not (say the agent has information about demand or not), there are several information conditions.

We consider the polar cases whether the agent precisely recognises the actual value of the demand parameter or does not know the parameter at all. Let $\eta_i = 1$ denote the information condition where the agent i has information about the demand parameter, and $\eta_i = 0$ denote otherwise. The information structure can be represented by $\eta = [\eta_1, \eta_2]$, where the manufacturer is indexed by $i = 1$ and the retailer by $i = 2$. Then there are four information structures:

[1] $\eta^1 = [0, 0]$: No one has information (no information),
[2] $\eta^2 = [0, 1]$: Only the retailer has information (private information),
[3] $\eta^3 = [1, 0]$: Only the manufacturer has information (private information),
[4] $\eta^4 = [1, 1]$: Both of them have information (public information).

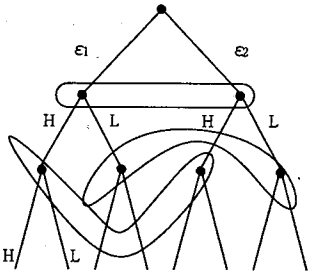
Even if each agent sets prices under demand uncertainty, the pricing behavior differs from whether the agent has information or not. The agent who has information can set prices contingent on the demand parameter ε, but the agent with no information cannot set prices contingent on the demand parameter.

As for the price determination we suppose that the manufacturer is a Stackelberg's leader and the retailer is a follower. That is, the retailer

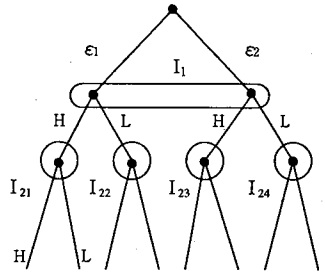
sets its retail margin m by taking the manufacturer's margin as given. The manufacturer sets his margin w by taking into account the retailer's reaction. Let C_m denote the manufacturer's average cost and C_r the retailer's cost, both of which are supposed to be constant. Then the retail price is given by $p=(w+C_m+m+C_r)$. We suppose that each agent is risk neutral and its payoff is given by the expected profits. When the agent has no information, he maximises the expected profit and sets a constant margin independent from demand conditions. If the agent has information, he sets his margin depending on the possible value of the demand parameter.

The situation can be formulated as a game with imperfect information. The game is played in a sequential manner. We suppose that firstly *nature* draws the demand parameter ε. Both the manufacturer and retailer are supposed to know only the probability distribution of ε. Secondly, the manufacturer chooses manufacturer's margin w under demand uncertainty. Thirdly, the retailer chooses the retailer's margin m under uncertainty. When each agent can recognise the *ex post* value of ε (that is, when each agent has information about demand), he can set the price system contingent on ε. We suppose that there is a common knowledge among agents about the information structure. For example when there are two possible values of ε, and two alternatives, that is, high margin (H) and low margin (L) for both of the manufacturer and retailer, information structures of our game are depicted in Figure 1.

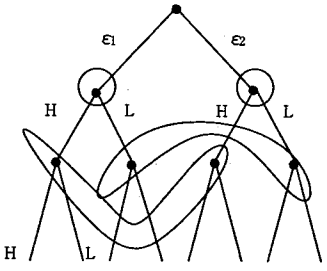
In these figures I_1 and I_2 denote the information sets of the manufacturer and the retailer respectively, which depict the information condition of each player. For example in the case of private information (η^2) the manufacturer's information set (I_1) is the oval connecting the manufacturer's nodes, which indicates that he has the same information whether the nature moves ε_1 or ε_2 : he has no information about the *ex post* value of the demand parameter. But the information sets of retailer (I_{21}, I_{22}, I_{23}, I_{24}) are singletons, which indicate that he has different information about the demand parameter: he has information about the *ex post* value of the demand parameter.



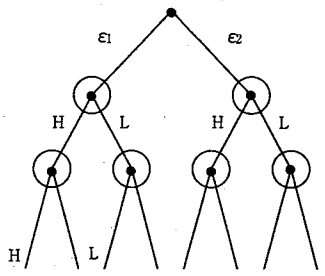
$\eta^1 = [0, 0]$: no information



$\eta^2 = [0, 1]$: private information



$\eta^3 = [1, 0]$: private information



$\eta^4 = [1, 1]$: public information

Figure 1

In the next section we will consider the equilibria in several information structures. To this end we must specify demand function. We suppose that the retail demand function is linear and is given by

(1) $q = \alpha + \varepsilon - \beta p,$

where α and β are positive and constant, and ε is a random variable with its mean μ and variance σ^2.

III. Equilibria in Vertical Relationships

III.1. The Case of No Information : $\eta^1 = [0, 0]$

The retailer has no information about the demand parameter. Hence, given the manufacturer's margin w, the retailer maximises its expected profits with respect to its retail margin m. That is, the retailer solves

(2) Max $E\pi^d = mEq = m\,[\alpha + \mu - \beta\,(w + C_m + m + C_r)],$

from which it follows that

(3) $m = [\alpha + \mu - \beta (w + C_m + C_r)]/(2\beta)$.

The manufacturer also has no information about the demand parameter. The manufacturer maximises its expected profit with respect to its manufacturer's margin w by considering the retailer's reaction (i.e., equation (3)). The manufacturer solves

(4) Max $E\pi^m = wEq = w\,[\alpha + \mu - \beta (w + C_m + m + C_r)]$

under the condition of equation (3). From which it follows that the manufacturer's margin is

(5) $w = [\alpha + \mu - \beta (C_m + C_r)]/(2\beta)$.

By using the equations (3) and (5), the retail margin is given by

(6) $m = [\alpha + \mu - \beta (C_m + C_r)]/(4\beta)$.

From equations (5) and (6) the equilibrium retail price is given by

(7) $p = [3(\alpha + \mu) + \beta (C_m + C_r)]/(4\beta)$.

We can calculate the expected profit of the manufacturer

(8) $E\pi^m = [\alpha + \mu - \beta (C_m + C_r)]^2/(8\beta)$,

and the expected profit of the retailer

(9) $E\pi^d = [\alpha + \mu - \beta (C_m + C_r)]^2/(16\beta)$.

III.2. The Case of Public (or Shared) Information : $\eta^4 = [1, 1]$

Both of the manufacturer and retailer have information about the demand parameter. Hence, given the manufacturer's margin w , the retailer maximises its profits with respect to its retail margin m. That is, the retailer solves

(10) Max $\pi^d = mq = m\,[\alpha + \varepsilon - \beta (w + C_m + m + C_r)]$

for any ε,

from which it follows that

$$(11)\quad m = [\alpha + \varepsilon - \beta(w + C_m + C_r)]/(2\beta) \qquad \text{for any } \varepsilon$$

The manufacturer also has information about the demand parameter. The manufacturer maximises its expected profit by considering the retailer's reaction (i.e., equation (11)). The manufacturer solves

$$(12)\quad \text{Max } \pi^m = wq = w[\alpha + \varepsilon - \beta(w + C_m + m + C_r)] \qquad \text{for any } \varepsilon$$

under the condition of equation (11). From which it follows that the manufacturer's margin is

$$(13)\quad w = [\alpha + \varepsilon - \beta(C_m + C_r)]/(2\beta) \qquad \text{for any } \varepsilon.$$

By using the equations (11) and (13), the retail margin is given by

$$(14)\quad m = [\alpha + \varepsilon - \beta(C_m + C_r)]/(4\beta) \qquad \text{for any } \varepsilon.$$

From equations (13) and (14) the equilibrium retail price is given by

$$(15)\quad p = [3(\alpha + \varepsilon) + \beta(C_m + C_r)]/(4\beta) \qquad \text{for any } \varepsilon.$$

We can calculate the expected profit of the manufacturer as

$$(16)\quad E\pi^m = \{[\alpha + \mu - \beta(C_m + C_r)]^2 + \sigma^2\}/(8\beta),$$

and the expected profit of the retailer as

$$(17)\quad E\pi^d = \{[\alpha + \mu - \beta(C_m + C_r)]^2 + \sigma^2\}/(16\beta).$$

III.3. The Case of Private Information : $\eta^2 = [0, 1]$

The retailer has information about the demand parameter. Then the retailer maximises its profits with respect to its retail margin m, given the manufacturer's margin w. The retail margin is given by the equation (11). But the manufacturer has no information about the demand parameter. The manufacturer maximises its expected profit under the condition of equation (11). The manufacturer solves

$$(18)\quad \text{Max } E\pi^m = wEq = w\,[\alpha+\mu-\beta\,(w + C_m + Em + C_r)] \\ = w\,[\alpha+\mu-\beta\,(w + C_m + C_r)]/2,$$

from which it follows that the manufacturer's margin is

$$(19)\quad w = [\alpha+\mu-\beta\,(C_m + C_r)]/(2\beta).$$

By using the equations (11) and (19), the retail margin is given by

$$(20)\quad m = [\alpha+2\varepsilon-\mu-\beta\,(C_m + C_r)]/(4\beta) \qquad \text{for any } \varepsilon.$$

From equations (19) and (20) the equilibrium retail price is given by

$$(21)\quad p = [3\alpha+2\varepsilon+\mu+\beta\,(C_m + C_r)]/(4\beta) \qquad \text{for any } \varepsilon.$$

We can calculate the expected profit of the manufacturer

$$(22)\quad E\pi^m = [\alpha+\mu-\beta\,(C_m + C_r)]^2/(8\beta),$$

and the expected profit of the retailer

$$(23)\quad E\pi^d = \{[\alpha+\mu-\beta\,(C_m+C_r)]^2 + 4\sigma^2\}/(16\beta).$$

III.4. The Case of Private Information : $\eta^4 = [1, 0]$

Only the manufacturer has information about the demand parameter. It can be shown that this case reduces to the case of public (or shared) information (η^4), because in our model we suppose that the manufacturer is a first mover in setting prices and the retailer is a second mover. In such a situation we must consider two cases whether the manufacturer sets its manufacturer's margin depending on the demand parameter or he sets a constant margin independent from demand conditions. Consider the first case. If the manufacturer takes a contingent price policy depending upon the demand conditions and he sets some specified shipping price (or manufacturer's margin) in some demand condition, then as a matter of fact such a price setting behavior reveals information about the demand condition to the retailer. The retailer has no information beforehand, but he has information through the manufacturer's pricing behavior. In this

case as information is shared, the expected profit of the manufacturer is given by equation (16).

Next, if the manufacturer takes a constant price policy not depending upon demand conditions, then the situation coincides with the case of no information, and the expected profit of the manufacturer is given by equation (8). Because the expected profit is higher in the case of public (or shared) information, the manufacturer takes a contingent price policy depending on the demand conditions. Hence, the situation reduces to that of the public (or shared) information.

The equilibrium expected profits of manufacturer and retailer are summarised in Table 4.

Table 4 : Information Structure and Expected Payoff

Information Structure	Manufacturer	Retailer
$\eta^1 = [0,0]$	$E\pi^m[0,0]$	$E\pi^d[0,0]$
$\eta^2 = [0,1]$	$E\pi^m[0,0]$	$E\pi^d[0,0] + \sigma^2/(4\beta)$
$\eta^3 = [1,0]$	$E\pi^m[0,0] + \sigma^2/(8\beta)$	$E\pi^d[0,0] + \sigma^2/(16\beta)$
$\eta^4 = [1,1]$	$E\pi^m[0,0] + \sigma^2/(8\beta)$	$E\pi^d[0,0] + \sigma^2/(16\beta)$

where $E\pi^m[0,0] = [\alpha+\mu-\beta(C_m+C_r)^2]/(8\beta)$, and $E\pi^d[0,0] = [\alpha+\mu-\beta(C_m+C_r)^2]/(16\beta)$

We have the following proposition.

PROPOSITION

$$E\pi^m(\eta^4) = E\pi^m(\eta^3) > E\pi^m(\eta^2) = E\pi^m(\eta^1),$$

$$E\pi^d(\eta^2) > E\pi^d(\eta^4) = E\pi^d(\eta^3) > E\pi^d(\eta^1).$$

From this proposition we have many interesting implications. First, it can be seen that the case of public (or shared) information (η^4) is preferred to the case of no information (η^1) for any agent, that is the information about demand has a positive value for any agent in our model. This result would be compatible with our intuition.

Secondly, the expected profit of each agent is the same in the cases of public information (η^4) and private information (η^3). This is due to the fact that the manufacturer's pricing behavior reveals his information to the retailer. The result depends on our assumption that the manufacturer

is a first mover in price setting. However, in many situations it can be seen that the manufacturer chooses the shipping price (or manufacturer's margin) first, and responding to it the retailer chooses the retail price second. So casual empiricism supports our assumption of a sequence in the decision making.

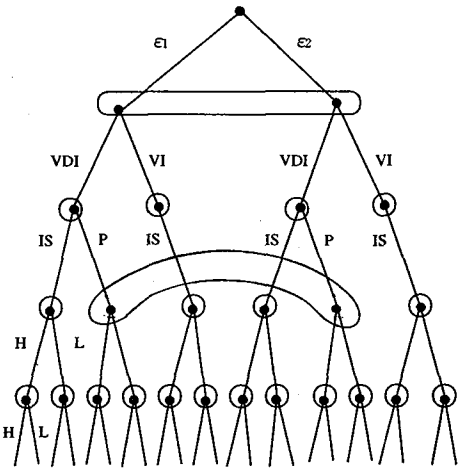
Thirdly, consider the case in which the retailer is privately informed (η^2). It is the most natural situation where the retailer has information about its local demand, but the manufacturer does not have such detailed information. Among the expected profits of the retailer, the expected profit is maximal in this case. Hence, even if the manufacturer wants information sharing with retailer, the retailer does not want to reveal information. We can often find such an actual case. Retailers are gathering much information about demand by using information technologies such as POS systems, but for example in Japan it is usually said that the retailer does not want to reveal such information to the manufacturer. So at least for the manufacturer this is an important problem, which provides an incentive for coordination in vertical relationships.

IV. Vertical Coordination and Communication

IV.1. Vertical Integration as an Equilibrium Outcome

Now consider the game with asymmetric information played in a sequential manner. First, nature chooses the state of demand. We suppose an asymmetric information structure in which only the retailer is privately informed about demand conditions. This information structure is common knowledge between manufacturer and retailer. Secondly, the manufacturer chooses vertical relationships under uncertainty whether he vertically integrates the retail level or not. Thirdly, the retailer chooses information strategies whether he reveals information to a manufacturer or not. Fourthly, the manufacturer chooses the shipping price (or manufacturer's margin). Finally, the retailer chooses the retail price (or retailer's margin). The situation is depicted in figure 2.

To derive the equilibrium in this game, we will consider the two cases. When the manufacturer vertically integrates the retail level, the integrated firm has information about demand and it maximises the joint profits with respect to the retail price p. That is, the vertically integrated firm solves



VI : Vertical Integration, VDI : Vertical Disintegration,
IS : Information Sharing, P : Private Information

Figure 2 Sequential Game of Vertical Integration

$$(24) \quad \text{Max } \pi = [p - (C_m + C_r)]\, q = [p - (C_m + C_r)]\ (\alpha + \varepsilon - \beta p) \quad \text{for any } \varepsilon,$$

from which it follows that

$$(25) \quad p = [\alpha + \varepsilon + \beta (C_m + C_r)]/(2\beta) \qquad \text{for any } \varepsilon.$$

The expected profit is given by

$$(26) \quad E\pi = \{[\alpha + \mu - \beta (C_m + C_r)]^2 + \sigma^2\}/(4\beta).$$

When the manufacturer does not choose vertical integration, the situation reduces to the case in which the retailer is privately informed. In this case as shown in section III the retailer has no incentive to reveal information to the manufacturer. Hence the expected profit of the manufacturer is given by equation (22).

Comparing the expected profit in equation (26) with that in equation (22), the expected profit is larger in the situation of vertical integration. Considering this result, the manufacturer vertically integrates the retail level. This is the equilibrium in our sequential game.

IV.2. Welfare Considerations of Vertical Coordination

It is trivial that the joint profit maximization with information sharing is the first best outcome for the manufacturer and retailer. In fact the expected joint profit given by equation (26) is larger than the expected joint profit in the case of the retailer being privately informed (see equations (22) and (23)). Vertical coordination between manufacturer and retailer increases the total profit under asymmetric information condition. What then is the effect for consumers? Now we will consider this aspect.

As *consumer surplus* is defined as the area between the demand curve and the line at the retail price level, by using the equation (1) consumer surplus in our model is given by

$$\Sigma = [(\alpha + \varepsilon)/\beta - p]q/2 = q^2/(2\beta). \tag{27}$$

Let $E\Sigma\ [0,1]$ denote the expected consumer surplus in the case of the privately informed retailer. By using the equation (21) the retail demand is given by

$$q = [\alpha + 2\varepsilon - \mu - \beta(C_m + C_r)]/4.$$

Through equation (27) the expected consumer surplus is given by

$$E\Sigma\ [0,1] = \{[\alpha + \mu - \beta(C_m + C_r)]^2 + 4\sigma^2\}/(32\beta). \tag{28}$$

On the other hand from equation (25) the retail demand in vertical integration is given by

$$q = [\alpha + \varepsilon - \beta(C_m + C_r)]/2.$$

Through equation (27) the expected consumer surplus $E\Sigma^*$ is given by

$$E\Sigma^* = \{[\alpha + \mu - \beta(C_m + C_r)]^2 + \sigma^2\}/(8\beta). \tag{29}$$

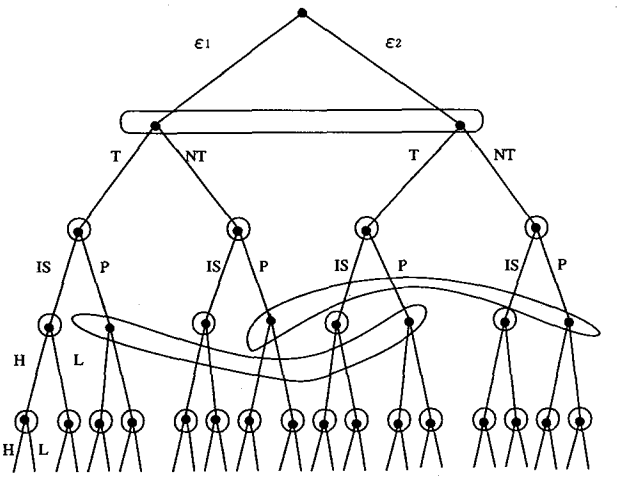
From equations (28) and (29) it can be seen that vertical coordination is beneficial also for consumers.

IV.3. Tatene Pricing System

Now we will examine the attainability of the first best outcome of vertical integration in an alternative way. In Japan the *tatene system* can

be seen in many vertical pricing structures. The term tatene system is used with several meanings in different situations, but for consumer goods it is defined as a suggested price system by manufacturers. The manufacturer in Japan often suggests a retail price as a manufacturer's recommendation for buyers.

Consider the game with asymmetric information played in a sequential manner. First, nature chooses the state of demand. Secondly, the manufacturer decides under demand uncertainty whether he employs the tatene vertical pricing system or not. Thirdly, the retailer chooses information strategies of whether to reveal information to a manufacturer or not. Fourthly, the manufacturer chooses the shipping price (or manufacturer's margin) and a suggested retail price. Finally, the retailer chooses the retail price (or retailer's margin). The situation is depicted in Figure 3.



T : To Employ Tatene Vertical Pricing System,
NT : Not To Employ Tatene Vertical Pricing System
IS : Information Sharing,
P : Private Information

Figure 3 Sequential Game of Tatene Vertical Pricing System

If the manufacturer does not employ the tatene pricing system, the situation is the same case as that in which the retailer is privately informed : the information structure η^2. This case is already explained in

section III so that we must examine the case in which the manufacturer employs the tatene pricing system.

If the retailer reveals information, the manufacturer sets a suggested retail price system at the level of joint profit maximisation contingent on the demand parameter. The manufacturer's suggested retail price, when it plays the role of the list price, means that the retailer cannot sell at a higher price than that. The manufacturer's suggested price in fact sets the maximum level of retail prices. When looking at Table 2 in Section I, among the reasons why support was given to the suggested retail price by the retailers is that they can recognise the upper bound of retail price and by the consumers is that the suggested retail prices check the retailers' higher pricing behavior. We suppose such a case. Then the retailer chooses its margin by maximising profit under the constraints of the upper bound of retail prices.

Under the tatene pricing system if the retailer reveals information, the manufacturer determines the suggested retail price by solving the problem of joint profit maximisation depicted in equation (24) from which it follows that the suggested retail price is given by equation (25). Then the suggested retail price sets an upper bound for retail prices,

$$p = (w + C_m + m + C_r) \leqq \text{the suggested retail price} = [\alpha + \varepsilon + \beta(C_m + C_r)]/(2\beta),$$

which induces the constraint on the retail margin, that is,

$$(30) \quad m \leqq [\alpha + \varepsilon - \beta(C_m + C_r)]/(2\beta) - w.$$

The retailer chooses its retail margin by maximising its profit under the constraint of equation (30). It can be easily checked that the constraint (30) is binding if the manufacturer's margin w is positive. Hence the retail margin is given by

$$(31) \quad m = [\alpha + \varepsilon - \beta(C_m + C_r)]/(2\beta) - w.$$

It can be seen that the retail price is set at the level of joint profit maximising through the tatene vertical pricing system.

Now suppose that the manufacturer sets its margin w at the level

(32) $w = 3[\alpha + \mu - \beta(C_m + C_r)]/(8\beta)$.

By using the equations (31) and (32) retailer's margin is given by

(33) $m = [\alpha + 4\varepsilon - 3\mu - \beta(C_m + C_r)]/(8\beta)$ for any ε.

The expected profit of the retailer is calculated as

(34) $E\pi^d = \{[\alpha + \mu - \beta(C_m + C_r)]^2 + 4\sigma^2\}/(16\beta)$.

This is at the same level as the one of the case in which retailer is privately informed (see equation (23) in the information structure η^2).

By using equation (32) the expected profit of the manufacturer is given by

(35) $E\pi^m = 3[\alpha + \mu - \beta(C_m + C_r)]^2/(16\beta)$,

which is larger than the expected profit of the case in which retailer is privately informed (compare with equation (22)).

On the other hand if the retailer does not reveal information under the tatene vertical pricing system, the manufacturer sets the suggested retail price at the level

(36) $p = (\alpha + \bar{\varepsilon})/\beta$

where $\bar{\varepsilon}$ is a maximum value of the support of ε. We must note that when the suggested retail price is given by equation (36) the retail demand is zero at such a suggested retail price. Then this suggested price is not at all binding for the retailer's choice of margin because the retailer sets the retail price to get positive demand, which is always a lower price than the suggested price. Hence in this case the tatene vertical pricing system has no effect on the retailer's information strategy and pricing strategy. The situation reduces to the case in which retailer is privately informed.

Now we can derive the equilibrium of our sequential game. If the manufacturer employs the tatene vertical pricing system, it can be seen that the retailer will reveal information, because the expected profit of the retailer is the same if he reveals or not (see equations (34) and (23)). As

the retailer is indifferent, he would reveal information. Then the expected profit of the manufacturer is given by equation (35). On the other hand if the manufacturer does not employ the tatene pricing system the retailer does not reveal information so that the expected profit of the manufacturer is given by equation (22). Comparing the expected profits in equations (35) and (22), the expected profit of the manufacturer is larger in the tatene vertical pricing system. Considering this result, the manufacturer employs the tatene pricing system. This is the equilibrium outcome of our sequential game. In the equilibrium the joint expected profit of the manufacturer and the retailer is maximised and also consumer surplus is maximised. Hence it has been shown that the first best outcome of vertical integration can be attained through the tatene pricing system.

V. Concluding Remarks

In conclusion, (1) when the retailer is privately informed about retail demand, he does not reveal information even if information sharing is beneficial for the manufacturer, (2) vertical integration is the first best outcome with asymmetric information, which makes clear the necessity of vertical coordination from the aspect of communication in vertical relationships, (3) the tatene vertical pricing system in Japan can be seen as a device for vertical coordination, which can attain the first best outcome of vertical integration in an alternative way.

This paper sheds light on the strategic interaction in a vertical relationship. The horizontal strategic interactions among manufacturers and among retailers are not treated in this paper. This remains for further work which could explore, for example, the interbrand competition in marketing channel choice.

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