Observation of Common Retail Cost under Exclusive Dealing

Kojun Hamada*

This paper examines whether the manufacturer should observe the common retail cost when exclusively delegating a retailer to sell her goods. We show that the expected sum of profits between the manufacturer and retailer is greater when the former does not observe the cost ex ante than when they do. However, the manufacturer cannot acquire a greater expected private payoff when not observing the cost, regardless of the optimal contract. Even if the commitment to not observe the cost alleviates competition, the manufacturer must always pay higher information rent than the increasing payoff to the retailer.

Keywords: Contract theory, Exclusive dealing, Retail cost

JEL Classification: D43, D82, L13

I. Introduction

This paper examines whether the manufacturer should observe the common retail cost when exclusively delegating a retailer to sell her goods. We analyze the manufacturer's decision on observations

* Associate Professor, Faculty of Economics, Niigata University, 8050 Ikarashi 2-no-cho, Niigata, Japan 950-2181, (Tel) +81-25-262-6538, (Fax) +81-25-262-6538, (E-mail) khamada@econ.niigata-u.ac.jp. I would like to thank Toshihiko Hayashi, Hideshi Itoh, and Munetomo Ando for their useful comments and suggestions. I would also like to thank the participants at the Summer Seminar of the Contract Theory Workshop (CTW) and the Applied Spatial Economic Workshop held at the University of Tokyo. I thank anonymous referees for helpful comments. The research for this paper is supported by the Grant-in-Aid for Scientific Research (KAKENHI 16730095) from JSPS and MEXT of the Japanese Government. Any remaining errors are mine.

of the common retail cost when she is unaware of the cost in advance. We clarify the manner in which observation of the retail cost affects sales profit and the manufacturer's private payoff.

According to the agency theory, asymmetric information results in a principal having to pay information rent to her agent in order to elicit private information; the principal's expected private payoff in this case is less than that under complete information. However, when multiple retailers face market competition, interaction among agents affects the expected private payoff. We examine whether private information leads to an increase in the expected private payoff if market competition is alleviated under asymmetric information.

Applying the agency theory under adverse selection, we compare the expected sum of profits between the manufacturer and the retailer as well as the manufacturer's expected private payoff. Focusing on the optimal exclusive contract that the manufacturer offers to her retailer, we analyze the manufacturer's decision on the observation of the common retail cost. We clarify whether or not the manufacturer observes the cost before offering the contract.

This paper analyzes the distributional structure wherein retailers possess common private information. We show that a greater expected total profit between the manufacturer and the retailer can be obtained when the former does not observe the cost, regardless of the degree of informational asymmetry. Nevertheless, we show that the manufacturer cannot acquire the expected private payoff, regardless of the optimal contract. Although the commitment to not observe the cost alleviates market competition and leads to an increase in the total profit, the manufacturer must always pay more information rent to the retailer than the increasing payoff. The result describes a conflict of interests with regard to information sharing between the parties engaged in exclusive dealing.

This paper is closely related to the study of the delegation game, which investigates the situation wherein the principal strategically delegates an agent. In the existing literature, Fershtman and Judd (1987) dealt with this delegation game under Cournot quantity competition. They showed that a Pareto-efficient outcome appears as the equilibrium of the game. Their conclusion suggests that delegating an agent enables the principal to take any actions chosen by the agent and the outcome of such collusion can be attained under the Cournot duopolistic competition. In particular, the observability of the contract, which is stipulated on the agent's action, functions as a means of commitment. Fershtman, Judd, and Kalai (1991) have presented a similar conclusion. They analyzed the contractual environment in which the contract is unobservable and show that the delegation may obtain a Pareto-efficient outcome even if the contract is not public.[1]

This paper refers to the delegation game with respect to this role of commitment. In our paper, the rival's contract is unobservable. The question of whether to observe private information functions as a means of commitment to the output chosen by the agent. This commitment affects the principal's expected private payoff. The existing literature on the delegation game deals with an issue similar to the present one, in the sense that the principal's commitment influences the expected private payoff. Nevertheless, our result differs from that of the delegation game. In this paper, the principal cannot increase the expected private payoff by committing to strategically not observe the cost under any contract, to delegate an agent whose cost is unknown.

This paper is also related to the argument of strategic ignorance in which the player chooses not to collect information. Kessler (1998) describes the strategic ignorance of an agent with regard to information collection before the establishment of a contract. Kessler (1998) focuses on the strategic ignorance of an agent, while this paper focuses on that of the principal.

In the existing literature that analyzes exclusive dealing under asymmetric information, Martimort (1996) compares exclusive dealing with common agency in the context of adverse selection. He deals with the trade-off between the distortion of incentive, which is caused by the interference of multiple principals under a common agency, and coordination failure of the final market competition under exclusive dealing. Our analysis is based on his adverse selection model. Likewise, Bernheim and Whinston (1998) examine whether exclusive dealing controls the degree of competition in the context of moral hazard. They analyze the distortion of incentives and the existence of externalities that occur when multiple manufacturers offer contracts to their retailers.

The remainder of this paper is organized as follows: Section II

[1] Caillaud, Jullien, and Picard (1995) are representatives of the articles that analyze the delegation game under the oligopoly game. See also Caillaud and Rey (1995) for the survey on strategic delegation.

introduces the model. Section III derives the optimal contract and compares the expected profits with respect to cost observation. Section IV presents the concluding remarks.

II. Model

We describe the exclusive dealing between a manufacturer and a retailer under common retail cost. Two manufacturers independently search for a retailer in order to delegate him to sell their products exclusively. They choose one among many potential retailers before the common retail cost is known to the retailers. Thereafter, the manufacturer (principal: P_i, $i=1,2$) offers an exclusive sales contract to her retailer (agent: A_i). The retailer decides whether to accept the offered contract. After accepting the contract, the retailer sells the manufacturer's products exclusively in the market. We model the market competition under the Cournot duopoly.

Each retailer utilizes one unit of wholesale goods that is purchased from the manufacturer in order to sell one unit of final goods. Since the retailer is essential for accomplishing the sales activity, the manufacturer can never completely sell goods on her own.

Before being offered the contract, A_i is aware of the common marginal retail cost, θ, which is considered as a type of retail cost.

The principal is unaware of the type of retail cost when choosing the agent. After P_i chooses one agent among the many potential retailers, P_i can choose whether to observe θ before offering a contract to this retailer. When choosing to observe θ, she can stipulate the implementable contract that is based on θ. If P_i chooses not to observe θ, she is unaware of the type of retail cost when offering a contract. In this unobservable case, the principal forecasts that the type of retail cost follows a certain probability distribution. We assume that this probability distribution is differentiable almost everywhere, and the cumulative distribution and density function are denoted by $F(\theta)$ and $f(\theta)$, $\theta \in [\underline{\theta}, \overline{\theta}]$, respectively. This distribution is common knowledge for the principals and agents. We assume a monotone hazard rate condition (MHRC), which is $d(F(\theta)/f(\theta))/d\theta > 0$ and $d(F(\theta)/f(\theta))/d\theta = 1$ for $\theta = \underline{\theta}$. $\Delta\theta \equiv \overline{\theta} - \underline{\theta}$.

The principal offers a sales contract to this retailer, which stipulates the non-linear transfer $t_i(q_i)$ depending on the wholesale quantity. This implies that the payment t_i from the agent depends on the quantity of sales q_i. It is supposed that a contract, $t_i(q_i)$ is made in secret for a rival pair, (P_j, A_j). The rival pair cannot view the contents of this contract.

Without loss of generality, we focus on the direct truth-telling mechanism, $(q_i(\hat{\theta}_i),\ t_i(\hat{\theta}_i))$, whereby the quantity of sales and payment are self-selected by the agent by reporting the private information. This is attributed to the revelation principle. The contract is represented by functions from the type of retail cost reported by A_i to P_i to the sales level and transfer.

It is noteworthy that P_i cannot draw the contract based on the quantity of sales q_j chosen by A_j. This implies that the rival information cannot be verified. In the unobservable case, after collecting information ex post by using the revelation principle, the principal cannot increase her expected private payoff by adding any information acquired ex post through the contract. In other words, the principal commits to the ex ante contract.

When choosing to observe the type of retail cost, the manufacturer can always determine the true type and designate the sales level and transfer in accordance with it. Otherwise, the manufacturer makes her retailer report the type of retail cost and relates the sales level and transfer to this reported type under the direct truth-telling contract.

After A_i reports $\hat{\theta}_i$, the quantity of sales, $q_i(\hat{\theta}_i)$, and the transfer, $t_i(\hat{\theta}_i)$, are implemented. Although A_j simultaneously reports $\hat{\theta}_j$, the rival's report is not known to the manufacturer until the retailer begins selling the products. For the purpose of simplification, we denote the ex post sales profit as $\pi_i(q_i,q_j;\theta)$, which is identical and quasilinear and depends on the sales quantities (q_i,q_j) and the common marginal retail cost θ.

The manufacturer produces goods with no cost and her utility is identical. P_i maximizes the transfer t_i from the retailer. Accepting the offered contract, the agent is guaranteed more than the reservation utility normalized by 0. The retailers sell the goods to customers at a common marginal retail cost θ. The ex post payoff of the agent is $\pi_i(q_i(\hat{\theta}_i),q_j(\hat{\theta}_j);\hat{\theta}_i)-t_i(\hat{\theta}_i)$.

We specify the functional form, and the inverse demand function is denoted by

$$p(Q)=1-bQ,\ Q=q_1+q_2. \tag{1}$$

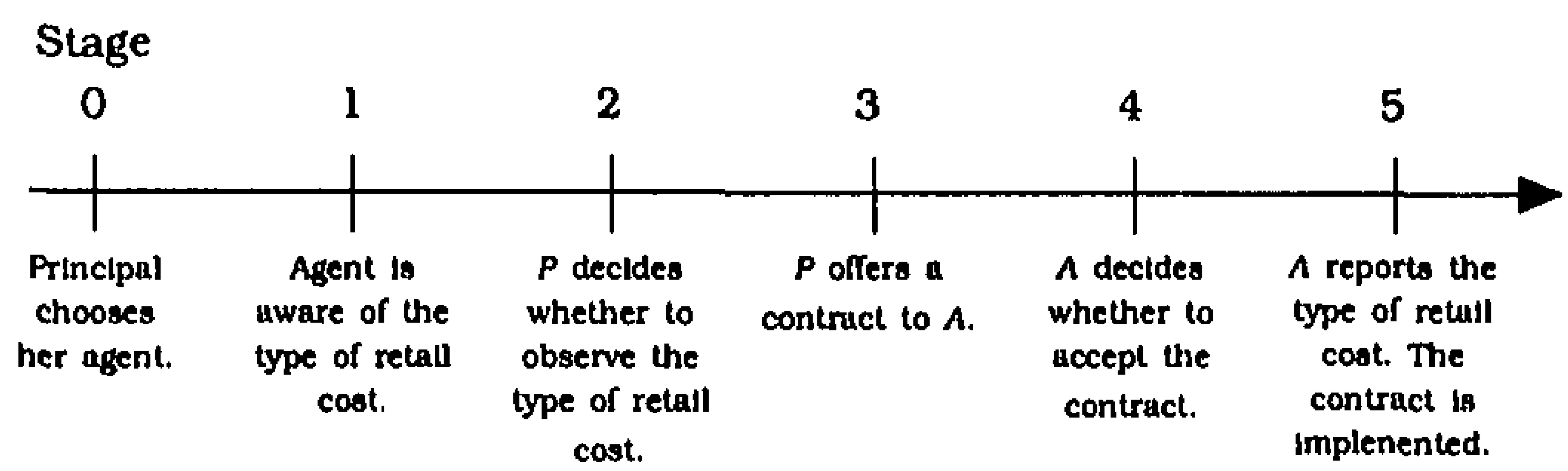

FIGURE 1
THE TIMING OF THE GAME

It is assumed that $1>\bar{\theta}$. The ex post total profit of (P_i, A_i) is as follows:

$$\pi_i(q_i, q_j; \theta)=(p-\theta)q_i=(1-\theta)q_i-bq_i^2-bq_iq_j. \tag{2}$$

Finally, we describe the timing of the game.

0. P_i chooses an agent among many potential retailers.
1. A_i is aware of the type of retail cost, θ.
2. P_i decides whether to observe θ.
3. P_i offers the contract $(q_i(\hat{\theta}_i), t_i(\hat{\theta}_i))$ simultaneously and noncooperatively.
4. A_i decides whether to accept the contract simultaneously and noncooperatively. If A_i denies the contract, A_i obtains a reservation payoff.
5. A_i reports the type $\hat{\theta}_i$ to P_i, and the sales quantity $q_i(\hat{\theta}_i)$ and the payment $t_i(\hat{\theta}_i)$ are implemented.

The timing of the game is shown in Figure 1. The solution concept follows the perfect Bayesian equilibrium.

In the following section, we compare two different cases of whether the principal observes the type of retail cost in the second stage.

III. Derivation of Output and Sales Profit in Equilibrium

A. The Observable Case

We derive an equilibrium output and sales profit in the case in which P_i observes θ before offering the contract. Due to the lack of asymmetric information, the principal can deprive her agent of the overall maximized sales profit without paying the information rent. The principal takes into consideration only the participation constraint of her agent and maximizes the sales profit. The optimal contract that should be offered by P_i can be obtained by solving the maximization problem.

$$\max_{\{q_i(\theta),t_i(\theta)\}} t_i(\theta) \quad s.t. \ \pi_i(q_i(\theta),q_j(\theta);\theta)-t_i(\theta)\geq 0 \ \ \forall\theta. \tag{3}$$

The participation constraint in (3) binds, that is, $t_i(\theta)=\pi(q_i(\theta), q_j(\theta);\theta)$.

The manufacturer's expected private payoff in the first stage is

$$Et_i(\theta)\equiv\int_{\underline{\theta}}^{\overline{\theta}} t_i(\theta)f(\theta)d\theta.^2 \tag{4}$$

The principal maximizes the expectation of $\pi_i(q_i(\theta),q_j(\theta);\theta)$ on θ with respect to $q_i(\theta)$. The reaction function satisfies the following first-order condition (f.o.c.):

$$\frac{d\pi_i(q_i,q_j(\theta);\theta)}{dq_i}=1-b(q_i+q_j)-\theta-bq_i=0. \tag{5}$$

The reaction function, $q_i=q_i(q_j(\theta);\theta)$, can be obtained as follows:

$$q_i=q_i(q_j(\theta);\theta)=\frac{1}{2b}(1-\theta-bq_j(\theta)). \tag{6}$$

By solving the intersection of the reaction functions of A_i and A_j, we obtain the equilibrium output. By symmetry, $q^o(\theta)\equiv q_1^o(\theta)\equiv q_2^o(\theta)$.

$$q^o(\theta)=\frac{1-\theta}{3b}. \tag{7}$$

The equilibrium output evidently decreases with θ.

Next, we calculate the expected total sales profit, which is equal to the manufacturer's expected private payoff. The final profit of (P_i,A_i) obtained after θ is known is given by

$$\pi_i(q_i^o(\theta),q_j^o(\theta);\theta)=\frac{(1-\theta)^2}{9b}. \tag{8}$$

[2] E denotes the operator of expectation on θ. σ^2 denotes the variance of θ.

The ex ante expected profit of (P_i, A_i) when θ is unknown is given by

$$E[\pi_i(q_i^o(\theta), q_j^o(\theta); \theta)] = \frac{1}{9b}[(1 - E\theta)^2 + \sigma^2]. \tag{9}$$

Under the uniform distribution, the expected profit is as follows:

$$E[\pi_i(q_i^o(\theta), q_j^o(\theta); \theta)] = \frac{1}{9b}[(1 - \underline{\theta})^2 - (1 - \underline{\theta})\Delta\theta + \frac{1}{3}(\Delta\theta)^2]. \tag{10}$$

B. The Unobservable Case

We derive the equilibrium output and sales profit in the case in which P_i does not observe θ when offering the contract. Due to asymmetric information, a conflict of interests occurs. We derive the optimal contract from the direct truth-telling contract offered by P_i.

First, let us consider the incentive compatibility (IC) constraint of the agent. Being aware of the type of cost, A_i maximizes the realized payoff on θ. The payoff, when A_i reports $\hat{\theta}_i$, is denoted as follows:

$$U_i(\hat{\theta}_i \mid \theta) \equiv \pi_i(q_i(\hat{\theta}_i), q_j(\hat{\theta}_j); \theta) - t_i(\hat{\theta}_i). \tag{11}$$

Given the truth-telling contract of the rival agent, the IC constraint can be written as follows:

$$\theta \in \arg\max_{\hat{\theta}_i}\{\pi_i(q_i(\hat{\theta}_i), q_j(\theta); \theta) - t_i(\hat{\theta}_i)\}. \tag{12}$$

It is supposed that $q_i(\theta)$ and $t_i(\theta)$ are continuously differentiable. Rewriting (12) into the f.o.c. yields the following:

$$\left.\frac{\partial U_i(\hat{\theta}_i \mid \theta)}{\partial \hat{\theta}_i}\right|_{\hat{\theta}_i = \theta} = \dot{q}_i(\theta)\frac{d\pi_i(q_i(\theta), q_j(\theta); \theta)}{dq_i} - \dot{t}_i(\theta) = 0.^{3} \tag{13}$$

Differentiating the information rent of A_i from (11) yields the following:

$$\begin{aligned} \dot{U}_i(\theta) &= \left.\frac{\partial U_i(\hat{\theta}_i \mid \theta)}{\partial \hat{\theta}_i}\right|_{\hat{\theta}_i = \theta} + \frac{\partial U_i(\hat{\theta}_i \mid \theta)}{\partial \theta} = \pi_{i\theta} + \pi_{ij}\dot{q}_j(\theta) \\ &= -(1 + b\dot{q}_j(\theta))q_i(\theta) < 0.^{4} \end{aligned} \tag{14}$$

[3] $\dot{q}(\theta)$ and $\dot{U}(\theta)$ denote the derivative on θ.

The first term of (14), $\pi_{i\theta}$, is the standard effect that is found on the usual principal-agent model. The second term, $\pi_{ij}\dot{q}_j$, is referred to as the competing contract effect, which is derived by the effect that its own optimal output level is influenced by the market competition when the rival changes its output level. This effect causes a reduction in output q_j and increases the second source of the agent's rent.

The information rent decreases with respect to θ, $\dot{U}_i(\theta)<0$. $\dot{q}_i(\theta)$ and $\dot{U}_i(\theta)$ are negative. Since $\dot{U}_i(\theta)<0$, the participation constraint binds only if $\theta=\bar{\theta}$, that is, $\dot{U}_i(\bar{\theta})=0$. The derivation is shown in the Appendix.

The optimal contract to be solved by P_i in the second stage is as follows:

$$\max_{\{q_i(\theta),U_i(\theta)\}} \int_{\underline{\theta}}^{\bar{\theta}} \{\pi_i(q_i(\theta),q_j(\theta);\theta)-U_i(\theta)\}f(\theta)d\theta, \tag{15}$$

s.t.

$$\dot{U}_i(\theta)=-(1+b\dot{q}_j(\theta))q_i(\theta), \tag{16}$$

$$U_i(\bar{\theta})=0. \tag{17}$$

The objective function of (15) can be replaced as $\int_{\underline{\theta}}^{\bar{\theta}}\{\pi_i(q_i(\theta),q_j(\theta);\theta)+\dot{U}_i(\theta)(F(\theta)/f(\theta))\}f(\theta)d\theta$ by using the partial integration formula. The f.o.c. is

$$1-b(q_i(\theta)+q_j(\theta))-\theta-bq_i(\theta)-(1+b\dot{q}_j(\theta))\frac{F(\theta)}{f(\theta)}=0. \tag{18}$$

The reaction function, $q_i^u=q_i^u(q_j(\theta);\theta)$, is

$$\begin{aligned} q_i^u=q_i^u(q_j^u(\theta);\theta)&=\frac{1}{2b}(1-V(\theta)-bq_j^u(\theta)-b\dot{q}_j^u(\theta)\frac{F(\theta)}{f(\theta)};\\ V(\theta)&\equiv\theta+\frac{F(\theta)}{f(\theta)}. \end{aligned} \tag{19}$$

$V(\theta)$ denotes the virtual type of retail cost. By solving the intersection of the reaction functions, we can obtain the equilibrium

[4] $\pi_{i\theta}$ (resp. π_{ij}) denotes the derivatives of π_i with regard to θ (resp. q_j).

output in the unobservable case. The equilibrium output, $q^u(\theta) \equiv q_1^u(\theta) = q_2^u(\theta)$, satisfies the following equation:

$$q^u(\theta) = \frac{1}{bF(\theta)^3}\left[\int_{\underline{\theta}}^{\theta} (f(\theta)(1-\theta) - F(\theta))F(\theta)^2 d\theta\right], \quad \theta \in (\underline{\theta}, \bar{\theta}]. \tag{20}$$

When $\theta = \underline{\theta}$, $q^u(\underline{\theta}) = q^*(\underline{\theta})$ by (19). Under MHRC, the output decreases with θ. The derivation is given in the Appendix.

Under uniform distribution,

$$q^u(\theta) = \frac{2(1-\underline{\theta}) - 3(\theta - \underline{\theta})}{6b}. \tag{21}$$

For any type of cost to make positive sales, $\Delta\theta \le 2/3(1-\underline{\theta})$ is a necessary condition.

Next, we calculate the expected total sales profit. We confine the argument pertaining to the comparison of profit under uniform distribution. The final profit of (P_i, A_i) is as follows:

$$\pi_i(q_i^u(\theta), q_j^u(\theta); \theta) = \frac{(1-\underline{\theta})[2(1-\underline{\theta}) - 3(\theta - \underline{\theta})]}{18b}. \tag{22}$$

The ex ante profit of (P_i, A_i) is as follows:

$$E[\pi_i(q_i^u(\theta), q_j^u(\theta); \theta)] = \frac{(1-\underline{\theta})[4(1-\underline{\theta}) - 3\Delta\theta]}{36b}. \tag{23}$$

In the unobservable case, the expected private payoff of P_i differs from the expected total profit due to the information rent $\int_{\underline{\theta}}^{\bar{\theta}} U_i(\theta) f(\theta) d\theta$. By partial integration and $\dot{U}_i(\theta) = -(3(1-\theta) - (1-\underline{\theta}))/12b$ under uniform distribution, the information rent is as follows:

$$\int_{\underline{\theta}}^{\bar{\theta}} U_i(\theta) f(\theta) d\theta = -\int_{\underline{\theta}}^{\bar{\theta}} \dot{U}_i(\theta) F(\theta) d\theta = \frac{\Delta\theta(1-\underline{\theta}-\Delta\theta)}{12b} > 0. \tag{24}$$

Therefore, the manufacturer's ex ante expected private payoff is as follows:

$$\begin{aligned} &E[\pi_i(q_i^u(\theta), q_j^u(\theta); \theta)] - \int_{\underline{\theta}}^{\bar{\theta}} U_i(\theta) f(\theta) d\theta \\ &= \frac{1}{36b}[4(1-\underline{\theta})^2 - 6(1-\underline{\theta})\Delta\theta + 3(\Delta\theta)^2]. \end{aligned} \tag{25}$$

C. Comparison of the Expected Profits

We examine the manner in which the observation by the manufacturer influences the equilibrium sales output. Comparing (7) with (20), the following lemma is derived.

Lemma 1

The output level when the manufacturer observes the cost is more than that when she does not observe it under any types. That is,

$$q^{o}(\theta)\geq q^{u}(\theta),\quad \theta\in[\underline{\theta},\bar{\theta}]. \tag{26}$$

The equality holds only if $\theta=\underline{\theta}$.

Proof: Refer to the Appendix.

The result does not depend on the uniformity of the distribution.

This result is similar to that suggested by the usual principal agent theory. It is desirable for the principal to make the most efficient agent select the same efficient action under complete information as under asymmetric information. As the cost becomes less efficient, the principal makes less efficient agents sell fewer products in order to reduce the information rent paid to the more efficient agents. As a result, market competition can be alleviated by underprovision under Cournot quantity competition.

We proceed to compare the ex post expected total profit and the manufacturer's expected private payoff under both the observable and unobservable cases.

The expected total profit under the observable (resp. unobservable) case is shown by (10) (resp. (23)). We define the difference between the expected profits as $\Delta E\pi\equiv E[\pi_i(q_i(\theta),q_j(\theta);\theta)]-E[\pi_i(q_i^{u}(\theta),q_j^{u}(\theta);\theta)]$ and this difference is as follows:

$$\Delta E\pi=\frac{\Delta\theta}{108b}[4\Delta\theta-3(1-\underline{\theta})]. \tag{27}$$

By (27), $\Delta E\pi\leq 0$ holds if $0\leq\Delta\theta\leq 3/4(1-\underline{\theta})$. By (21), $\Delta\theta\leq 2/3(1-\underline{\theta})$ is a necessary condition in order to satisfy $q_i^{u}(\theta)\geq 0$. As the argument is confined to positive sales, we consider the range of $0\leq\Delta\theta\leq 2/3(1-\underline{\theta})$ as the proper range of $\Delta\theta$. In this range of informational asymmetry, the following proposition is derived.

Proposition 1

Suppose that any type of cost enables positive sales under uniform distribution. The expected total profit under the unobservable case is always greater than that under the observable case, regardless of the degree of informational asymmetry, that is, $\Delta E\pi<0$.

Proof: This is a direct consequence of (27), which is immediately obtained from (10) and (23).

This proposition implies that nonobservance of the common retail cost results in greater expected total sales profit than in cases where it was observed. It is better to be unaware of the cost. Greater expected profit can be attained because market competition can be alleviated by offering a contract that enforces underprovision on the retailer due to the reduction of information rent.

Next, we compare the manufacturer's expected private payoff. This payoff under the observable (resp. unobservable) case is shown by (10) (resp. (25)). We define the difference in the manufacturer's expected private payoff by $\Delta E\pi^M$, which is $\Delta E\pi^M=\Delta E\pi+\int_{\underline{\theta}}^{\bar{\theta}}U_i(\theta)f(\theta)d\theta$. By (10) and (23), $\Delta E\pi^M$ under uniform distribution can be written as follows:

$$\Delta E\pi^M=\frac{\Delta\theta}{108b}[6(1-\underline{\theta})-5\Delta\theta]. \tag{28}$$

The following proposition is derived from (28).

Proposition 2

Suppose that any type of cost enables positive sales under uniform distribution. The manufacturer's expected private payoff under the unobservable case is always smaller than that under the observable case, regardless of the degree of informational asymmetry, that is, $\Delta E\pi^M>0$.

Proof: This is a direct consequence of (28), which is directly obtained from (10) and (25).

This proposition implies that the manufacturer cannot acquire a greater expected private payoff when not observing the private information, even if the expected total sales profit increases, as shown by Proposition 1. Although ignorance of private information leads to an increase in the total profit, the manufacturer cannot recover this increased gain with any optimal contracts.

Market competition can be alleviated by underprovision, as shown by Lemma 1. When the manufacturer does not observe the common retail cost, there exists a competition effect by which there is a decline in the information rent paid to the retailer. As a result, the incentive for the agent to lie to the principal is lessened because the retailers face market competition, which in turn transmits the information indirectly. Thus, the information rent paid for the common retail cost decreases. However, the manufacturer cannot acquire a greater expected private payoff by being unaware of the type of retail cost because the retailer deprives the manufacturer of the increased profit share acquired by alleviation of market competition. Even if market competition is alleviated due to underprovision, the information rent paid to the retailer always exceeds this anticompetitive gain.

IV. Concluding Remarks

We examine whether it is desirable for the manufacturer to observe the common retail cost under adverse selection when each manufacturer exclusively delegates the retailer to sell her goods. Our result shows that the commitment to not observe the common retail cost ex ante increases the total sales profit between the manufacturer and the retailer because it alleviates market competition; the manufacturer can then never recover more private payoffs from this increased total profit, regardless of the optimal contract.

Our result explains the conflict of interests with regard to information sharing on cost under the distributional structure, when the manufacturer exclusively delegates a retailer to sell her products. This is an example of the Prisoner's Dilemma about observation on cost by manufacturers. This result is in contrast with that of the delegation game. The existing literature on the delegation game shows that any outcome desired by the principal can be attained by delegating an agent because delegation results in the setting of an objective for the agent, which is different from profit maximization. Our result shows that the principal prefers to directly control the agent by reinforcing the observation of the agent's private information, even if delegation occurs. As a result, although the manufacturer's expected private payoff increases, the total sales profit decreases.

When multiple manufacturers make an exclusive contract with their respective retailers, informational asymmetry between the manufacturers and the retailers characterizes the optimal contract through downstream market competition. On analyzing the exclusive contract, we take into consideration market competition among retailers. This paper analyzes the design of the optimal sales contract by taking market competition into consideration. This paper clarifies the relationship between the observation on sales information and the manufacturer's expected private payoff.

However, whether our result remains unchanged when costs between retailers are imperfectly correlated remains an issue. We focus on an identical manufacturer and retailer and a common sales cost. Under a different cost structure and distributional channel, an extension to more general distributions should be considered in the future. Likewise, we have limited the argument to perfect substitutes. Under imperfect substitutes or complements, this result may be reinforced because the competitive pressure is weaker. Furthermore, we need to consider what happens when some inefficient agents withdraw from sales, that is, $\Delta\theta > 2/3(1-\underline{\theta})$. We require more comprehensive results on the overall type space. In order to avoid the complexity of information structure, we do not consider such asymmetric choice wherein one manufacturer chooses to observe the cost while the other chooses not to. As an extension to this paper, imperfect monitoring of the type of cost with any monitoring cost should be taken into consideration.

(Received 15 January 2004; Revised 15 April 2005)

Appendix

Derivation of $q^u(\theta)$

Under the identical agent, the output level is equal, $q^u(\theta) \equiv q_i^u(\theta)$, $i=1,2$. We rewrite the reaction function (19) as follows:

$$q^u(\theta) = \frac{1}{2b}(1 - V(\theta) - bq^u(\theta) - b\dot{q}^u(\theta)\frac{F(\theta)}{f(\theta)}). \tag{A1}$$

Arranging this first-order differential equation (A1) on $\dot{q}^u(\theta)$ yields the following:

$$\dot{q}^u(\theta)+\frac{3}{\dfrac{F(\theta)}{f(\theta)}}\,q^u(\theta)=\frac{1-V(\theta)}{b\,\dfrac{F(\theta)}{f(\theta)}},\quad \theta\in(\underline{\theta},\bar{\theta}]. \tag{A2}$$

When $\theta=\underline{\theta}$, $q^u(\underline{\theta})=q^*(\underline{\theta})=(1-\underline{\theta})/3b$ by (A1). It is noteworthy that (A2) is not satisfied when $\theta=\underline{\theta}$ because the denominator of (A2) is indefinite.

(A2) is the first-order non-simultaneous linear differential equation. This differential equation can be solved by using the ordinary formula. Replacing the right-hand side of (A2) with zero, we can separate the variable $q^u(\theta)$. Under $q^u(\theta)>0$,

$$\frac{1}{q^u(\theta)}\cdot\frac{dq^u(\theta)}{d\theta}+3\frac{F'(\theta)}{F(\theta)}=0,\quad \theta\in(\underline{\theta},\bar{\theta}]. \tag{A3}$$

It should be noted that $F'(\theta)=f(\theta)$. By integrating (A3) in some intervals of the subset $\theta\in(\underline{\theta},\bar{\theta}]$, we can obtain the general solution:

$$\ln q^u(\theta)+3\ln F(\theta)=C_1,\quad \theta\in(\underline{\theta},\bar{\theta}]. \tag{A4}$$

C_1 is the optional integral constant. By expressing (A4) using the exponential function, a general solution for the above simultaneous linear differential equation (A3) can be derived.

$$q^u(\theta)=CF(\theta)^{-3},\quad \theta\in(\underline{\theta},\bar{\theta}]. \tag{A5}$$

$C(=\exp(C_1))$ is the optional integral constant.

Next, in order to solve the non-simultaneous linear differential equation (A2), we replace the optional integral constant C with an unknown function $z(\theta)$.

$$q^u(\theta)=z(\theta)F(\theta)^{-3},\quad \theta\in(\underline{\theta},\bar{\theta}]. \tag{A6}$$

The following equation is held under (A6).

$$\dot{q}^u(\theta)+\frac{3}{\dfrac{F(\theta)}{f(\theta)}}\,q^u(\theta)=\frac{dz}{d\theta}F(\theta)^{-3},\quad \theta\in(\underline{\theta},\bar{\theta}]. \tag{A7}$$

As $(1-V(\theta))/(F(\theta)/f(\theta))=(F'(\theta)(1-\theta)/F(\theta))-1$, the non-simultaneous linear differential equation is transformed as follows:

$$\frac{dz}{d\theta}=\frac{1-V(\theta)}{b\dfrac{F(\theta)}{f(\theta)}}F(\theta)^3=\frac{1}{b}(f(\theta)(1-\theta)-F(\theta))F(\theta)^2. \tag{A8}$$

It should be noted that (A8) holds also when $\theta=\underline{\theta}$. $z(\theta)$ can be obtained.

$$z(\theta)=\frac{1}{b}\int(f(\theta)(1-\theta)-F(\theta))F(\theta)^2d\theta+C_0. \tag{A9}$$

By (A5), we can derive the following solution as the general solution for $q^u(\theta)$:

$$q^u(\theta)=\frac{1}{bF(\theta)^3}[\int(f(\theta)(1-\theta)-F(\theta))F(\theta)^2d\theta+C], \quad \theta\in(\underline{\theta},\bar{\theta}]. \tag{A10}$$

C_0 and C_1 are the optional integral constants. By replacing the integral constants within parentheses on the right-hand side of (A10) with a definite integral, we can obtain the solution as follows:

$$q^u(\theta)=\frac{1}{bF(\theta)^3}[\int_{\underline{\theta}}^{\theta}(f(\theta)(1-\theta)-F(\theta))F(\theta)^2d\theta], \quad \theta\in(\underline{\theta},\bar{\theta}]. \tag{A11}$$

Finally, we calculate $q^u(\theta)$ under uniform distribution. By substituting (A11) for $f(\theta)=1/\Delta\theta$ and $F(\theta)=(\theta-\underline{\theta})/\Delta\theta$, the following equation in $\theta\in(\underline{\theta},\bar{\theta}]$ can be obtained.

$$\begin{aligned}
q^u(\theta)&=\frac{1}{b(\theta-\underline{\theta})^3}\int_{\underline{\theta}}^{\theta}(1+\underline{\theta}-2\theta)(\theta-\underline{\theta})^2d\theta,\\
&=\frac{1}{b(\theta-\underline{\theta})^3}\left[-\frac{\theta^4}{2}+\frac{(1+5\underline{\theta})\theta^3}{3}-\underline{\theta}(1+2\underline{\theta})\theta^2+(1+\underline{\theta})\underline{\theta}^2\theta\right]_{\underline{\theta}}^{\theta}\\
&=\frac{1}{b(\theta-\underline{\theta})^3}\left[-\frac{(\theta-\underline{\theta})^3(3\theta-(\underline{\theta}+2))}{6}\right]=\frac{2(1-\underline{\theta})-3(\theta-\underline{\theta})}{6b}.
\end{aligned} \tag{A12}$$

When $\theta=\underline{\theta}$, $q^u(\underline{\theta})=(1-\underline{\theta})/3b$. The above equation (A12) holds also when $\theta=\underline{\theta}$ Therefore, (21) holds in the overall domain of $\theta\in[\theta,\bar{\theta}]$.

Slope of $q^u(\theta)$

Differentiating (A11) with regard to θ, the slope of the output function $\dot{q}^u(\theta), \theta \in (\underline{\theta}, \bar{\theta}]$ can be obtained as follows:

$$\dot{q}^u(\theta) = -\frac{3f(\theta)}{bF(\theta)^4}\left[\int_{\underline{\theta}}^{\theta}(f(\theta)(1-\theta)-F(\theta))F(\theta)^2 d\theta - \frac{F(\theta)^3(f(\theta)(1-\theta)-F(\theta))}{3f(\theta)}\right]$$

$$= -\frac{f(\theta)}{bF(\theta)^4}\left[\int_{\underline{\theta}}^{\theta}\frac{F(\theta)^3}{f(\theta)^2}(2f(\theta)^2-F(\theta)f'(\theta))d\theta\right] < 0. \quad \text{(A13)}$$

The second equality is derived by $[F^3(f(1-\theta)-F)/3f]' = (F^2f(1-\theta)) - (5F^3/3) + (F^4f'/3f^2)$. The sign of inequality of (A13) is determined by the MHRC, which is $(d(F/f))/d\theta = (f^2 - Ff')/f^2 > 0$, because $2f^2 - Ff' > 0$ holds.

We show that $1 + b\dot{q}^u(\theta) > 0$. By $(F^4/f)' = 4F^3 - f^4f'/f^2$,

$$1 + b\dot{q}^u(\theta) = 1 - \frac{f(\theta)}{F(\theta)^4}\left[\int_{\underline{\theta}}^{\theta}\frac{F(\theta)^3}{f(\theta)^2}(2f(\theta)^2 - F(\theta)f'(\theta))d\theta\right]$$

$$= \frac{f(\theta)}{F(\theta)^4}\left[\frac{F(\theta)^4}{f(\theta)} - \int_{\underline{\theta}}^{\theta}\frac{F(\theta)^3}{f(\theta)^2}(2f(\theta)^2 - F(\theta)f'(\theta))d\theta\right]$$

$$= \frac{f(\theta)}{F(\theta)^4}\int_{\underline{\theta}}^{\theta}\left[4F(\theta)^3 - \frac{f(\theta)^4f'(\theta)}{f(\theta)^2} - \frac{F(\theta)^3}{f(\theta)^2}(2f(\theta)^2 - F(\theta)f'(\theta))\right]d\theta$$

$$= \frac{2f(\theta)}{F(\theta)^4}\int_{\underline{\theta}}^{\theta}F(\theta)^3 d\theta > 0. \quad \text{(A14)}$$

Thus, the condition $\dot{U}(\theta) < 0$ follows.

Proof of Lemma 1

We compare the output level under both the observable and unobservable cases. By symmetry, $q^o(\theta) \equiv q_i^o(\theta)$ and $q^u(\theta) \equiv q_i^u(\theta)$. By (7) and (20), the output levels under the observable and unobservable cases are as follows:

$$q^o(\theta) = \frac{(1-\theta)}{3b}. \quad \text{(A15)}$$

$$q^u(\theta) = \frac{1}{bF(\theta)^3}\left(\int_{\underline{\theta}}^{\theta}(f(\theta)(1-\theta) - F(\theta))F(\theta)^2 d\theta\right), \ \theta \in (\underline{\theta}, \bar{\theta}]. \quad \text{(A16)}$$

When the type of retail cost is $\theta=\underline{\theta}$, $q^o(\underline{\theta})=q^u(\underline{\theta})=(1-\underline{\theta})/3b$ is satisfied. By comparing (A15) and (A16), the lemma can be immediately derived. As $q^o(\theta)$ and $q^u(\theta)$ are the decreasing functions of θ, we show that $q^u(\theta)$ is steeper than $q^o(\theta)$ under MHRC.

$$\dot{q}^o(\theta)-\dot{q}^u(\theta)=-\frac{1}{3b}+\frac{f(\theta)}{bF(\theta)^4}\left[\int_{\underline{\theta}}^{\theta}\frac{F(\theta)^3}{f(\theta)^2}(2f(\theta)^2-F(\theta)f'(\theta))\,d\theta\right]$$

$$=\frac{f(\theta)}{bF(\theta)^4}\left[-\frac{F(\theta)^4}{3f(\theta)^2}+\int_{\underline{\theta}}^{\theta}\frac{F(\theta)^3}{f(\theta)^2}(2f(\theta)^2-F(\theta)f'(\theta))\,d\theta\right]$$

$$=\frac{f(\theta)}{bF(\theta)^4}\int_{\underline{\theta}}^{\theta}\left[-\frac{1}{3}\left(4F(\theta)^3-\frac{F(\theta)^4f'(\theta)^4}{f(\theta)^2}\right)+\frac{F(\theta)^3}{f(\theta)^2}(2f(\theta)^2-F(\theta)f'(\theta))\right]d\theta$$

$$=\frac{2f(\theta)}{3bF(\theta)^4}\int_{\underline{\theta}}^{\theta}\frac{F(\theta)^3}{f(\theta)^2}(f(\theta)^2-F(\theta)f'(\theta))\,d\theta>0. \tag{A17}$$

The third equality is derived by the derivative formula $(F^4/f)'=4F^3-(F^4(f')^4)/f^2)$. The last inequality is shown by the MHRC assumption $d(F(\theta)/f(\theta))/d\theta=(f^2-Ff')/f^2>0$. Thus, $q^o(\theta)$ is always steeper than $q^u(\theta)$ for all $\theta\in[\underline{\theta},\bar{\theta}]$.

References

Bernheim, Douglas B., and Whinston, Michael D. "Exclusive Dealing." *Journal of Political Economics* 106 (February 1998): 64-103.

Caillaud, Bernard, Jullien, Bruno, and Picard, Pierre. "Competing Vertical Structures: Precommitment and Renegotiation." *Econometrica* 63 (May 1995): 621-46.

Caillaud, Bernard, and Rey, Patrick. "Strategic Aspects of Vertical Delegation." *European Economic Review* 39 (April 1995): 421-31.

Fershtman, Chaim, and Judd, Kenneth L. "Equilibrium Incentives in Oligopoly." *American Economic Review* 77 (December 1987): 927-40.

Fershtman, Chaim, Judd, Kenneth L., and Kalai, Ehud. "Observable Contracts: Strategic Delegation and Cooperation." *International Economic Review* 32 (August 1991): 551-9.

Kessler, Anke S. "The Value of Ignorance." *Rand Journal of Economics* 29 (Summer 1998): 339-54.

Martimort, David. "Exclusive Dealing, Common Agency, and Multiprincipals Incentive Theory." *Rand Journal of Economics* 27 (Spring 1996): 1-31.