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Channel Competition and Vertical Restraints under Asymmetric Information

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Abstract

This paper studies vertical restraints in a duopoly market when retailers have private information on demand uncertainty. If both manufacturers are able to charge their retailers franchise fees, they will delegate the decision to determine retail prices to their retailers. If both manufacturers are unable to charge their retailers franchise fees, the degree of product differentiation plays an important role in equilibrium. If both products are more or less differentiated, both manufacturers will directly set the retail prices without delegation. If both products are extremely homogeneous, there will exist two equilibria; resale price maintenance (RPM) and delegation.

From a social welfare standpoint, an efficient equilibrium depends on the degree of product differentiation as well as on the degree of demand uncertainty. If the degree of product differentiation is high, it is efficient for regulators to let manufacturers to be able to employ RPM, irrespective of demand uncertainty. If the degree of product differentiation is at the intermediate level, it is desirable that regulators allow a contract with a franchise fee. If both products are sufficiently homogeneous, it is efficient for regulators to prohibit vertical restraints. This implies that authorities may also realize a desirable equilibrium without vertical restraints.

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1. Introduction

It is rare for manufacturers to directly establish transactions with consumers. Generally speaking, retailers, as intermediaries, facilitate transactions between two parties because the retailers, which have a decent knowledge (or information) of regional (or local) markets, would be better at predicting the local market demand than manufacturers. Under the asymmetric information, the expected payoffs for channels will increase if manufacturers delegate the right to decide retail prices to their retailers. Thus, if manufacturers delegate the right to set retail prices to their retailers, it will have beneficial effects on manufacturers' profitability, by allowing them to utilize valuable information. This paper examines vertical restraints under asymmetric information on demand uncertainty.

Previous studies on vertical restraints have two mainstreams. One has been focused on understanding the relationship between a single manufacturer and a single retailer or on the relationship between a single manufacturer and multiple retailers[3]. The other has been focused on analyzing the competitive relationships between two manufacturers that contract with an exclusive retailer[4]. The first framework has been provided in justification of employing vertical restraints. RPM is employed in order to extract the existence of externalities of retailers' services [Telsor(1960)]. RPM can solve the problem of double marginalization [Spengler(1950)]. On the assumption that retailers have private information on the state of demand, franchise contract and linear pricing are more desirable than that of RPM [Rey and Tirole(1986)], even with a single manufacturer.

The second framework has examined that the vertical restraints might not be absolutely favorable in an oligopoly. Therefore, earlier findings in the literatures dealing with vertical separation in oligopoly have mainly shown that delegation is superiority to vertical restraints. Vertical restraints are not necessarily desirable if both the products are sufficiently homogeneous and the fixed retailing costs are sufficiently high under conditions of demand uncertainty, but with symmetric information [Gal-Or(1991a)].

The problem of vertical restraints has also been dealt with under conditions of asymmetric information. Delegation leads to a trade-off relationship between information benefits and information costs. From the standpoint of contract theory,

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[3] See, for instance, Spengler(1950), Telser(1960), Gould and Preston(1965), Matheson and Winter(1984), Bresnahan and Reiss(1985), Rey and Tirole(1986), Nariu(1996), Deneckere, Marvel and Peck(1997), Utaka(2003), and so on.

[4] See, Gal-Or(1991a, 1991b), Bonanno and Vickers(1988), Rey and Stiglitz(1988), McGuire and Staelin(1983), Fershtman and Judd(1987), and so on.

vertical restraints may be efficient if both products are sufficiently differentiated and/or the degree of demand uncertainty is sufficiently large under asymmetric information [Gal-Or(1991b)]. Unlike this model, our paper approaches the question of whether manufacturers delegate the decision on retail prices or not by introducing a trade-off relationship between the utilization of valuable information and double marginalization. Delegating the retail price decision to retailers has the beneficial effect of alleviating competition by taking advantage of valuable information. However, it also brings about the detrimental effect of double marginalization.

This paper examines the vertical restraints under demand uncertainty. The following conclusions emerge from our analysis. Under asymmetric information about the state of demand, if manufacturers can charge the franchise fees to their retailers, there exists a unique equilibrium in which they delegate the pricing decision to their retailers. Under the circumstance that manufacturers cannot charge the franchise fees, and if both products are extremely homogeneous, there exist dual equilibria; a delegation equilibrium and an RPM equilibrium. If both products are somewhat differentiated, they will enforce retail prices without delegating the right to determine retail prices. From a social welfare standpoint, it is desirable for regulators to permit RPM if both product differentiation and demand uncertainty are sufficiently high. It is desirable for regulators to prohibit RPM and franchise contracts, if product differentiation is sufficiently low. It is also desirable for regulators only to permit franchise contracts only if product differentiation is intermediate.

This paper is organized as follows: in the next section, we present the model and analyzes the contracts with franchise fees. Section 3 examines the contract without franchise fees. In section 4, we extend our model to examine an augmented game with equilibria derived from the above sections. In Section 5, we analyze how vertical restraints should be controlled from a social welfare and consumer welfare standpoint. Concluding remarks are in Section 6.

2. The Model

Consider a duopoly market that consists of two manufacturers and two retailers. Two products produced by the manufacturers are differentiated. Both manufacturers sell their products to their own retailers. The demand function for manufacturer i is given by:

$$q_i = a + x - p_i + bp_j, \quad a > 0 \;\; and \;\; 0 \le b \le 1, i, j = 1,2; \quad i \ne j \tag{1}$$

where q_i is the quantity produced by manufacturer i, p_i and p_j are the retail prices charged for product i and j, respectively, and x[5] is a random variable that is distributed with mean 0 and variance σ^2. The assumption that $b \geq 0$ implies that the two products are substitutes. The parameter b measures the degree of differentiation between two products, i.e., as b approaches one, the products become less differentiated. Conversely, as b approaches zero, the products become more differentiated. For simplicity of exposition, it is assumed that both manufacturers and retailers are all risk-neutral, and that the marginal costs for producing both products are normalized to zero. We also assume that each manufacturer prohibits its retailer from transacting and distributing the product produced by the rival manufacturer.

This paper considers a game consisting of three stages. At stage one, each manufacturer offers a contract to its own retailer. The contract is composed of three variables; franchise fee, decision-right with regard to retail price, and wholesale price. At stage two, the state of demand is realized and the realized state of demand can be observed only by retailers. At stage three, each retailer (or manufacturer) sets their retail prices. When manufacturers employ RPM at the first stage, notice that retailers will not make any decision, apart from accepting the contract offered by their manufacturers whenever their profits are satisfied by non-negative condition.

2.1. Franchise Contract with Delegation

We consider the case in which each manufacturer is able to charge franchise fee and delegates the right to decide the retail prices to its retailer. At stage three, retailer i chooses the retail price p_i so as to maximize its profits as follows:

$$Max \quad y_i = (p_i - w_i)q_i - F_i = (p_i - w_i)(a + x - p_i + bp_j) - F_i, \quad w.r.t \ \ p_i \tag{2}$$

where w_i is the wholesale price and F_i is the franchise fee. The retail price that maximizes Eq. (2) is independent of the value of F_i. Therefore, retailer i chooses its retail price as the function of wholesale prices as follows:

[5] We assume that the boundary condition is satisfied. It guarantees that each manufacturer finds it beneficial to produce the products even under the worst state of demand.

$$p_i(w_i, w_j) = \frac{(2+b)(a+x)+2w_i+bw_j}{(4-b^2)}, \qquad i,j=1,2;\quad i \neq j. \tag{3-1}$$

The retail price is derived by differentiating the objective function Eq. (2) with respect to p_i and by solving two reaction functions for (p_i, p_j) in terms of (w_i, w_j). Substituting it into Eq. (1) and Eq. (2), we obtain the quantity q_i, the expected quantity Eq_i, and the expected payoff Ey_i, when the state of demand is x, respectively:

$$q_i(w_i, w_j) = \frac{(2+b)(a-x)-(2-b^2)w_i+bw_j}{(4-b^2)}, \qquad i,j=1,2;\quad i \neq j. \tag{3-2}$$

$$Eq_i(w_i, w_j) = \frac{(2+b)a-(2-b^2)w_i+bw_j}{(4-b^2)}, \qquad i,j=1,2;\quad i \neq j. \tag{3-3}$$

$$Ey_i(w_i, w_j) = \frac{[(2+b)(a-x)-(2-b^2)w_i+bw_j]^2}{(4-b^2)^2} + \frac{\sigma^2}{(2-b)^2} - F_i. \tag{3-4}$$

At the first stage, manufacturer i chooses a wholesale price w_i and a franchise fee F_i so as to maximize its expected profit for a given w_j, which is selected by the rival manufacturer j. Manufacturer i chooses the retail price so as to maximize its profits as follows:

$$Max \quad E\pi_i = w_i Eq_i(w_i, w_j) + F_i, \quad s.t.\ Ey_i(w_i, w_j) \geq 0,\ w.r.t.\ w_i, F_i \tag{4}$$

Noting that the constraint condition of Eq. (4) is binding, we rewrite Eq. (4) as follows:

$$Max \quad E\pi_i = \frac{w_i[(2+b)a-(2-b^2)w_i+bw_j]}{(4-b^2)} + \frac{[(2+b)a-(2-b^2)w_i+bw_j]^2}{(4-b^2)^2} + \frac{\sigma^2}{(2-b)^2},\ w.r.t.\ w_i. \tag{5}$$

The equilibrium wholesale price for manufacturer i is derived by differentiating the objective function (5) with respect to w_i and by solving the two reaction functions for (w_i, w_j) in terms of $(w_i(w_j),\ w_j(w_i))$ as follows:

$$w_i^{RF} = \frac{ab^2}{(4-2b-b^2)}. \tag{6-1}$$

where the superscripts R and F respectively denote that the right to determine the retail price is delegated to the retailer and that each manufacturer is able to charge the franchise fee to their retailers. Substituting Eq. (6-1) into Eq. (3-1), Eq. (3-2) and Eq. (5) gives the equilibrium price, equilibrium quantity and equilibrium expected payoff, when the state of demand is x, respectively.

$$p^{RF} = \frac{2a}{(4-2b-b^2)} + \frac{x}{(2-b)} \tag{6-2}$$

$$q_i^{RF} = \frac{(2-b^2)a}{(4-2b-b^2)} + \frac{x}{(2-b)} \tag{6-3}$$

$$E\pi_i^{RF} = \frac{(2-b^2)a^2}{(4-2b-b^2)^2} + \frac{\sigma^2}{(2-b)^2} \tag{6-4}$$

2.2 Resale Price Maintenance with Franchise Fee

We now turn to the case in which each manufacturer is able to enforce the wholesale price as well as the retail price. However, manufacturers have no information on the state of demand. Therefore, they have no other option than to set the retail price and the wholesale price equally, without regard to the state of demand. Therefore, retailers do not make any decision, apart from accepting the contract offered by their manufacturers, when their profits are satisfied by non-negative conditions. In these circumstances, manufacturer i chooses w_i, p_i, and F_i so as to maximize its profits for the given w_j, p_j, and F_i selected by the rival manufacturer. Manufacturer i chooses w_i, p_i, and F_i so as to maximize its profits as follows:

$$Max \quad E\pi_i = w_i Eq_i + F_i,\ s.t.\ Ey_i = (p_i - w_i)Eq_i - F_i \geq 0,\ w.r.t.\ w_i, p_i,\ and\ F_i \tag{7}$$

Noticing that the constraint condition of Eq. (7) is binding, we rewrite it as follows:

$$Max \quad E\pi_i = p_i Eq_i = p_i(a - p_i + bp_j),\ w.r.t.\ p_i \tag{8}$$

By differentiating the objective function Eq. (8) with respect to p_i, and by solving the two reaction functions for (p_i, p_j) in terms of $(p_i(p_j), p_j(p_i))$, the retail prices are derived as follows:

$$p_i^M = \frac{a}{(2-b)}. \tag{9-1}$$

Substituting Eq. (9-1) into Eq. (1) and Eq. (8), we have, respectively, the equilibrium quantity and equilibrium expected payoff, when the state of demand is x.

$$q_i^M = \frac{a}{(2-b)} + x \tag{9-2}$$

$$E\pi_i^M = \frac{a^2}{(2-b)^2} \tag{9-3}$$

where the superscript M implies the case in which each manufacturer is able to enforce its retail price. Comparing Eq. (9-3) with Eq. (6-4), we obtain the following result under the condition that $0 \le b \le 1$:

$$E\pi_i^M = \frac{a^2}{(2-b)^2} \le \frac{(2-b^2)a^2}{(4-2b-b^2)^2} + \frac{\sigma^2}{(2-b)^2} = E\pi_i^{RF}$$ [6]

Lemma 1. If both manufacturers are able to charge franchise fees to their retailers, they will delegate the right to determine the retail prices to their retailers. They enjoy higher payoffs from delegation than from RPM.

Lemma 1 gives rise to us of three facts. Firstly, delegating the retail prices to their retailers induces the retailers to set retail prices suitable to the realized state of demand. Secondly, it plays a role in mitigating competition between manufacturers under vertical separation. Thirdly, contracts with franchise fees are designated to extract retailer surplus acquired by dominant information. We suppose that manufacturers also have the information on the state of demand. If manufacturers are able to enforce RPM, their expected payoffs are given by:

$$E\pi_i^{MX} = \frac{a^2}{(2-b)^2} + \frac{\sigma^2}{(2-b)^2}$$ [7]

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[6] When b=0 and σ^2=0, the equality of the equation is satisfied.

where the superscript X denotes the case that manufacturers completely know the state of demand. The above equation implies that information rents for retailers correspond to $\sigma^2/(2-b)^2$.

2.3 Delegation vs. RPM

We consider the case wherein manufacturer i employs delegation with a franchise contract, while manufacturer j employs RPM with a franchise contract. At the third stage, retailer i chooses p_i so as to maximize its profit for the given w_i, p_j and F_j

$$Max \quad y_i = (p_i - w_i)q_i - F_i = (p_i - w_i)(a + x - p_i + bp_j) - F_i, \quad w.r.t \;\; p_i \tag{10}$$

Retailer i chooses its retail price p_i as a function of both its wholesale price w_i and the rival's retail price p_j as follows:

$$p_i(w_i, p_j) = \frac{(a + x + w_i + bp_j)}{2} \tag{11-1}$$

Therefore, the expected retail price is given by

$$Ep_i(w_i, p_j) = \frac{(a + w_i + bp_j)}{2} \tag{11-2}$$

On the other hand, manufacturer j, who does not know the state of demand, chooses p_j so as to maximize its profit for the rival's given retail price p_i

$$Max \quad \pi_j = p_j Eq_j = p_j(a - p_i + bEp_i), \quad w.r.t \;\; p_j \tag{12}$$

Differentiating Eq. (12) with respect to p_j gives the reaction function in terms of p_i as follows:

$$p_j(p_i) = \frac{(a + bEp_i)}{2} \tag{13}$$

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7 The expected payoffs can be produced by setting $w_i=w_j=0$ and $F_i=F_j=(a^2+\sigma^2)/(2-b)^2$.

Substituting Eq. (11-2) into Eq. (13) and solving two reaction functions for (p_i, p_j) in terms of $(p_i(w_i, p_j),\ p_j(w_i))$, the retail prices are derived as follows:

$$p_i(w_i) = \frac{2(2+b)a + (4-b)x + 4w_i}{2(4-b^2)} \tag{14-1}$$

$$p_j(w_i) = \frac{(2+b)a + bw_i}{(4-b^2)} \tag{14-2}$$

Substituting Eq. (14-1) and Eq. (14-2) into Eq. (1) and Eq. (2), when the state of demand is x, we obtain, respectively, the quantity, the expected quantity and the expected payoff:

$$q_i(w_i) = \frac{2(2+b)a + (4-b^2)x - 2(2-b^2)w_i}{2(4-b^2)} \tag{14-3}$$

$$Eq_i(w_i) = \frac{(2+b)a - (2-b^2)w_i}{(4-b^2)} \tag{14-4}$$

$$Ey_i(w_i) = \frac{[(2+b)a - (2-b^2)w_i)]^2}{2(4-b^2)^2} + \frac{\sigma^2}{4} - F_i \tag{14-5}$$

At the first stage, manufacturer i chooses w_i so as to maximize its profits.

$$Max \quad E\pi_i = w_i Eq_i(w_i, p_j) + F_i, \quad s.t.\ Ey_i(w_i, p_j) \geq 0,\ w.r.t.\ w_i, F_i \tag{15}$$

Noting that the constraint condition of Eq. (15) is binding, it can be rewritten as follows:

$$Max \quad E\pi_i = \frac{[(2+b)a + 2w_i][(2+b)a - (2-b^2)w_i]}{(4-b^2)^2} + \frac{\sigma^2}{4},\ w.r.t.\ w_i. \tag{16}$$

Differentiating Eq. (16) with respect to w_i leads to the equilibrium wholesale price.

$$w_i^{ARF} = \frac{(2+b)b^2 a}{4(2-b^2)}. \tag{17-1}$$

Substituting Eq. (17-1) into Eq. (14-1), Eq. (14-2), Eq. (14-3), Eq. (14-5), and Eq. (16), the corresponding equilibrium retail prices, quantities, franchising fee, and expected payoffs are produced as follows:

$$p^{ARF} = \frac{(2+b)+a}{2(2-b^2)} + \frac{x}{2} \tag{17-2}$$

$$p^{AM} = \frac{(4+2b-b^2)a}{4(2-b^2)} \tag{17-3}$$

$$q^{ARF} = \frac{(2+b)a+2x}{4} \tag{17-4}$$

$$q^{AM} = \frac{[(4+2b-b^2)a/(2-b^2)+2(2+b)x]}{4} \tag{17-5}$$

$$F^{ARF} = \frac{[(2+b)+a]^2}{16} + \frac{\sigma^2}{4} \tag{17-6}$$

$$E\pi^{ARF} = \frac{[(2+b)a]^2}{8(2-b^2)} + \frac{\sigma^2}{4} \tag{17-7}$$

$$E\pi^{AM} = \frac{[(4+2b-b^2)a]^2}{16(2-b^2)^2} \tag{17-8}$$

where the superscript A denotes the asymmetric case that manufacturer i delegates the right to determine retail price to its retailer and the other manufacturer employs RPM.

[Table 1 here]

In order to decide the problem of whether manufacturers will choose delegation with franchise fee or RPM, it is necessary to compare payoffs described above. All payoffs are summarized in Table 1. When $0 \leq b \leq 1$, notice that the following results are satisfied:

$$E\pi^{M} = \frac{a^2}{(2-b)^2} \leq \frac{[(2+b)a]^2}{8(2-b^2)} + \frac{\sigma^2}{4} = E\pi^{ARF}$$

$$E\pi^{AM} = \frac{[(4+2b-b^2)a]^2}{16(2-b^2)^2} \leq \frac{[2(2-b^2)a^2]}{(4-2b-b^2)^2} + \frac{\sigma^2}{(2-b)^2} = E\pi^{RF}$$ [8]

Proposition 1. In duopolistic equilibrium under the equation (1), if manufacturers are able to charge franchise fees to their retailers, they will delegate the right to determine the retail prices to their retailers. They enjoy higher payoffs from delegation than they

[8] When b=0 and σ^2=0, the equality is satisfied.

would have from RPM.

3. Contract with No Franchise Fee

In this section, we examine the case in which manufacturers are unable to charge franchise fees to their retailers.

3.1 Delegation with No Franchise Fee

As was explained in the above section, the retail prices at stage three are independent of franchise fees. Therefore, Eq. (3) indicates the equilibrium retail prices independent of the franchise contract. Then, at the first stage, manufacturer i chooses w_i in order to maximize its expected profit for a given w_j, which is selected by the rival manufacturer. Manufacturer i chooses the wholesale price so as to maximize its profits as follows:

$$Max \quad E\pi_i = w_i Eq_i(w_i, w_j) = \frac{[(2+b)a-(2-b^2)w_i + bw_j]}{(4-b^2)}, \; w.r.t. \; w_i \qquad (18)$$

By differentiating the objective function (18) with respect to w_i and by solving the two reaction functions for (w_i, w_j) in terms of $(w_i(w_j),\ w_j(w_i))$, manufacturer i chooses its wholesale prices as follows:

$$w_i^R = \frac{(2+b)a}{(4-2b-b^2)}. \qquad (19\text{-}1)$$

Substituting Eq. (19-1) into Eq. (3-1), Eq. (3-2) and Eq. (18) gives, respectively, the equilibrium price, the equilibrium quantity, the equilibrium expected payoff and the equilibrium expected channel's payoff, denoted by Ez, when the state of demand is x.

$$p^R = \frac{[2(3-b^2)a]}{[(2-b)(4-b-2b^2)]} + \frac{x}{(2-b)} \qquad (19\text{-}2)$$

$$q_i^R = \frac{[(2-b^2)a]}{[(2-b)(4-b-2b^2)]} + \frac{x}{(2-b)^2} \qquad (19\text{-}3)$$

$$Ey_i^R = \left[\frac{(2-b^2)a}{(2-b)(4-b-2b^2)}\right]^2 + \frac{\sigma^2}{(2-b)^2} \qquad (19\text{-}4)$$

$$E\pi_i^R = \frac{[(2+b)(2-b^2)a^2]}{[(2-b)(4-b-2b^2)^2]} \qquad (19\text{-}5)$$

$$Ez_i^R = \frac{[(2+b)(2-b^2)(3-b^2)a^2]}{[(2-b)^2(4-b-2b^2)^2]} + \frac{\sigma^2}{(2-b)^2} \tag{19-6}$$

Comparing Eq. (9-3) with Eq. (19-5), we obtain the following results:

$$E\pi_i^R [>=<] E\pi_i^M \Leftrightarrow (4-b^2)(2-b^2)[>=<](4-b-2b^2)^2$$
$$\Leftrightarrow b[>=<]0.70781(=b_1)$$

Lemma 2. Consider the case wherein manufacturers are unable to charge franchise fees to their retailers. In duopolistic equilibrium under equation (1), if $b>b_1$, they will delegate the right to determine the retail prices to their retailers. They enjoy higher payoffs from delegation than from RPM.

We omit RPM with no franchise fee because that case produces the same results as explained in the previous section for RPM with a franchise fee.

3.2 Delegation vs. RPM with No Franchise Fees

We turn to an asymmetric case where manufacturer *i* gives the right to decide the retail price to its retailer, whereas manufacturer *j* employs RPM at stage one. The equilibrium, at stage three, is identical to Eq. (14-1) and Eq. (14-2). At the first stage, manufacturer *i* chooses the wholesale price w_i so as to maximize its profits as follows:

$$Max \quad E\pi_i = w_i Eq_i(w_i, p_j) = w_i[(2+b)a-(2-b^2)w_i], \ w.r.t. \ w_i \tag{20}$$

Differentiating Eq. (20) with respect to w_i leads to the equilibrium wholesale price.

$$w_i^{\wedge R} = \frac{(2+b)a}{2(2-b^2)}. \tag{21-1}$$

where the superscripted symbol ^ denotes the asymmetric case with no franchise fee, in which manufacturer *i* delegates the right to determine retail price to its retailer and manufacturer *j* employs RPM. When the equilibrium wholesale price is given by Eq. (21-1), the equilibrium retail prices, quantities, expected payoffs and franchising fee are produced as follows:

$$p^{\wedge R} = \frac{(3-b^2)a}{(2-b)(2-b^2)} + \frac{x}{2} \quad (21\text{-}2)$$

$$p^{\wedge M} = \frac{(4+b-2b^2)a}{2(2-b)(2-b^2)} \quad (21\text{-}3)$$

$$q^{\wedge R} = \frac{a+2(2-b)x}{2(2-b)} \quad (21\text{-}4)$$

$$q^{\wedge M} = \frac{1}{2}\left[\frac{(4+b-2b^2)a}{(2-b)(2-b^2)} + (2+b)x\right] \quad (21\text{-}5)$$

$$Ey^{\wedge R} = \frac{a^2}{4(2-b)} + \frac{\sigma^2}{4} \quad (21\text{-}6)$$

$$\pi^{\wedge R} = \frac{(2+b)a^2}{4(2-b)(2-b^2)} \quad (21\text{-}7)$$

$$Ez^{\wedge R} = \frac{(3-b^2)a^2}{2(2-b)^2(2-b^2)} + \frac{\sigma^2}{4} \quad (21\text{-}8)$$

$$E\pi^{\wedge M} = \frac{[(4+b-2b^2)a]^2}{[2(2-b)(2-b^2)]^2} \quad (21\text{-}9)$$

[Table 2 here]

In order to understand the problem of whether manufacturers will choose RPM or not, it will be useful to compare the payoffs described above. All payoffs are summarized in Table 2. Noticing that $0 \leq b \leq 1$, we obtain the following results:

$$E\pi^{\wedge R} < E\pi^{M}$$
$$E\pi^{R}[>=<]E\pi^{\wedge M} \Leftrightarrow 4(4-b^2)(2-b^2)^3[>=<](4-b-2b^2)^2(4-b-2b^2)^2$$
$$\Leftrightarrow b[>=<]0.93091 = b_2 (> b_1)$$

Proposition 2. Consider the case in which both manufacturers are unable to charge franchise fees to their retailers. In duopolistic equilibrium under the equation (1), if $b<b_2$*, there exists a unique equilibrium that both manufacturers employ RPM. If* $b>b_2$*, there exist two equilibria: Delegation and RPM. In the former, both delegate the right to determine their retail price to their retailers. In the latter, both employ RPM. In multiple equilibria, delegation payoffs are higher than those from RPM.*

Proposition 2 has the following implications. If the detrimental effect of double marginalization is extremely large, when there are no franchise fees, both manufacturers employ RPM. The reason is that the retail price is lower with RPM than with delegation. However, if both products are sufficiently homogeneous ($b>b_2$), it may be beneficial for retailers to employ retail prices. In other words, delegation brings more payoffs to manufacturers by playing a role in alleviating competitions between them.

4. The Augmented Game

We obtained three equilibria in Section 2 and 3: delegation with franchise fees, RPM with no franchise fees and delegation with no franchise fees. We shall further examine an augmented game with these equilibria. The augmented game requires us to compare payoffs of delegation with franchise fees with those of delegation with no franchise fees. The retail price and quantity in a franchise contract are produced by Eq. (3-1) and Eq. (3-2), respectively. We suppose that manufacturer i employs delegation with franchise fees whereas manufacturer j enforces delegation with no franchise fees. The reaction functions for manufacturers i and j are described by Eq. (6-1) and Eq. (17-1), respectively. Solving these two reaction functions produces wholesale prices as follows:

$$w_i^{\#RF}=\frac{b^2(2+b)(4+b-2b^2)a}{(32-32b^2+7b^4)}. \tag{22-1}$$

$$w_j^{\#R}=\frac{(4-b^2)(4+2b-b^2)a}{(32-32b^2+7b^4)}. \tag{22-2}$$

We denote by $\#RF$ and $\#R$ an asymmetric case in which manufacturer i is able to charge franchise fee and manufacturer j is unable to charge franchise fee, respectively. Substituting Eq. (22-1) and Eq. (22-2) into Eq. (5) and Eq. (18) gives the expected payoffs for both manufacturers as follows:

$$E\pi_i^{\#RF}=\frac{2(2-b^2)(2+b)^2(4+b-2b^2)^2a^2}{(32-32b^2+7b^4)^2}+\frac{\sigma^2}{(2-b)^2}. \tag{23-1}$$

$$E\pi_j^{\#R}=\frac{(2-b^2)(4-b^2)(4+2b-b^2)^2a^2}{(32-32b^2+7b^4)^2}. \tag{23-2}$$

From Eq. (23-1) and Eq. (23-2), a payoffs matrix for the augmented game is presented in Table 3

[Table 3 here]

From Table 3, when $0 \le b \le 1$ and $\sigma^2 > 0$, we obtain the following results.

$$E\pi^{ARF} > \max\{E\pi^{M}, E\pi^{\wedge R}\}$$
$$E\pi^{\#RF} > \max\{E\pi^{\wedge M}, E\pi^{R}\}$$
$$E\pi^{RF} > \max\{E\pi^{AM}, E\pi^{\#R}\}$$

Therefore, each manufacturer will always employ Delegation with franchise fees regardless of the rival manufacturer's strategy.

Proposition 3. In the duopolistic equilibrium under the equation (1), when $0 \le b \le 1$ and $\sigma^2 > 0$, each manufacturer will always employ delegation with a franchise fee, regardless of the rival manufacturer's strategy.

However, it is possible to produce the Prisoners' Dilemma. Suppose that $b=1$. Then, the matrix in Table 3 can be rewritten as the matrix in a Table 4. From the matrix in Table 4, when both manufacturers are able to charge the franchise fees to their retailers, their payoffs will be $2a^2+\sigma^2$, whereas their payoffs with no franchise fees will be $3a^2$. Essentially, this case also occurs when both products are sufficiently homogeneous. In fact, we obtain the following result by comparing Eq. (6-4) with Eq. (19-5):

$$E\pi^{R} \ge E\pi^{RF} \Leftrightarrow f(b) = \frac{(2-b)(2-b^2)^2(16-24b-2b^2+9b^3)}{[(4-2b+b^2)(4-b-2b^2)]^2} \ge \frac{\sigma^2}{a^2}$$

Note that the function $f(b)$ is strictly increasing in the interval $0 \le b \le 1$, and it is zero when b=0.81352. Therefore, if the degree of products differentiation or demand uncertainty is sufficiently large, it is obvious that the Prisoners' Dilemma equilibrium will not exist.

5. Vertical Restraints and Social Welfare

In the previous section, we analyzed the augmented game. This section will now deal with the three equilibria from the standpoint of social welfare and consumer welfare. Under Eq. (1), the expected consumer surplus is described as follows:

$$CS = \sum_{i=1}^{2}\left(\frac{q_i^2}{2}\right).$$

Substituting Eq. (9-2), Eq. (6-3) and Eq. (19-3) into the above function produces the expected consumer surpluses as a result of the three equilibria as follows:

$$CS^{M} = \left[\frac{a}{(2-b)}\right]^2 + \sigma^2 \tag{24-1}$$

$$CS^{RF} = \left[\frac{(2-b^2)a}{(4-2b-b^2)}\right]^2 + \frac{\sigma^2}{(2-b)^2} \tag{24-2}$$

$$CS^{R} = \left[\frac{(2-b^2)a}{(2-b)(4-2b-b^2)}\right]^2 + \frac{\sigma^2}{(2-b)^2} \tag{24-3}$$

Therefore, we obtain the expected total surpluses of the three equilibria as follows:

$$TS^{M} = \frac{3a^2}{(2-b)^2} + \sigma^2 \tag{25-1}$$

$$TS^{RF} = \frac{(2-b^2)(6-b^2)a^2}{(4-2b-b^2)^2} + \frac{3\sigma^2}{(2-b)^2} \tag{25-2}$$

$$TS^{R} = \frac{(2-b^2)(14-5b^2)a^2}{\{(2-b)(4-b-b^2)\}^2} + \frac{3\sigma^2}{(2-b)^2} \tag{25-3}$$

From Eq. (24-1), Eq. (24-2), and Eq. (24-3), under the condition that $0 \le b \le 1$, we obtain the following results.

$$CS^{M} > CS^{RF} > CS^{R}$$

From the standpoint of consumer welfare, it is most beneficial for both manufacturers to employ RPM. However, Proposition 3 means that if each manufacturer is able to charge franchise fees to its retailer, it employs a unique equilibrium that each manufacturer gives its retailer the authority to decide retail price. Even if the equilibrium is not the first-best for consumers, payoffs from delegation with franchise fees will be larger than those from delegation with no franchise fees. If both products are somewhat differentiated, both manufacturers will employ RPM. From the consumer's perspective, this is the most efficient selection, and it will increase the consumer welfare. Therefore, the authorities can realize an efficient equilibrium by prohibiting franchise contracts in these cases.

Proposition 4. From a social welfare standpoint, a regulator can make the following efficient decision on vertical restraint. Given that 0≤b≤1,

(1) if b>0.679, it is desirable for the regulator not to implement any vertical restraint;

(2) if $\frac{(2+b)(-10+17b+2b^2-3b^3)}{(1-4b+b^2)(4-b-2b^2)^2} < \frac{\sigma^2}{a^2}$ *and b<0.679, it is efficient for the regulator to permit manufacturers to be able to charge franchise fees to their retailers;*

(3) if $\frac{\sigma^2}{a^2} < \frac{(2+b)(-10+17b+2b^2-3b^3)}{(1-4b+b^2)(4-b-2b^2)^2}$*, it is efficient for the regulator to permit manufacturers to employ RPM.*

[Figure 1 here]

Proposition 4 implies that if product differentiation is not at a high level, delegation with no franchise fees (or delegation with franchise fees) is more efficient than the efficiency of RPM, from a social welfare standpoint. The reason is that employing RPM deteriorates social welfare due to demand uncertainty. On the other hand, if product differentiation is sufficiently high, delegation deteriorates social welfare due to double marginalization. We present simple numerical examples to understand Proposition 4.

Example 1. When $\sigma^2/a^2=0$, the relationships among total surpluses in equilibria are given by:

$$TS^M > TS^{RF} > TS^R, \text{ if } b<0.518$$
$$TS^{RF} > TS^M > TS^R, \text{ if } 0.518<b<0.653$$
$$TS^{RF} > TS^R > TS^M, \text{ if } 0.653<b<0.679$$
$$TS^R > TS^{RF} > TS^M, \text{ if } 0.679<b$$

Finally, we postulate that both the degree of demand uncertainty and the degree of product differentiation are given by the above simple example. How can the authorities achieve the most efficient results from the viewpoint of social welfare? If the authorities can not regulate manufacturers' actions, manufacturers will charge franchising fees and delegate the right to decide their retail prices. When products differentiation is occurring to an intermediate degree (0.51822<b<0.67896), the authorities can accomplish the most efficient equilibrium by not enforcing any regulation. When both products are substantially differentiated (b<0.51822), the authorities can induce manufacturers to employ RPM by prohibiting franchising charges. When both products are somewhat homogeneous (0.67896< b), the authorities can implement an efficient equilibrium by forbidding RPM as well as franchising charges. Until now, we have examined how authorities can realize the most efficient equilibrium by employing proper vertical restraints, in any given case.

Example 2. When $0 \leq b < 2-\sqrt{3}$, total surpluses in equilibria are always satisfying the following relationship.

$$TS^{M} > TS^{RF} > TS^{R}$$

Example 3. When $\sigma^2/a^2 \geq 5/4$, the relationships among total surpluses in equilibria are given by:

$$\begin{aligned} &TS^{R} > TS^{RF} > TS^{M}, \text{ if } \ b>0.679 \\ &TS^{RF} > TS^{R} > TS^{M}, \text{ if } \ 2-\sqrt{3} \leq b < 0.679 \\ &TS^{M} > TS^{RF} > TS^{R}, \text{ if } \ 0 \leq b < 2-\sqrt{3} \end{aligned}$$

So far, the most efficient policy for social welfare has been reviewed according to Proposition 4 and by giving some numerical examples. However, it is evident that the actions that are desirable for manufacturers are different from the ones that are efficient for social welfare. Therefore, the regulator has to implement vertical restraints properly, according to the degree of product differentiation and the degree of demand uncertainty. Comparing the results obtained in section 4 with the above-mentioned results, it is desirable for regulator to permit RPM to manufacturers, if both product differentiation and demand uncertainty are sufficiently high. This means that the cost of double marginalization is too high to delegate the right to decide the retail price to retailers. The result holds a convexity relationship between product differentiation and demand uncertainty. It is also desirable for the regulator to prohibit RPM and franchise contracts, if product differentiation is sufficiently low. This means that the beneficial effect of taking advantage of valuable information is superior to the detrimental one of double marginalization. It is also desirable for the regulator only to permit only franchise contracts if product differentiation is intermediate. This means that the superiority of delegation with franchise contracts over RPM is holds true in this domain.

6. Concluding Remarks

This paper examined the vertical restraints under demand uncertainty. The following conclusions emerged from our analysis. Under incomplete information on the state of demand, if manufacturers can charge franchise fees to their retailers, there exists a unique equilibrium in which they delegate the pricing decision to their retailers. Under the circumstance in which manufacturers can not charge franchise fees, if both products are extremely homogeneous, there exist dual equilibria: a delegation equilibrium and an RPM equilibrium. If both products are somewhat differentiated, they will enforce retail prices without delegating the right to determine retail prices. It is desirable for regulator to permit RPM to manufacturers, from a social welfare standpoint, if both product differentiation and demand uncertainty are sufficiently high. It is desirable for regulator to prohibit RPM and franchise contracts, if product differentiation is sufficiently low. It is also desirable for the regulator to permit only franchise contracts, if product differentiation is intermediate.

Much of the previous relevant literatures have been focused on the justification of employing vertical restraints within a single channel. Another approach has been illustrated here, in that vertical restraints might not be desirable in an oligopolistic environment. The conclusion of our paper leaves the question as to why vertical restraints should always be prohibited.

Reference

Bresnahan, T. F. and P. C. Reiss (1985), "Dealer and Manufacturer Margins", *Rand Journal of Economics*, Vol.16, No.3, pp.253-268.

Bonanno, G. and J. Vickers (1988), "Vertical Separation", *Journal of Industrial Economics*, Vol.36, No.3, pp.257-265.

Deneckere, R., H. Marvel, and J. Peck (1997), "Demand Uncertainty and Price Maintenance: Markdowns as Destructive Competition", *American Economic Review*, Vol.87, pp.619-641.

Fershtman, C. and K. L. Judd(1987), “Equilibrium Incentives in Oligopoly” , *American Economic Review*, Vol.77, pp.927-940.

Gal-Or, E. (1991a), "Duopolistic Vertical Restraints", *European Economic Review*, Vol.35, pp.1237-1253.

Gal-Or, E. (1991b), "Optimal Franchising in Oligopolistic Markets with Uncertain Demand", *International Journal of Industrial Organization*, Vol. 9, pp.343-364.

Gould, J. P. and L. E. Preston (1965), "Resale Price Maintenance and Retail Outlet", *Economica*, Vol.33, pp.302-312.

Mathewson, F. and R. Winter (1983), "The Incentive for Resale Price Maintenance under Imperfect Information", *Economic Inquiry*, Vol.21, No.3, pp.337-348.

McGuire, T. and R. Staelin (1983), "An Industry Equilibrium Analysis of Downstream Vertical Integration ", *Marketing Science*, Vol. 2, pp. 161-192.

Rey, P. and J. Tirole (1986), "The Logic of Vertical Restraints", *American Economic Review*, Vol.76, No.5, pp.921-939.

Nariu, T. (1996), "Manufacture Acceptance of Returns", *Japanese Economic Review*, Vol.47, No.4, pp.426-431.

Rey, P. and J. Stiglitz (1988), "Vertical Restraints and Producers' Competition", *Europian Economic Journal*, Vol.32, No.2-3, pp.561-568.

Spengler, R. (1950), "Vertical Integration and Anti-trust Policy", *Journal of Political Economy*, Vol.58, pp.86-105.

Telser, L. (1960), "Why Should Manufacturers Want Fair Trade?", *Journal of Law & Economics*, Vol.3, pp.86-105.

Utaka, A. (2003), "An Economic Analysis of Japanese Distribution Systems", *Manegerial and Decision Economics*, Vol.24, pp.411-416.

Table 1

j / i	M	RF
M	$(E\pi^{M}, E\pi^{M})$	$(E\pi^{AM}, E\pi^{ARF})$
RF	$(E\pi^{ARF}, E\pi^{AM})$	$(E\pi^{RF}, E\pi^{RF})$

- We denote by M and R the case that manufacturer and retailer decide the retail price, respectively.
- The superscript A implies the asymmetric case.
- The superscript F implies the producer charges franchise fee to its retailer.

Table 2

j / i	M	RF
M	$(E\pi^{M}, E\pi^{M})$	$(E\pi^{AM}, E\pi^{ARF})$
RF	$(E\pi^{ARF}, E\pi^{AM})$	$(E\pi^{RF}, E\pi^{RF})$

- The superscript A implies the asymmetric case.

Table 3

j / i	M	R	RF
M	$(E\pi^{M}, E\pi^{M})$	$(E\pi^{\wedge M}, \pi^{\wedge R})$	$(E\pi^{AM}, E\pi^{ARF})$
R	$(\pi^{\wedge R}, E\pi^{\wedge M})$	$(E\pi^{R}, E\pi^{R})$	$(E\pi^{\#R}, E\pi^{\#RF})$
RF	$(E\pi^{ARF}, E\pi^{AM})$	$(E\pi^{\#RF}, E\pi^{\#R})$	$(E\pi^{RF}, E\pi^{RF})$

Table 4: Payoffs of the Augmented Game (b=1)

i \ j	M	R	RF
M	(a^2, a^2)	($9a^2/4$, $3a^2/4$)	($25a^2/16$, $9a^2/8+ \sigma^2/4$)
R	($3a^2/4$, $9a^2/4$)	($3a^2$, $3a^2$)	($75a^2/49$, $162a^2/49+\sigma^2$)
RF	($9a^2/8+\sigma^2/4$, $25a^2/16$)	($162a^2/49+\sigma^2$, $75a^2/49$)	($2a^2+\sigma^2$,$2a^2+\sigma^2$)

Figure 1. Efficient Decision on Retail Price from Social Welfare standpoint