Economics Bulletin

Volume 41, Issue 1

Positive Effects of Bundling on Rival's Profit and Social Welfare in a Vertical Relationship

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Abstract

The effects of bundling on the rival's profit and social welfare are analyzed in this paper. We consider a vertical relationship with an upstream firm offering inputs to two downstream firms. In the downstream market, one firm produces two products and can bundle them, while the other produces only one product. We find that bundling is preferred and can also increase the rival firm's profit and social welfare, which is in contrast to the conventional wisdom that profitable bundling never increases the profit of the rival and social welfare in a Cournot competition.

We are grateful to the editor and two anonymous referees for their comments, which greatly improved this paper. We gratefully acknowledge the financial support of the Japan Society for the Promotion of Science (JSPS), KAKENHI Grant Numbers JP16K17116, JP19K20899, JP17H00959, and JP19H01483. The usual disclaimer applies.

Citation: Qing Hu and Tomomichi Mizuno, (2021) "Positive Effects of Bundling on Rival's Profit and Social Welfare in a Vertical Relationship", *Economics Bulletin*, Vol. 41 No. 1 pp. 85-92
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Submitted: March 14, 2020. **Published:** March 10, 2021.

1. Introduction

Under Cournot competition, when the firm bundles its products, it increases the output in the oligopolistic market and thus harms the rivals' profits (Carbajo et al., 1990).[1] Since bundling has the potential to exclude the competitive rivals, it has attracted the attention of academics and regulators. Whinston (1990) suggests that bundling is profitable because it leads to the exclusion of the rival firm.[2] In Japan, Microsoft monopolizes the spreadsheet market (Excel) but competes with Ichitaro in the word processor market. Japan Fair Trade Commission recommended ceasing this Microsoft's bundling of Word and Excel in 1995 because this bundling is suspected as a behavior to exclude Ichitaro. This study also looks at the effect of bundling on the rivals and challenges the well-known result under Cournot competition by considering bundling in a vertically related market.

More formally, we consider a three-stage game in a vertical relationship with an upstream firm offering inputs to two downstream firms. In the downstream market, one firm produces two products and can bundle them, while the other produces only one product. In the first stage, the multiproduct downstream firm decides whether to bundle. In the second stage, the upstream firm sets the input prices. In the final stage, the downstream firms decide production quantities.

We find that profitable bundling may increase the rival's profits as well as social welfare. This is in contrast to the well-known harmful property of bundling on the rivals' profits under Cournot competition in non-vertical markets. The analysis of our model shows that if the output of the downstream bundling firm in the monopolistic market is small, the bundling reduces the firm's output in the duopolistic market. This is a negative effect of bundling on its own profit. Meanwhile, because of strategic substitutability, the downstream rival firm expands its output and profit, and the aggregate output decreases. The upstream firm has an incentive to choose a lower wholesale price

[1] Under Bertrand competition, an increase in the price of the bundling firm raises rivals' prices because of strategic complementarity. In the literature, bundling is considered profitable for rivals only under Bertrand competition (Carbajo et al., 1990; Rennhoff and Serfes, 2009; Chung et al., 2013).

[2] Nalebuff (2004) and Peitz (2008) consider the entry-deterrence effects of bundling. Although these studies relate to that of Whinston (1990), their models are quite different from ours.

for the bundling firm. The positive effect of the reduction in wholesale price may dominate the negative effect of the reduction in output for the bundling firm. Moreover, since a reduction of the wholesale price mitigates the double marginalization problem, bundling may also increase social welfare.

Some studies show that, even if its competitors are not excluded, a firm may have an incentive to bundle (Carbajo et al., 1990; Martin, 1999; Chung et al., 2013). In their models, bundling reduces the profits of competitors under Cournot competition, whereas bundling increases rival firms' profits under Bertrand competition. However, these studies do not consider vertical relationships and the marginal cost of bundling firm is exogenously given. However, we consider that the marginal cost of the bundling firm is endogenously decided.

Another related literature strand discusses the incentive to bundle in a vertical market structure. For example, Rennhoff and Serfes (2009) consider a market with two upstream and two downstream firms. The downstream firms compete in a circular city, à la Salop (1979), and choose their own prices. They show that bundling increases competitors' profits and reduces consumer surplus.[3] In their model, downstream firms produce differentiated products and compete in prices. Therefore, our results complement their study.

The remainder of the paper is organized as follows. Section 2 presents the model. Section 3 presents the analysis. Section 4 describes our main results. Section 5 concludes the study.

2. The Model

We consider a two-tier industry with one upstream and two downstream markets (M and D) where there are one upstream firm (U) and two downstream firms (F_1 and F_2). The upstream firm produces input with zero marginal cost and sells to the downstream firms at input prices w_i, $i = 1,2$. Product M (monopoly) is solely produced by F_1, while product D (duopoly) is produced

[3] Bakos and Brynjolfsson (2000) also consider a vertical market. However, their model is rather different from ours.

by both firms. To produce one unit of each final product, the downstream firms must buy one unit of input. The downstream firms incur no other costs except input price.

When F_1 sells its products, the firm can decide whether to bundle them. When F_1 does not bundle the products, it freely chooses quantities q_{M1} and q_{D1} for the sale of products M and D, respectively; F_2 chooses q_{D2} for the sale of product D. Therefore, the aggregate sales of products M and D are $Q_M = q_{M1}$ and $Q_D = q_{D1} + q_{D2}$, respectively. For simplicity, we assume the two products M and D are independent.[4] The utility maximization problem of the representative consumer without bundling is given as:

$$\max_{Q_M, Q_D} \; aQ_M - \frac{k}{2}Q_M^2 + Q_D - \frac{1}{2}Q_D^2 - p_M Q_M - p_D Q_D,$$

where p_i denotes the price of product $i = M, D$. Then, the inverse demand functions are $p_M = a - kQ_M = a - kq_{M1}$ and $p_D = 1 - Q_D = 1 - (q_{D1} + q_{D2})$.

On the other hand, when F_1 decides to bundle, it chooses the sale quantity for the bundle $b_1(= q_{M1} = q_{D1})$, while F_2 sets its sales as $b_2(= q_{D2})$. Therefore, the aggregate sales are $Q_M = b_1$ and $Q_D = b_1 + b_2$. For bundling, when the representative consumer buys b_1 units of the bundled products, she consumes b_1 units of each product. Then, the maximization problem with bundling becomes:

$$\max_{b_1, b_2} \;\; ab_1 - \frac{k}{2}b_1^2 + (b_1 + b_2) - \frac{1}{2}(b_1 + b_2)^2 - p_1 b_1 - p_2 b_2,$$

where p_i denotes the price of the product sold by firm F_i $(i = 1,2)$. Then, the inverse demand function of the bundled product is $p_1 = (a - kb_1) + (1 - b_1 - b_2)$ and the inverse demand of firm F_2's product is $p_2 = 1 - b_1 - b_2$.[5]

In the above setting, the profit of each downstream firm is:

$$\pi_1 = \begin{cases} (a - kb_1)b_1 + (1 - b_1 - b_2)b_1 - 2w_1 b_1 & \text{if } F_1 \text{ bundles its products,} \\ (a - kq_{M1})q_{M1} + (1 - q_{D1} - q_{D2})q_{D1} - w_1(q_{D1} + q_{D2}) & \text{otherwise,} \end{cases}$$

[4] Even if the products are not independent, we can obtain similar results when the products are sufficiently differentiated. However, numerical calculations are needed to demonstrate the results.

[5] This formulation is similar to those of Martin (1999) and Hinloopen et al. (2014).

$$\pi_2 = \begin{cases} (1 - b_1 - b_2)b_2 - w_2 b_2 & \text{if } F_1 \text{ bundles its products,} \\ (1 - q_{D1} - q_{D2})q_{D2} - w_2 q_{D2} & \text{otherwise.} \end{cases}$$

The profit of the upstream firm is:

$$\pi_U = \begin{cases} 2w_1 b_1 + w_2 b_2 & \text{if } F_1 \text{ bundles its products,} \\ w_1(q_{M1} + q_{D1}) + w_2 q_{D2} & \text{otherwise.} \end{cases}$$

Consumer surplus is given as:

$$CS = \begin{cases} \frac{1}{2} k b_1^2 + \frac{1}{2}(b_1 + b_2)^2 & \text{if } F_1 \text{ bundles its products,} \\ \frac{1}{2} k q_{M1}^2 + \frac{1}{2}(q_{D1} + q_{D2})^2 & \text{otherwise.} \end{cases}$$

The industry profit is given as $IP = \pi_U + \pi_1 + \pi_2$ and social welfare as $SW = CS + IP$.

We consider a three-stage game. In the first stage, F_1 decides whether to bundle. In the second stage, the upstream firm sets its input prices. In the final stage, the downstream firms decide production quantities. Using backward induction, we solve this game.

3. Analysis

3.1. Downstream competition and the "benchmark" outcomes without upstream markets

First, we consider the case without bundling. In the third stage, the maximization problems for the firms are as follows:

$$\max_{q_{M1}, q_{D1}} \; (a - kq_{M1})q_{M1} + (1 - q_{D1} - q_{D2})q_{D1} - w_1(q_{D1} + q_{D2}),$$

$$\max_{q_{D2}} \; (1 - q_{D1} - q_{D2})q_{D2} - w_2 q_{D2}.$$

Solving the above and we obtain the firms' outputs:

$$q_{M1}^N(w_1) = \frac{a - w_1}{2k}, \quad q_{D1}^N(w_1, w_2) = \frac{1 - 2w_1 + w_2}{3}, \quad q_{D2}^N(w_1, w_2) = \frac{1 + w_1 - 2w_2}{3},$$

where superscript N indicates the case without bundling.

Next, we consider the case with bundling. The firms face the following maximization problems:

$$\max_{b_1} \; (a - kb_1)b_1 + (1 - b_1 - b_2)b_1 - 2w_1 b_1,$$

$$\max_{b_2} \; (1 - b_1 - b_2)b_2 - w_2 b_2.$$

Solving the first-order conditions, we obtain the sales as:

$$b_1^B(w_1, w_2) = \frac{1 + 2a - 4w_1 + w_2}{3 + 4k}, \quad b_2^B(w_1, w_2) = \frac{1 - a + 2k + 2w_1 - 2(1 + k)w_2}{3 + 4k},$$

where superscript B indicates the case with bundling.

Here, we consider the case without the upstream market and assume that the equilibrium input price is zero. Then, substituting the above outcomes and $w_1 = w_2 = 0$ into the profits of firms F_1 and F_2 and social welfare, we have the outcomes without bundling:

$$\pi_1^N(0) = \frac{9a^2 + 4k}{36k}, \quad \pi_2^N(0) = \frac{1}{9}, \quad SW^N(0) = \frac{27a^2 + 32k}{72k}.$$

Similarly, the outcomes with bundling are:

$$\pi_1^B(0) = \frac{(1 + 2a)^2(1 + k)}{(3 + 4k)^2}, \quad \pi_2^B(0) = \frac{(1 - a + 2k)^2}{(3 + 4k)^2},$$

$$SW^B(0) = \frac{a^2(11 + 12k) + a(8 + 8k) + 12k^2 + 19k + 8}{2(3 + 4k)^2}.$$

First, comparing the outcomes with and without bundling, we have a condition for profitable bundling.

$$\pi_1^B(0) - \pi_1^N(0) = \frac{(2k - 3a)[3a(9 + 8k) - 2k(15 + 16k)]}{36k(3 + 4k)^2} \geq 0.$$

Solving the above equation for a, we have

$$\frac{2k}{3} \leq a \leq \frac{2k(16k + 15)}{3(8k + 9)}.$$

Next, we consider the effect of bundling on the rival firm's profit. The condition for a positive effect on the rival firm's profit is

$$\pi_2^B(0) - \pi_2^N(0) = \frac{(3a - 10k - 6)(3a - 2k)}{9(3 + 4k)^2} > 0.$$

Solving it for a, we have

$$a < \frac{2k}{3} \quad \text{or} \quad a > \frac{6 + 10k}{3}.$$

Finally, we consider the condition where bundling increases social welfare.

$$SW^B(0) - SW^N(0) = \frac{(2k - 3a)[a(81 + 84k) - 2k(21 + 20k)]}{72k(3 + 4k)^2} > 0.$$

Solving the above equation for a, we have

$$\frac{(42+40k)k}{81+84k} < a < \frac{2k}{3}.$$

Therefore, from these inequalities, we have the following result.

Result 1. *In a non-vertical market, the condition for profitable bundling is* $2k/3 \leq a \leq k(32k+30)/(24k+27)$. *Profitable bundling never increases the rival firm's profit and social welfare.*

Proof.

We can easily show the following.

$$\frac{6+10k}{3} - \frac{2k(16k+15)}{3(8k+9)} = \frac{2(8k^2+18k+9)}{9+8k} > 0.$$

Then, we obtain the result. ■

The intuition behind this result is as follows. When a firm bundles its products, equilibrium sales in the monopoly market must be different from that before bundling. Thus, the bundling firm loses a part of the profit in the monopoly market. If bundling brings positive effects on the firm, the profit in the other market where the firm competes with a rival firm must increase. Since bundling alters the maximization problem for the bundling firm, the best response will shift. When bundling involves a commitment of aggressive behavior, the bundling firm will achieve a profitable shift of best response. For the bundling firm, one of the profitable shifts of best response yields the Stackelberg outcome in a duopolistic market. However, if bundling deviates equilibrium outcomes away from the Stackelberg outcome, then bundling is not profitable. Therefore, there exists intermediate parameter ranges such that bundling becomes profitable.

Next, we consider the effect of bundling on the rival firm's profit. Since we assume Cournot competition, a commitment of aggressive behavior by the bundling firm always reduces the rival firm's sales and consequently its profit. However, in order to bring some gain to the rival firm, the commitment must lead to less aggressive behavior of the bundling firm. Therefore, when a firm has an incentive to bundle, the rival firm's profit must decrease.

Finally, we explain the effects of bundling on social welfare. When bundling yields aggressive behavior of the bundling firm, the sales in the monopolistic market must be larger than that in the duopolistic market before bundling. This is because bundling eliminates the difference of sales in the two markets. Then, profitable bundling decreases the sales in the monopolistic market. Thus, the welfare loss in the monopolistic market comes from insufficient sales in the market. On the other hand, since the aggressive behavior of the bundling firm raises the aggregate sales in the duopolistic market, welfare in this market increases. In our model, the welfare loss in the monopolistic market dominates the welfare gain in the duopolistic market. Therefore, profitable bundling reduces social welfare.

3.2. Decision on input price

In the second stage, the upstream firm sets its input price. First, we consider the case without bundling. Then the maximization problem for the upstream firm without bundling is as follows:

$$\max_{w_1,w_2} \; w_1[q_{M1}^N(w_1) + q_{D1}^N(w_1,w_2)] + w_2 q_{D2}^N(w_1,w_2).$$

Then, we have the following outcomes in this stage:

$$w_1^N = \frac{a+k}{2(1+k)}, \;\; w_2^N = \frac{1+a+2k}{4(1+k)}.$$

The outcomes of this subgame are as follows:

$$\pi_1^N = \frac{9a^2(1+4k) - 48ak + k(25+4k)}{144k(1+k)}, \;\; \pi_2^N = \frac{1}{36}, \;\; \pi_U^N = \frac{3a^2 + 6ak + k + 4k^2}{24k(1+k)},$$

$$SW^N = \frac{9a^2(7+12k) - 84ak + k(119+80k)}{288k(1+k)}.$$

Next, we consider the case with bundling. The maximization problem for the upstream firm in the bundling case is as follows:

$$\max_{w_1,w_2} \; 2w_1 b_1^B(w_1,w_2) + w_2 b_2^B(w_1,w_2).$$

From the first-order condition, we have:

$$w_1^B = \frac{1+a}{4}, \;\; w_2^B = \frac{1}{2}.$$

The outcomes in this subgame are as follows:

$$\pi_1^B = \frac{(1+2a)^2(1+k)}{4(3+4k)^2}, \quad \pi_2^B = \frac{(-1+a-2k)^2}{4(3+4k)^2}, \quad \pi_U^B = \frac{1+a+a^2+k}{2(3+4k)},$$

$$SW^B = \frac{20+47k+28k^2+4a(5+6k)+a^2(23+28k)}{8(3+4k)^2}.$$

3.3. Decision on bundling

Bundling incentive is characterized as follows:

$$\pi_1^B - \pi_1^N = \Phi_2(k)a^2 + \Phi_1(k)a + \Phi_0(k) \geq 0,$$

where

$$\Phi_2(k) = -\frac{9+44k+80k^2+48k^3}{16k(1+k)(3+4k)^2}, \Phi_1(k) = \frac{12+30k+19k^2}{3(1+k)(3+4k)^2},$$

$$\Phi_0(k) = -\frac{189+564k+460k^2+64k^3}{144(1+k)(3+4k)^2}.$$

Note that, $\Phi_2(k) < 0$, $\Phi_1(k) > 0$, and $\Phi_0(k) < 0$. Solving $\pi_1^B - \pi_1^N \geq 0$, we have the following proposition.

Proposition 1. *Downstream firm F_1 decides to bundle its products if the following conditions are satisfied:*

$$1.52336 \geq k \geq 0.64456 \quad and$$

$$\frac{\Phi_1(k) - \sqrt{[\Phi_1(k)]^2 - 4\Phi_2(k)\Phi_0(k)}}{-2\Phi_2(k)} \leq a \leq \frac{\Phi_1(k) + \sqrt{[\Phi_1(k)]^2 - 4\Phi_2(k)\Phi_0(k)}}{-2\Phi_2(k)}. \#(1)$$

Proof. See Appendix.

Since the firm has an incentive to bundle when the parameters are in the intermediate ranges, the intuition is the same as Result 1.

4. Effects of bundling

Next, we consider the effects of bundling on the rival firm's profit and social welfare. We calculate the signs of $\pi_2^B - \pi_2^N$ and $SW^B - SW^N$ in the region where the incentive for bundling is satisfied. With parameters (k, a), which satisfy (1) in Proposition 1, solving $\pi_2^B - \pi_2^N > 0$ for a yields:

$$\boldsymbol{a < \frac{2k}{3}. \#(2)}$$

Similarly, with parameters (k, a), which satisfy (1) in Proposition 1, solving $SW^B - SW^N = \Omega_2(k)a^2 + \Omega_1(k)a + \Omega_0(k) > 0$ for a, we have:

$$1.293 \le k \le 1.679 \quad and$$
$$\frac{\Omega_1(k) - \sqrt{[\Omega_1(k)]^2 - 4\Omega_2(k)\Omega_0(k)}}{-2\Omega_2(k)} < a < \frac{\Omega_1(k) + \sqrt{[\Omega_1(k)]^2 - 4\Omega_2(k)\Omega_0(k)}}{-2\Omega_2(k)}, \#(3)$$

where

$$\Omega_2(k) = -\frac{63 + 184k + 196k^2 + 80k^3}{32k(1+k)(3+4k)^2}, \qquad \Omega_1(k) = \frac{123 + 300k + 184k^2}{24(1+k)(3+4k)^2},$$
$$\Omega_0(k) = -\frac{351 + 1164k + 1124k^2 + 272k^3}{288(1+k)(3+4k)^2}.$$

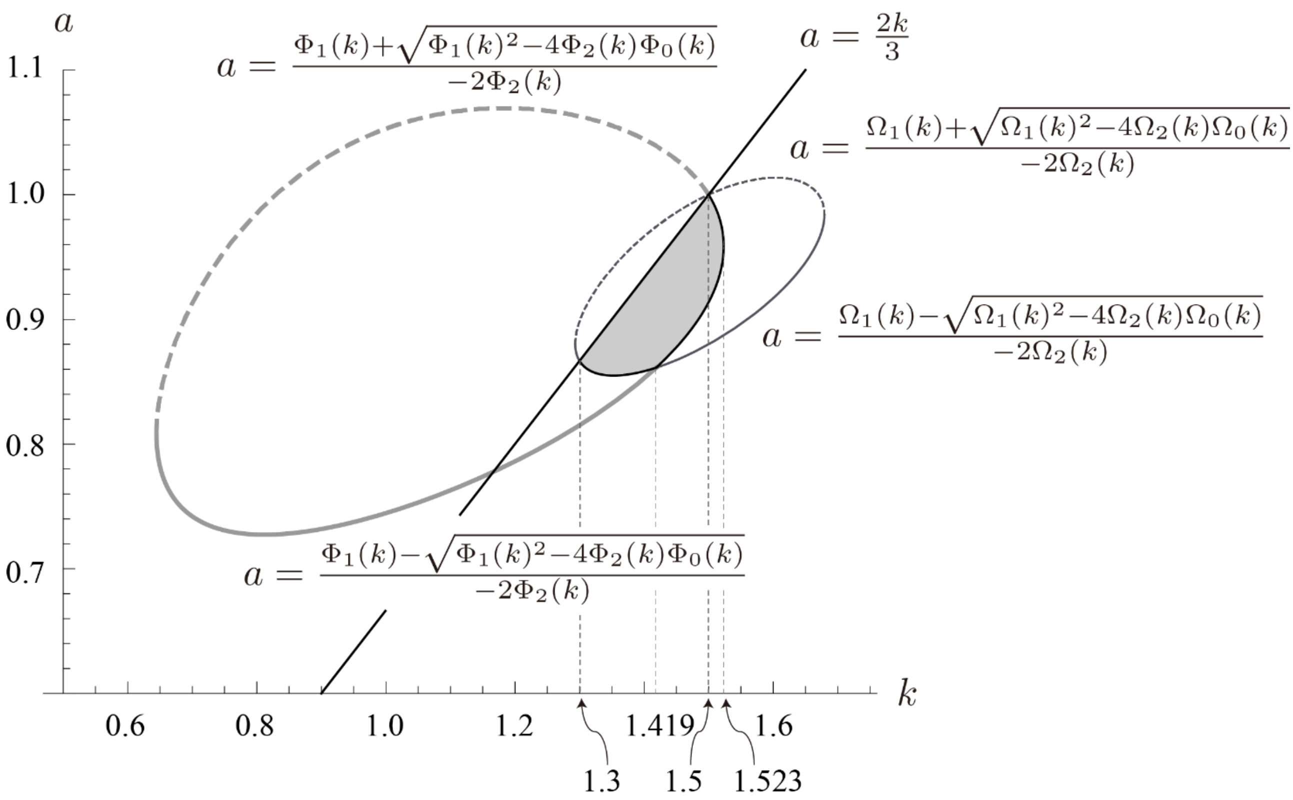
Comparing (1), (2), and (3), we obtain the following proposition.

Proposition 2. *When downstream firm F_1 has an incentive to bundle its products, the bundling increases the rival firm's profit and social welfare if*

$$\frac{\Omega_1(k) - \sqrt{[\Omega_1(k)]^2 - 4\Omega_2(k)\Omega_0(k)}}{-2\Omega_2(k)} < a < \frac{2k}{3} \quad for \quad k \in [1.3, 1.419],$$
$$\frac{\Phi_1(k) - \sqrt{[\Phi_1(k)]^2 - 4\Phi_2(k)\Phi_0(k)}}{-2\Phi_2(k)} < a < \frac{2k}{3} \quad for \quad k \in [1.419, 1.5],$$
$$\frac{\Phi_1(k) - \sqrt{[\Phi_1(k)]^2 - 4\Phi_2(k)\Phi_0(k)}}{-2\Phi_2(k)} < a < \frac{\Phi_1(k) + \sqrt{[\Phi_1(k)]^2 - 4\Phi_2(k)\Phi_0(k)}}{-2\Phi_2(k)} \quad for \quad k \in [1.5, 1.523].$$

We depict the condition for this proposition in Figure 1. In the shadowed area, profitable bundling increases the rival's profit and social welfare. With a moderate range of parameters, our main result holds.

Figure 1. Positive effect of profitable bundling on rival firm's profit and social welfare.



In order to clearly explain the intuition behind this proposition, we raise an example by substituting $a = 0.9$ and $k = 1.4$ into the equilibrium outcomes and consider how the equilibrium outcomes are changed by bundling. Then, we have

$$\pi_1^B - \pi_1^N|_{a=0.9,k=1.4} \approx 0.00062, \qquad \pi_2^B - \pi_2^N|_{a=0.9,k=1.4} \approx 0.00065,$$

$$SW^{Bc} - SW^{Nc}|_{a=0.9,k=1.4} \approx 0.00032.$$

$$b_1^B - q_{M1}^N|_{a=0.9,k=1.4} \approx 0.012, \qquad b_1^B - q_{D1}^N|_{a=0.9,k=1.4} \approx -0.014,$$

$$b_2^B - q_{D2}^N|_{a=0.9,k=1.4} \approx 0.0019,$$

$$w_1^B - w_1^N|_{a=0.9,k=1.4} \approx -0.0042, \qquad w_2^B - w_2^N|_{a=0.9,k=1.4} \approx 0.010,$$

$$p_M^B - p_M^N|_{a=0.9,k=1.4} \approx -0.017, \qquad p_D^B - p_D^N|_{a=0.9,k=1.4} \approx 0.012.$$

The intuition behind this proposition is as follows. When bundling increases the rival firm's profit, the bundling firm must have a less aggressive behavior in the duopolistic market. Then, we have $b_1^B - q_{D1}^N < 0$. On the other hand, bundling leads to excess production in the monopolistic market $(b_1^B - q_{M1}^N > 0)$. The less aggressive behavior in the duopolistic market and the excess production in the monopolistic market tend to reduce the profit of the bundling firm and increase those of the rival firm $(\pi_2^B - \pi_2^N > 0)$. Because the upstream firm tends to adjust the competitiveness between the downstream firms, it has the incentive to decrease the marginal cost of the bundling firm and increase that of the rival. Hence, the input price of the bundling firm decreases $(w_1^B - w_1^N < 0)$ and that of the rival firm increases $(w_2^B - w_2^N > 0)$. If the effect of input price changes dominates the effect of profit loss due to the less aggressive behavior of the bundling firm, bundling increases its profit $(\pi_1^B - \pi_1^N > 0)$. Moreover, since the bundling firm produces in both markets, the total sales of the firm are larger than that of its rival. Therefore, the welfare-enhancing effect due to decreasing the input price of the bundling firm dominates the welfare-reducing effect from increasing the rival firm's input price. Hence, bundling may increase social welfare.

When the competition authorities challenge bundling, our results can be applied. When we consider bundling in a vertical market and the marginal cost is endogenously decided, bundling may benefit rival's profit as well as the social welfare.

5. Conclusions

We show that profitable bundling may increase the rival firm's profit and social welfare, which is in contrast to the conventional wisdom that bundling always decreases the rival's profit and social welfare. Our results depend on the size of the monopolistic market. We show that bundling may reduce the marginal cost of the bundling firm by considering an upstream firm, which mitigates double marginalization problem, and thus also increases social welfare.

Proof of Proposition 1

In order to guarantee a solution for the equation $\pi_1^B - \pi_1^N = \Phi_2(k)a^2 + \Phi_1(k)a + \Phi_0(k) = 0$, we consider the discriminant $[\Phi_1(k)]^2 - 4\Phi_2(k)\Phi_0(k)$. Numerically solving the condition where the discriminant is non-negative, we have $1.52336 \geq k \geq 0.64456$. Since $\Phi_2(k)$, the coefficient of a^2 is negative and firm F_1 has no incentive to bundle for the case where the discriminant is negative: $k > 1.52336$ or $k < 0.64456$.

Since for the case with $1.52336 \geq k \geq 0.64456$, the discriminant has a non-negative value, solving $\pi_1^B - \pi_1^N = \Phi_2(k)a^2 + \Phi_1(k)a + \Phi_0(k) \geq 0$ for a, we obtain the following condition for bundling.

$$\frac{-\Phi_1(k) + \sqrt{[\Phi_1(k)]^2 - 4\Phi_2(k)\Phi_0(k)}}{2\Phi_2^c(k)} \geq a \geq \frac{-\Phi_1(k) - \sqrt{[\Phi_1(k)]^2 - 4\Phi_2(k)\Phi_0(k)}}{2\Phi_2^c(k)}.$$

Then, we obtain this proposition.■

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