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 rivals' profits (Carbajo et al., 1990).[1] Since bundling has the potential to exclude competitive rivals, it has attracted the attention of academics and regulators. For instance, On February 27th, 2020, the Japan Times reported that "the Japan Fair Trade Commission on Thursday has asked drug store chain operators not to bundle face masks together with expensive products." The characteristics of this reported situation are as follows. First, only drug stores that obtain masks, which became scarce due to COVID-19, are able to bundle masks with their products, for example, the second- or third-class OTC drugs, which include expensive energy drinks.[2] Second, to buy two or more masks, consumers must buy the same number of bundled products. Third, since it was impossible to increase the production of masks, the mask price was determined according to the number of masks owned by the drug stores. Finally, consumers were willing to buy more than one mask. Therefore, this situation is suitable to assume Cournot competition with bundling products.[3]

This study investigates the effect of bundling on 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 found that profitable bundling may increase rivals' profits as well as social welfare. This is in contrast to the well-known harmful effect of bundling on 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, 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 for the bundling firm. The positive effect of the reduction in the wholesale price may dominate the negative effect of the reduction in output for the bundling firm. Moreover, since a reduction in the wholesale price mitigates the double

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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 In Japan, resale of the second- and third-class OTC drugs is banned. In the first half of 2020, resale of masks was also banned.

3 Bakos and Brynjolfsson (2000), Nalebuff (2004), Peitz (2008), and Whinston (1990) analyze the anti-competitive effects of bundling. The major difference between their studies and ours is that in their studies, consumers buy at most one unit of goods, while in our study, consumers buy two or more units of goods.

marginalization problem, bundling may also increase social welfare.

Many studies show that bundling is profitable (e.g., Adams and Yellen, 1976; McAfee et al., 1989). In addition, some studies analyze the effects of profitable bundling on competitors' profits. Carbajo et al. (1990), Martin (1999), and Chung et al. (2013) show that profitable bundling reduces (or increases) the profits of competitors under Cournot (or Bertrand) competition. However, these studies do not consider vertical relationships, and the marginal cost of the bundling firm is exogenously given. In addition, 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. 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 costs 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 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 the 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 that the two products M and D are independent.[4] The utility function for the representative consumer is $U = aQ_M - kQ_M^2/2 + Q_D - Q_D^2/2 - p_M Q_M - p_D Q_D$, 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 $Q_D = b_1 + b_2$. Since we assume a representative consumer, we do not need to consider that the consumer splits into components and resales them.[5] Under bundling, when

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 Even if we assume that there are many consumers, some products satisfy the assumption for resale

the representative consumer buys b_1 units of the bundled products, she consumes b_1 units of each product. This assumption means $b_1 = q_{M1} = q_{D1}$. More generally, we can assume $b_1 = q_{M1} = tq_{D1}$, where t is a positive value. However, the assumption $t = 1$ provides significantly simple analysis.[6] Hence, we employ the assumption $b_1 = q_{M1} = q_{D1}$. In addition, previous studies (Martin, 1999; Chung et al., 2013) that consider Cournot competition also use this assumption.

Denoting the price of the firm F_i's product under bundling by p_i $(i = 1,2)$ and solving the utility maximization problem, we obtain that 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 $p_2 = 1 - b_1 - b_2$.[7]

In the above setting, the profits of downstream firms are

$$\pi_1 = (a - kq_{M1})q_{M1} + (1 - q_{D1} - q_{D2})q_{D1} - w_1(q_{D1} + q_{D2}),$$

$$\pi_2 = (1 - q_{D1} - q_{D2})q_{D2} - w_2 q_{D2}, \qquad \pi_U = w_1(q_{M1} + q_{D1}) + w_2 q_{D2},$$

where if F_1 decides to bundle, we assume $b_1 = q_{M1} = q_{D1}$ and $b_2 = q_{D2}$. Consumer surplus, industry profit, and social welfare are given as $CS = kq_{M1}^2/2 + (q_{D1} + q_{D2})^2/2$, $IP = \pi_U + \pi_1 + \pi_2$, and $SW = CS + IP$, respectively.

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. Outcomes in the second and third stages

First, we consider the case without bundling. In the third stage, the first-order conditions lead to firms' outputs:

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

where superscript N indicates the case without bundling.

Next, solving the first-order conditions in the case with bundling, we obtain the sales as

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

where superscript B indicates the case with bundling.

Here, we consider profitability and the welfare effect of bundling when there is no upstream firm. We substitute the above outcomes and $w_1 = w_2 = 0$ into the profits of downstream firms and social welfare and compare them in the cases with and without bundling. Then, we find that profitable bundling never increases competitors' profit and

banning. As mentioned in the Introduction, resale of masks and second-class OTC drugs is not allowed in Japan.

[6] Moreover, given the bundling decision, since the profits of all firms are continuous for t, our analysis is robust around $t = 1$.

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

social welfare. This is a well-known result in the literature.

In the second stage, the upstream firm sets its input price. For the case without bundling, substituting (1) into the profit of the upstream firm and solving the first-order conditions, we get the following outcomes:

$$w_1^N = \frac{a+k}{2(1+k)},\ \ w_2^N = \frac{1+a+2k}{4(1+k)},\qquad \pi_1^N = \frac{9a^2(1+4k)-48ak+k(25+4k)}{144k(1+k)},$$

$$\pi_2^N = \frac{1}{36}, \pi_U^N = \frac{3a^2+6ak+k+4k^2}{24k(1+k)}, SW^N = \frac{9a^2(7+12k)-84ak+k(119+80k)}{288k(1+k)}.$$

Next, we consider the case with bundling. Substituting (2) into the profit of the upstream firm and solving the first-order conditions, we obtain the input prices and outcomes:

$$w_1^B = \frac{1+a}{4},\ \ w_2^B = \frac{1}{2},\qquad \pi_1^B = \frac{(1+2a)^2(1+k)}{4(3+4k)^2},\ \ \pi_2^B = \frac{(-1+a-2k)^2}{4(3+4k)^2},$$

$$\pi_U^B = \frac{1+a+a^2+k}{2(3+4k)},\qquad SW^B = \frac{20+47k+28k^2+4a(5+6k)+a^2(23+28k)}{8(3+4k)^2}.$$

3.2. Decision on bundling

Bundling incentive is characterized as $\pi_1^B - \pi_1^N = \Phi_2(k)a^2 + \Phi_1(k)a + \Phi_0(k) \geq 0$, where

$$\Phi_2(k) = -\frac{9+44k+80k^2+48k^3}{[16k(1+k)(3+4k)^2]} < 0,$$

$$\Phi_1(k) = \frac{12+30k+19k^2}{[3(1+k)(3+4k)^2]} > 0,\qquad \Phi_0(k) = -\frac{189+564k+460k^2+64k^3}{[144(1+k)(3+4k)^2]} < 0.$$

Solving $\pi_1^B - \pi_1^N \geq 0$, we have the following proposition. Note that we will explain the intuition behind the result after the next proposition is presented.

Proposition 1. *Downstream firm F_1 decides to bundle its products if* $1.52336 \geq k \geq 0.64456$ *and*

$$\frac{\Phi_1(k) - \sqrt{[\Phi_1(k)]^2 - 4\Phi_2(k)\Phi_0(k)}}{-2\Phi_2(k)} \leq a \leq \frac{\Phi_1(k) + \sqrt{[\Phi_1(k)]^2 - 4\Phi_2(k)\Phi_0(k)}}{-2\Phi_2(k)}. \#(3)$$

Proof. See Appendix.

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

$$a < \frac{2k}{3}. \#(4)$$

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

$$1.293 \le k \le 1.679 \quad and$$
$$\frac{\Omega_1(k) - \sqrt{[\Omega_1(k)]^2 - 4\Omega_2(k)\Omega_0(k)}}{-2\Omega_2(k)} < a < \frac{\Omega_1(k) + \sqrt{[\Omega_1(k)]^2 - 4\Omega_2(k)\Omega_0(k)}}{-2\Omega_2(k)}, \#(5)$$
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 (3), (4), and (5), we obtain the following proposition.

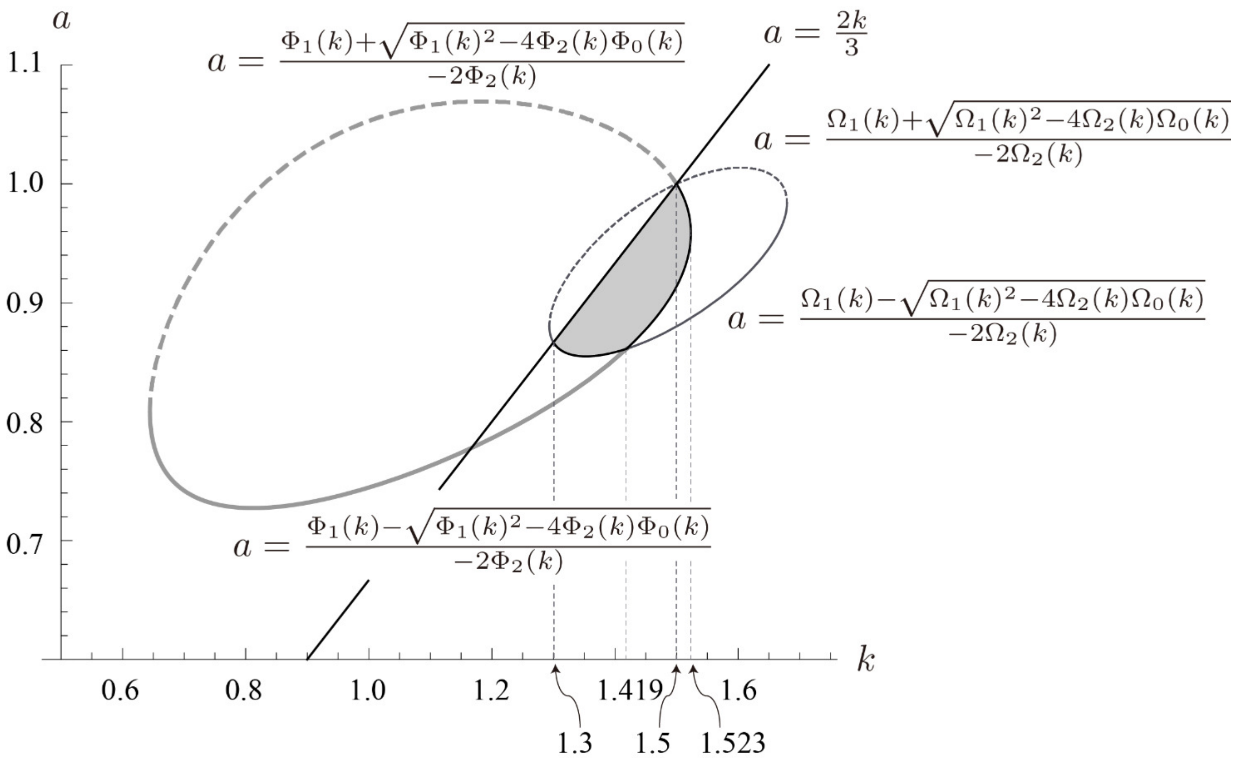
Proposition 2. *When downstream firm* F_1 *has an incentive to bundle its products, bundling increases the rival firm's profit and social welfare if*
$$\frac{\Omega_1(k) - \sqrt{[\Omega_1(k)]^2 - 4\Omega_2(k)\Omega_0(k)}}{-2\Omega_2(k)} < a < \frac{2k}{3} \quad for \quad k \in [1.3, 1.419],$$
$$\frac{\Phi_1(k) - \sqrt{[\Phi_1(k)]^2 - 4\Phi_2(k)\Phi_0(k)}}{-2\Phi_2(k)} < a < \frac{2k}{3} \quad for \quad k \in [1.419, 1.5],$$
$$\frac{\Phi_1(k) - \sqrt{[\Phi_1(k)]^2 - 4\Phi_2(k)\Phi_0(k)}}{-2\Phi_2(k)} < a < \frac{\Phi_1(k) + \sqrt{[\Phi_1(k)]^2 - 4\Phi_2(k)\Phi_0(k)}}{-2\Phi_2(k)} \quad for \quad k \in [1.5, 1.523].$$

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.

In order to clearly explain the intuition behind this proposition, we provide 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 intuitions behind Propositions 1 and 2 are 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 profits of the bundling firm and increase those of the rival firm $(\pi_2^B - \pi_2^N > 0)$.

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



Because the upstream firm tends to adjust 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 $(w_2^B - w_2^N > 0)$.

From the above discussion, if bundling increases both downstream firms' profits, the input price reduction effect for downstream firm F_1 (or the output expansion effect for downstream firm F_2) must dominate the output reduction effect for F_1 (or the input price increasing effect for F_2). This situation occurs if the slope of the inverse demand in market M, k, takes an intermediate value. With large k, bundling provides large reduction in F_1's output, which leads to a small demand for upstream firm U. Then, U must slightly increase w_2. In this case, the output expansion effect for F_2 dominates the input price increasing effect. With small k, bundling leads to large output for F_1, and the output reduction effect for F_1 is dominated by the effect of the reduction in the input price. Therefore, bundling is profitable for both downstream firms if k takes an intermediate value.

Moreover, since the bundling firm produces in both markets, the total sales of the firm are larger than those of its rival. Therefore, the welfare-enhancing effect due to decreasing the input price of the bundling firm dominates the welfare-reducing effect due to increasing the rival firm's input price. Hence, bundling may increase social welfare.

We assume a take-it-or-leave-it offer for the contract of input prices. If the assumption is relaxed, our results would be less plausible. To obtain our results, input price changes due to bundling are important. Note that, without an upstream firm, we cannot obtain our main result (Proposition 2). If downstream firms have some bargaining power, the input price change becomes small. Hence, our model is close to a model without an upstream firm. Therefore, we expect that the conditions for the main results to hold are more stringent.

Finally, our results are useful for competition policies. One of the necessary conditions for profitable and welfare-increasing bundling is that a monopoly market must be small. Hence, a competition authority should not allow bundling if a monopoly market is relatively large. In addition, if the monopoly market is small, social welfare may increase with bundling. Therefore, a competition authority needs to investigate the extent to which the prices of inputs change.

5. Conclusions

We showed 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 under Cournot competition. Our results depend on the size of the monopolistic market. We showed that bundling may reduce the marginal cost of the bundling firm by considering an upstream firm, which mitigates the double marginalization problem and thus 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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