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Bundling under Vertical Product Differentiation

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Abstract

This paper builds up a two-firm, two-product model, in order to analyze the effects of bundling on the competitor’s profit, consumer surplus, and social welfare, when the bundler is a high- or low-quality firm. There are firms A and B as well as independent products 1 and 2 in the market. Product 1 as the monopoly good is produced only by firm A, while vertically differentiated products 2 as the competing goods are produced by both firms A and B. The findings of this paper are as follows: When the bundling firm produces the high-quality competing product, bundling will reduce the consumer surplus while may increase the competitor’s profit and social welfare. On the contrary, when the bundling firm produces the low-quality competing good, then bundling has a foreclosure effect, making the market structure turn from a duopoly to a monopoly, hence decreasing the competitor’s profit, consumer surplus, and social welfare.

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1. Introduction

The antitrust divisions all over the world concern the adverse effects of bundling on fair competition, consumer surplus, and social welfare. However, the consumers evaluate the product and service quality levels of different firms differently. The welfare effects of bundling under homogeneous product competition may not apply to those of bundling under vertically differentiated product competition.

Take the bundling sales of the Total Petroleum Company as an example: The VAB Company in Belgium accused the Total Company as a leading firm in oil markets of bundling gasoline products and road emergency rescue service, hence violating the law of Belgium to prohibit bundled sales. Belgian laws consider bundling
as a measure damaging consumer surplus and violating competition principles. However, on April 23, 2009, the European Court found that Belgium’s prohibition of bundling being against the EU law and competition mechanism of the free market, and hence European Court was against any uniform regulation of any member country on any bundled product sales (van Engelen, 2010).

The trustbuster divisions all over the world concern the adverse effects of bundling on fair competition, consumer surplus, and social welfare. However, the consumers evaluate the product and service quality levels of different firms differently. The welfare effects of bundling under homogeneous product competition may not apply to those of bundling under vertically differentiated product competition. Therefore, this paper will analyze the effects of bundling on the competitor’s profit, consumer surplus, and social welfare under vertically differentiated product competition. Moreover, antitrust policy implications will also be derived and discussed.

Early literature mainly discusses the bundling behavior of a monopoly, including Adams and Yellen, 1976, Telser, 1979, Pierce and Winter, 1996, etc. The motivation for a monopoly to bundle consists of price differentiation in order to exploit consumer surplus and hence increase its own profit. Later a lot of economists relax the assumption on market structure and explore the incentive to bundle and its welfare effects. They usually assume two kinds of products: One product market is a monopoly while the other is a duopoly - for example, Carbajo et al., 1990, Whinston, 1990, Martin, 1999, Choi, 2004, and Peitz, 2008. The motivations of bundling include enhancing product differentiation, entry deterrence, monopoly power extension, and reduction in the competitor’s R&D level.

More recent literature has incorporated vertically differentiated products with different quality levels into the bundling model, such as Diallo, 2006, Kovac, 2007, Gilbert and Riordan, 2007, Kramer, 2009, Banciu et al., 2010, Brito and Vasconcelos, 2011, and Avenali et al., 2011. Gilbert and Riordan, 2007 establish a two-firm, two-system-product model. They assume identical consumer preferences toward quality levels. The vertically integrated firm is a monopoly of a factor for the system product and its competitor has to buy this monopolized factor from it. These two firms engage in R&D to improve the quality levels. The vertically integrated firm decides whether or not to bundle. This paper assumes that a bundling can lower the competitor’s quality level. As a result, bundling system products will induce the competitor to exit the market, reduce the consumer surplus as well as social welfare.

Kramer, 2009 assumes that consumers have different preferences toward quality of same product, the monopoly as well as competing good markets can both be uncovered in equilibrium, and two firms decide their own quality sequentially. He finds that if the sum of quality levels provided by the bundling firm is greater than the quality of its competitor’s product, the bundling will promote the quality of the bundling firm while lower the quality of its competitor; otherwise, there is no equilibrium quality under bundling while the bundling firm has an incentive to produce high quality products.

This paper will adopt a two-firm model with vertical product differentiation in which the two firms engage in price competition in product 2, in order to analyze the effects of bundling on the competitor’s profit, consumer surplus, and social welfare. The bundling discussed in this paper is a tool to extend the monopoly power from one market to another, which is different from those to strategically reduce the competitor’s quality such as Gilbert and Riordan, 2007. This paper finds that when the bundling firm is the high quality firm, bundling will reduce the consumer surplus while may increase the competitor’s profit as well as the social welfare. Our result is different from Gilbert and Riordan, 2007. When the bundling firm is a low quality firm, bundling will compel the competitor to exit the market and turn the market structure from a duopoly to a monopoly, making the competitor’s profit, consumer surplus, and social welfare all drop.

This paper is organized as follows: Following this introduction, Section 2 is the basic model which discussed the market demand functions for high- and low-quality goods without or with bundling, when products 1 and 2 are independent. Sections 3 and 4 analyze, respectively, the effects of bundling on profits,
consumer surplus, and social welfare when the bundling firm produces high- or low-quality good. Section 5 concludes this paper.

2. The Basic Model

There are two firms (firms A and B) and two products (products 1 and 2) in this model. Product 1 is a monopoly good which is produced only by firm A. Products 2 are vertically differentiated goods which are produced by both firms A and B. Products 1 and 2 are mutually independent. Firm A can extend its monopoly power from product 1 to product 2 via bundling products 1 and 2. In order to simplify the analysis without losing generality, we assume that at bundling one unit of product 1 is tied to one unit of product 2.

Consumers are uniformly distributed in a linear interval [0,1] with a length of one. All consumers can choose whether or not to buy exactly one unit of each kind of product and hence markets of product 1 and 2 can both be uncovered in equilibrium. The basic utility obtained by buying one unit of any product is $v$. The market product 1 is monopolized by firm A and the net utility of a representative consumer from buying one unit of product 1 is $1 + 1 \cdot v \cdot q \cdot p \cdot T$, where $q$ and $p$ are the quality and price of product 1, respectively. From the net utility of consuming one unit of product 1, we know that the marginal consumer is located at $x = 1 - q / \theta$. Hence the demand function for product 1 is $x = 1 - q / \theta$.

Assume that firms A and B produce vertically differentiated products 2. The quality level of firm $i$’s product 2 is $q_{i2}$, $i = A, B$. Consumers have heterogeneous preferences toward the quality of product 2. Denote the preference level toward quality of a consumer by $\theta$ where $\theta$ is uniformly distributed over the interval [0,1]. We further assume that the net utility for a consumer to buy the product 2 from firm $i$ is $u_{i2} = v + \theta q_{i2} - p_{i2}$, $i = A, B$, where $p_{i2}$ is the price of product 2 produced by firm $i$. Using the net utility of buying one unit of product 2, we know that the marginal consumer who feels indifferent between buying or not buying product 2 from firm B (i.e., B2) is located at $\theta = (p_{B2} - v) / q_{B2}$. Similarly, the marginal consumer who feels indifferent between buying and not buying product 2 from firm A (i.e., A2) is located at $\theta = (p_{A2} - v) / q_{A2}$. In addition, the marginal consumer who feels indifferent between buying A2 or B2 is located at $\theta = (p_{A2} - p_{B2}) / (q_{A2} - q_{B2})$. Therefore, when firm A produces the high quality product 2, firms A’s and B’s demand functions in product 2 are, respectively, $x_H = 1 - \theta$ and $x_L = \theta - \theta_A$; otherwise, they will be, respectively, $x_H = 1 - \theta$ and $x_L = \theta - \theta_A$.

Moreover, in order to distinguish from the case without bundling, denote $\tilde{x}^H$ and $\tilde{x}^L$ as the quantities of high and low quality products and $\tilde{p}$ and $\tilde{p}_{B2}$ as the prices of bundled product and firm B’s product 2, respectively. The net utility for consumer $\theta$ to buy the bundled product is $\tilde{u} = 2v + \theta (q_{A2} + q_{B2}) - \tilde{p}$ while the net utility for her to buy product B2 is $\tilde{u}_B = v + \theta q_{B2} - \tilde{p}_{B2}$. Therefore, under bundling the marginal consumer who feels indifferent between buying or not buying product B2 is located at $\tilde{\theta}_B = (\tilde{p}_{B2} - v) / q_{B2}$. Under bundling the marginal consumer who feels indifferent between buying or not buying the bundled product is located at $\tilde{\theta}_A = (\tilde{p} - 2v) / q_{A2}$. The marginal consumer who feels indifferent between buying the bundled product and B2 is located at $\tilde{\theta}_{AB} = (\tilde{p} - \tilde{p}_{B2} - v) / (q_{A2} - q_{B2})$. As a result, under bundling and firm A as the high
(low) quality firm, the demand functions for high and low quality products are $\tilde{x}_A^H = 1 - \tilde{\theta}_{AB}$ and $\tilde{x}_B^H = \tilde{\theta}_{AB} - \tilde{\theta}_B$, respectively; otherwise, they will be $\tilde{x}_A^L = 1 - \tilde{\theta}_{AB}$ and $\tilde{x}_B^L = \tilde{\theta}_{AB} - \tilde{\theta}_A$. The marginal cost for firm A to produce product 1 is $c(q_1) = q_1$. The marginal cost for firm $i$ to produce product 2 is $c_i(q_{i2}) = q_{i2}$. Therefore, increasing the product quality will increase the marginal cost of a product at a fixed rate of one.

Based on the above model settings, this paper builds up a two-stage game in which firm A can be either the high- or low-quality firm. The game structure is as follows: In stage one firm A decides whether or not to bundle its products 1 and 2. In stage two these two firms engage in price competition. The solution concept of subgame-perfect Nash equilibrium (SPNE) is applied to solve this game. Therefore, the backward induction will be used to find the SPNE outcome. Sections 3 and 4 further consider the cases when firm A is a high- or low-quality firm.

3. Firm A as a High-quality Producer

3.1. Equilibria without bundling

This subsection will analyze the equilibrium outcomes without bundling when firm A produces a high quality product 2 and firm B produces a low quality product 2; that is, $q_{A2} > q_{B2}$. The notations $\pi_A^H$ and $\pi_B^L$ denote the profits of firms A and B without bundling when products 1 and 2 are sold separately. The profit functions of high-quality firm A and low-quality firm B without bundling can be expressed as:

$$\pi_A^H = (p_1 - q_1)x_1 + (p_{A2} - q_{A2})x_{A2}$$

$$\pi_B^L = (p_2 - q_2)x_{B2}$$

The first-order conditions of profit maximization are:

$$\frac{d\pi_A^H}{dp_1} = q_1 - 2p_1 = 0$$

(2.1)

$$\frac{d\pi_A^H}{dp_{A2}} = 2(q_{A2} - p_{A2}) - q_{B2} + p_{B2} = 0$$

(2.2)

$$\frac{d\pi_B^L}{dp_{B2}} = q_{B2}(q_{A2} - q_{B2})$$

(2.3)

The equilibrium prices can be obtained by using Eq. (2). Substituting equilibrium prices into the demand functions, we find equilibrium quantities to be $x_1^* = q_1/2$, $x_{A2}^* = q_{A2}/4(q_{A2} - q_{B2})$, and $x_{B2}^* = q_{B2}/2(4q_{A2} - q_{B2})$. In order to ensure the total output quantities for two markets are not more than one, the following two conditions are needed: (1) $\alpha_1 = -q_1 < 0$ and (2) $\alpha_2 = q_{A2} + q_{B2} > 0$.

3.2. Equilibrium with Bundling

This paper assumes that bundling will not change the marginal costs as well as consumer preferences toward product quality. In order to distinguish the equilibria with and without bundling, the notation $\sim$ denotes the results under bundling. The profit functions under bundling are:

$$\hat{\pi}_A^H = (\hat{p} - q_1 - q_{A2})\hat{x}_A^H$$

(3.1)
The first-order conditions of profit maximization with bundling are:

\[
\frac{d \tilde{x}_a^*}{dp} = \frac{\nu x + 2(q_1 + q_{A2}) - q_{B2} - 2 \tilde{p} + \tilde{p}_{B2}}{q_1 + q_{A2} - q_{B2}} = 0,
\]

(4.1)

\[
\frac{d \tilde{x}_a^*}{dp_{B2}} = \frac{\nu(q_1 + q_{A2} + 2q_{B2}) - (2\tilde{p}_{B2} - q_{B2})v_1 + q_{B2}q_2}{q_{B2}(q_1 + q_{A2} - q_{B2})} = 0.
\]

(4.2)

In order to analyze the change in the price of firm A’s product 2 with and without bundling, we re-express the best response functions in Eqs. (2.2) and (4.1) as \( p_{A2} = \phi(p_{B2}) = \frac{(p_{B2} + 2q_{A2} - q_{B2})}{2} \) and \( \tilde{p} = \phi(\tilde{p}_{B2}) = \frac{(\tilde{p}_{B2} + \nu + 2(q_1 + q_{A2}) - q_{B2})}{2} \). Following Choi, 2004, we define the fictitious price of product A2 as the best response function in pricing the bundled products minus the monopoly price. Applying the fictitious price for firm A to produce product A2, \( p_{A2} = p - p_1 \), we can derive firm A’s best response function in product 2 as:

\[
\tilde{p}_{A2} = \phi(\tilde{p}_{B2}) - \nu v_1/2 = (\tilde{p}_{B2} + 2q_{A2} - q_{B2})/2 = \phi(p_{B2} + \nu).
\]

(5)

From Eq. (5), we know that given the price of product 2 of firm B, firm A will bundle its products such that the best response function in product A2 remains unchanged.

Comparing Eqs. (2.3) and (4.2), we obtain the change in firm B’s best response function with respect to firm A’s bundling behavior:

\[
\tilde{p}_{B2}(\tilde{p}) - p_{B2}(p_{A2}) - q_{B2}/4\left[q_1(2\nu + q_{A2} - p_{A2}) - 2q_{A2}(q_1 + q_{A2})\right].
\]

(6)

Eq. (6) tells that when the quality level of product 1 is sufficiently high (low), bundling shifts firm B’s best response curve upward (downward). Consequently, the effects of bundling on these firms’ prices are indeterminate.

The conditions for product B2 being strictly positive and the total output quantities of two markets being not more than one are, respectively, \( \alpha_3 = 2(q_1 + q_{A2}) - 3q_{B2} > 0 \) and \( \alpha_4 = q_{B2}/4(q_1 + q_{A2} - q_{B2}) - 2q_1(q_1 + q_{A2} + q_{B2}) > 0 \).

In order to analyze the effect of quality difference in products 2 on firm A bundling, we simplify the high quality level of product 1 to be one and hence \( q_{B2} \) can also measure the quality difference (i.e., \( q_{A2} = 1 \) and \( q_{B2} \in [0, 1] \)). Denote \( \Delta \Pi^H_a \) as the profit difference for firm A with and without bundling, which can be expressed as

\[
\Delta \Pi^H_a = \tilde{x}_a^* - x_a^* = \left( p_{A1} - q_{A1} \right) \tilde{x}_a^* + \frac{\left( \tilde{p}^H_{A2} - p_{A2} \right) x_a^* + \left( \tilde{p}^H_{B2} - p_{B2} \right) x_{a2}^*}{p_{A2} - q_{A2}}.
\]

(7)

\[
= \frac{\nu^2 \lambda_1}{q_1(q_1 + 4 - q_{B2})^2(q_1 + 1 - q_{B2})(4 - q_{B2})^2}.
\]

The \( \lambda_1 \) function implies that when \( q_{B2} = \tilde{q}_{B2}(q_1) \), \( \Delta \Pi^H_a = 0 \) must hold. In order to examine whether or not under bundling the quantities are strictly positive and the total output in a market is no more than one, we assume that the basic utility for a consumer to buy one unit of product is \( \nu = 0.5 \) and depict the conditions in Figure 1. Function \( \alpha_1 \) implies that \( q_1 \in (0.25, 1] \). Consequently, the regime of bundling in Figure is \( q_1 \in (0.25, 1] \times q_{B2} \in [0, 1] \) as the shadow area. The lines \( aa \), \( bb \), \( cc \), and \( dd \) are where functions \( \tilde{q}_{B2}(q_1) \), \( \alpha_2 \), \( \alpha_3 \), and \( \alpha_4 \) equal zero, respectively. As Figure 1 shows, in the shadow area where firm A bundles its products, the conditions to ensure a duopoly and the total output being no more than one in product market 2 must both hold. This result is summarized in Proposition 1.
**Proposition 1.** Suppose that firm A produces the high quality product. If \( q_{B2} > \hat{q}_{B2}(q_1) \), then bundling is a dominant strategy for firm A. Moreover, as the quality of monopoly product gets higher or the quality difference in competing products gets lower, firm A has a higher incentive to bundle.

First, let us discuss the effects of bundling on prices and quantities of products when bundling is a dominant strategy for firm A. Define \( \Delta p_T = \hat{p}_T^H - (p_1 + p_2) \), \( \Delta p_{B2} = \hat{p}_{B2} - p_{B2} \), \( \Delta \hat{x}_{A} = \hat{x}_A - x_A \), \( \Delta \hat{x}_{B} = \hat{x}_B - x_B \), and \( \Delta \hat{x}_{B2} = \hat{x}_{B2} - x_{B2} \) as changes in prices and quantities of products 1, 2A, and 2B. As Eqs (5) and (6) show, when bundling is a dominant strategy of firm A, its best response function in price is not affected by bundling while firm B’s best response function will be shifted up by firm A’s bundling. As a result, bundling increases all product prices; i.e., \( \Delta p_T |_{q_{A2}=q_{A2}(a)} = \Delta p_{B2} |_{q_{B2}=q_{B2}(a)} / 2 > 0 \). Moreover, bundling makes the location of marginal consumer who feels indifferent between buying or not buying the low quality product shift to the right while the location of marginal consumer who feels indifferent between buying product A2 or B2 shift to the left. Therefore, bundling increases the sales of product A2 while decreases the sales of product B2, but its effect on the sales of monopoly product is indeterminate, i.e., \( \Delta \hat{x}_{A} |_{q_{A2}=q_{A2}(a)} > 0 \), \( \Delta \hat{x}_{B} |_{q_{B2}=q_{B2}(a)} < 0 \), and \( \Delta \hat{x}_{B2} |_{q_{B2}=q_{B2}(a)} < 0 \).

Summing up the above analysis, firm A’s bundling always increases its own profit from product A2 while has an ambiguous effect on its own profit from the monopoly product. The direction of effect of bundling on firm A’s profit from the monopoly product depends on the degree of vertical quality differentiation: When the quality difference is sufficiently large (small), the profit from the monopoly profit will increase (decrease). Consequently, when the product difference is sufficiently large (i.e., \( q_{B2} > \hat{q}_{B2}(q_1) \)), bundling is a dominant strategy of firm A.

As the quality level of the monopoly product gets higher or product quality difference gets lower (i.e., \( q_{B2} \) gets higher), the price increase made by bundling gets higher. Moreover, an increase in quality of the monopoly product reduces the increase in quantity of product A2 caused by bundling while expands the decrease in quantity of product B2 caused by bundling. Meanwhile, as the quality difference in competing products gets smaller, it expands both of the magnitudes of increase in quantity of product A2 and decrease in quantity of product B2. The above discussion shows that the incentive for firm A to bundle gets higher as the
monopoly product’s quality gets higher or quality difference in competing products gets smaller. Lemma 1 summarizes the changes in equilibrium prices and quantities before and after bundling:

**Lemma 1.** If the bundling firm is the high quality firm, then bundling has an ambiguous effect on the quantity of monopoly product while increases the quantity of product $A_2$; and the price of bundled products is higher than the sum of prices of unbundled products. For its low quality competitor, bundling increases the price while decreases the quantity of product $B_2$.

![Fig. 2. The effects of bundling on the competitor's profit, consumer surplus, and social welfare when the bundling firm is high quality firm](image)

**3.3. Profits and Social Welfare before and after Bundling**

This subsection further analyzes the effects of bundling on its competitor’s profit, consumer surplus, and social welfare. Define $\Delta \Pi_B^1 = \Pi_B^1 - \Pi_B^0$ as the change in firm B’s profit before and after bundling. Substituting the equilibrium outcomes into firm B’s profit function, we have $\Delta \Pi_B^1 = \nu^2 \lambda_3 / (4q_1 + 4q_{B2})^2 (q_1 + 1 - q_{B2})$; moreover, if $q_{B2} \geq q_{B2}(q_1)$, then $\Delta \Pi_B^1 \geq 0$.

Summing up the consumer surpluses from buying the monopoly product and high and low quality competing products without bundling, we obtain $CS = CS_A + CS_B = \int_{q_1}^{1} (v + \theta q_1 - p_1) d\theta + \int_{0}^{q_{B2}} (v + \theta q_{A2} - p_{A2}) d\theta$. Under bundling the consumer surplus is $CS = CS_A + CS_B = \int_{0}^{q_{B2}} [(2v + \theta (q_1 + q_{A2}) - \tilde{p}) d\theta + \int_{0}^{q_{B2}} (v + \theta q_{B2} - p_{B2}) d\theta]$. Substituting the equilibrium outcomes into $CS$ and $\Delta CS$ and then taking their difference, we have $\Delta CS_A = CS_A - (CS_1 + CS_{A2})$ and $\Delta CS_B = CS_B - CS_{B2}$. It can be shown that $\Delta CS_B < 0$, $\Delta CS_A > 0$, and $|\Delta CS_B - \Delta CS_A|$. Define the social welfare is the sum of firm profits and consumer surpluses. Therefore, the social welfare functions before and after bundling are $w = \pi_A^H + \pi_B^L + CS$ and $\tilde{w} = \tilde{\pi}_A^H + \tilde{\pi}_B^L + CS$, respectively. We find that bundling may improve the social welfare, i.e., $\Delta W = \tilde{w} - w = \pi_A^H + \pi_B^L + CS = \nu^2 \lambda_3 / (4q_1 + 4q_{B2})^2 (4q_{B2})^2 (q_1 + 1 - q_{B2})$. When $q_{B2} \geq q_{B2}(q_1)$, $\Delta W \geq 0$. Figure 2 helps interpreting and Proposition 2 summarizes
the above results.

**Proposition 2.** When the bundling firm is the high quality firm, bundling always reduces the total consumer surplus and may increase its competitor’s profit and the social welfare.

Lemma 1 implies that bundling reduces the consumer surplus in product B2, i.e., $\Delta CS_B < 0$. Moreover, for consumers who purchase products A, the effect of surplus gains due to increasing the number of consumers dominates the surplus loss due to increasing price, hence making the consumer surplus in product A increase; that is, $\Delta CS_A > 0$. Since $|\Delta CS_B| > |\Delta CS_A|$, bundling will reduce the total consumer surplus. Figure 2(1) also shows the result of consumer surplus dropping in the bundling regime.

Similarly, Lemma 1 also tells that when the effect of price increase in product B2 dominates (is dominated by) that of quantity decrease, bundling makes the competitor’s profit increase (decrease). This net effect depends on the degree of quality differentiation. Figure 2(3) tells that when the degree of product quality differentiation is sufficiently small (i.e., $\overline{q}_{B2} < q_{B2} < 1$), bundling will increase the competitor’s profit, which corresponds to the shaded area. Otherwise, when the degree of quality differentiation is sufficiently large (i.e., $\hat{q}_{B2} < q_{B2} < \overline{q}_{B2}$), bundling will decrease the competitor’s profit.

The shaded area in Figure 2(3) corresponds to the situation where the degree of quality differentiation is sufficiently small (i.e., $\hat{q}_{B2} < q_{B2} < 1$) and bundling promotes the social welfare. This is because when the degree of quality differentiation is sufficiently small, bundling expands the magnitudes of increasing prices, increased quantity of product A2, and decreased quantity of product B2. However, since the magnitude of increased profits still dominates that of decreased consumer surplus, bundling increases the social welfare in this case. On the contrary, when $\hat{q}_{B2} < q_{B2} < \overline{q}_{B2}$, bundling will instead worsen the social welfare. The above results differ from those in Gilbert and Riordan, 2007 in which technology bundling will compel the competitor to exit the market and make both consumer surplus and social welfare drop.

4. **Multi-product Firm A as a Low-quality Producer**

Comparing to Section 3, in this section we only switch the quality levels of the bundling firm and its competitor, keeping other things being equal. In this section the equilibrium outcomes, second-order conditions for profit maximization, and stability condition without bundling are exactly the same with those in Subsection 3.1. In order to avoid duplicate statements, only the new and important results will be presented.

The first-order conditions for profit maximization are with bundling:

$$
\frac{d\tilde{\pi}^I}{d\tilde{p}} = \frac{v(q_1 + q_{A2} - q_{B2})}{(q_1 + q_{A2} - q_{B2})(q_1 + q_{A2})}\left(\tilde{p}_{B2} + q_{B2}\right)\left(q_1 + q_{A2}\right)^2 + 2\tilde{p}_{B2} q_{B2} = 0
$$

$$
\frac{d\tilde{\pi}^II}{d\tilde{p}_{B2}} = \frac{v(q_1 + q_{A2} - q_{B2})}{(q_1 + q_{A2} - q_{B2})(q_1 + q_{A2})}\left(q_1 + q_{A2}\right)^2 + 2\tilde{p}_{B2} - \tilde{p} = 0
$$

The condition for the existence of an interior solution can be obtained by using the first-order, second-order, and stability conditions: $\hat{q}_{B2} < q_{B2} < 0$. Moreover, the high-quality firm B’s unit revenue and quantity are both negative if the low-quality firm A bundles, that is, $\hat{p}_{B2} = v(q_1 + q_{A2})/(q_1 + q_{A2} - 4q_{B2}) < 0$ and $\hat{x}_{B2} = -v(q_1 + q_{A2})/(q_1 + q_{A2} - 4q_{B2})(q_1 + q_{A2} - q_{B2}) < 0$. Via the above analysis, we know that the bundling behavior of a low quality firm will compel its competitor to exit the market, changing the market structure from a duopoly to a monopoly. The results under a low-quality firm’s bundling are summarized in Proposition 3:

**Proposition 3.** The bundling behavior by a low-quality firm compels the competitor to exit the market and makes the market structure of the competing products to change from a duopoly to a monopoly.
Proposition 3 further implies that with bundling, there are only the bundled products provided by firm A in the market. Using the condition \( \bar{u}_A=0 \) to find the marginal consumer \( \bar{\theta} \) who feel indifferent between buying or not buying the bundled products, we obtain the demand function for the bundled products as: 
\[
x = 1 - \frac{\bar{\theta}}{\bar{\theta}} = \frac{(q_1 + q_{A2} + 2v - \tilde{p})}{q_1 + q_{A2}}.
\]
The optimal price of the bundled products to maximize firm A’s profit is 
\[
\tilde{p}^M = v + q_1 + q_{A2}.
\]
In order to ensure that the quantity of the bundled products to be no more than 1, the condition \( \alpha_5 = v - q_1 - q_{A2} < 0 \) is needed. The high quality level of product 2 is one as assumed previously.

Fig. 3. The shaded area for bundling to be a dominant strategy for firm A as the low quality firm

The profit difference with and without bundling for firm A is: 
\[
\Delta \Pi_A^M = \pi_A^M - \pi_A^S = \frac{\gamma_A^2}{4q_1q_{A2}(q_1 + q_{A2})(q_{A2} - 4)^2}.
\]
Let \( q_{A2} = \tilde{q}_{A2}(q_1) \) and then \( \Delta \Pi_A = 0 \). Figure 3 is drawn by using the parameter value \( v = 0.5 \) and depicting \( a_2, \alpha_5 \), and \( \tilde{q}_{A2}(q_1) \) on the space \( q_1 \in [0.25, 1] \). The shaded area in Figure 3 is where bundling is a dominant strategy for firm A.

We further analyze the effects of bundling on the consumer surplus and social welfare, when the bundling firm is the low quality firm. Via analysis, we know that if bundling is a dominant strategy of firm A, bundling will unambiguously reduce consumer surplus and social welfare.

**Proposition 4.** If the bundling firm is a low quality firm, then bundling reduces the consumer surplus and social welfare.

Substituting equilibrium outcomes with and without bundling into the consumer surplus and social welfare when firm A is the low quality firm, we obtain the surplus changes: 
\[
\Delta CS^M = -v^2\gamma_A/8q_1q_{A2}(q_1 + q_{A2})(q_{A2} - 4)^2
\]
and 
\[
\Delta MW^M = -v^2\gamma_A/8q_1q_{A2}(q_1 + q_{A2})(q_{A2} - 4)^2,
\]
where \( \gamma_A > 0 \) and \( \lambda_A < 0 \).

When firm A is the low quality firm, with bundling firm A monopolizes the two markets at the same time meanwhile the price of the bundled products is higher the sum of prices of unbundled products 1 and A2; that is, 
\[
\Delta \Pi_A^M = \frac{p^M - (p_1 + p_1^M)}{2} > 0.
\]
Since the magnitude of decreased consumer surplus and competitor profit dominates that of bundler’s profit gains, bundling by a low quality firm reduces the social welfare. This finding is consistent with Gilbert and Riordan, 2007 with different model settings. Recall that Gilbert and Riordan, 2007 assume homogenous consumer preferences toward quality; moreover, both firms can engage in R&D to improve their own quality level and technology bundling can effectively reduce the competitor’s quality level choice.

Our Propositions 2 and 4 support the viewpoint of the European Court on the Total Petroleum case, since the effects of bundling on consumer and social surplus depend on the product quality of the bundler. As a result, there should be no uniform regulation on bundling and the judgment of bundling should be on a case-by-case base (rule of reason).
5. Concluding Remarks

In the globalizing markets, more and more examples of bundling in order to extend a firm’s monopoly power keep occurring. The bundling issue also receives the attention in the antitrust sectors all over the world. This paper starts with the case with vertical product differentiation and shows that bundling by a high quality or low quality firm results in different effects on consumer surplus, competitor’s profit and social welfare. Our findings support the viewpoint of European Court in the Total Petroleum case that uniform regulation on bundling is not socially desirable.

This paper adopts a more realistic assumption to allow consumers to have heterogeneous preferences toward product quality. It is found that when the bundler is the high quality firm, bundling reduces the consumer surplus while the changes in the competitor’s profit and social welfare depend on the degree of quality differentiation of the competing products. On the contrary, when the bundler is the low quality firm, bundling compels its competitor to exit the market, turns the market structure from a duopoly to a monopoly, and reduces the competitor’s profit, consumer surplus, as well as social welfare.

According to the major findings of this paper, vertical quality differentiation is a key factor causing bundling to have very different effects on consumer surplus, competitor’s profit, and social welfare. Judgment of the welfare effects of bundling then should be on a case-by-case basis and follow the rule of reason.

References