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**Conference Paper**

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24th Biennial Conference of the International Telecommunications Society (ITS): "New bottles for new wine: digital transformation demands new policies and strategies", Seoul, Korea, 23-26 June, 2024

**Provided in Cooperation with:**

International Telecommunications Society (ITS)

*Suggested Citation:* Fujisawa, Chieko (2024) : Corporate strategies to exploit the social status created by advertising: quantity vs. price competition, 24th Biennial Conference of the International Telecommunications Society (ITS): "New bottles for new wine: digital transformation demands new policies and strategies", Seoul, Korea, 23-26 June, 2024, International Telecommunications Society (ITS), Calgary

This Version is available at:

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# **Corporate strategies to exploit the social status created by advertising: quantity vs. price competition**

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**Abstract:** When firms use advertising to differentiate their products and increase consumer appreciation of their products, the strategy, i.e., price or quantity, depends on the degree of product differentiation and the magnitude of advertising costs. If advertising costs in Bertrand competition are very much lower than advertising costs in Cournot competition, the firms will choose Bertrand competition. If advertising costs in Bertrand competition are comparable to advertising costs in Cournot competition, both firms will choose Cournot competition. If advertising costs in Bertrand competition are lower than those in Cournot competition, and differentiation is, to some extent greater, firms adopt different strategies each other. This is because firms take advantage of the different advertising effectiveness of competitors under the conditions of cost and differentiation increase profitability. There is also a mixed strategy option under these conditions. Furthermore, the differentiation strategy with advertising increases firms' profits and increases consumer surplus and total surplus compared to the case without advertising.

**Keywords:** Online media advertising, Mass media advertising, differentiation strategy, Cournot competition, Bertrand competition, Duopoly model

**JEL classification:** D43, L13, M37

**Declaration of interests:** The authors have no competing interests to declare.

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## 1. Introduction

Advancements in digitalization have given rise to social networking services (SNS) such as Instagram, Facebook, and TikTok. These platforms provide a means for consumers to share information and satisfy their desire for self-expression, leading to a multimedia-based advertising business. As the phrase "Keeping up with Jones" expresses, comparisons with neighbors significantly impact consumer satisfaction. Oswald (1997) states that the satisfaction of economic agents is influenced by relative rather than absolute wage levels. In other words, consumers' purchase of discriminatory branded products increases their satisfaction in comparison with others since comparison with others increases satisfaction. Many firms and luxury brands have recently increased their sales through multimedia advertising and social networking. The increase in sales in this multimedia environment can be attributed to strengthening the firms' differentiation strategies through diverse advertising. This trend can also be seen in the fact that in many countries, including Japan, total advertising expenditure has grown along with nominal GDP.

The term "brand" is said to have come from "Burned," a name branded on cattle and horses to distinguish them from other people's livestock and to have been used to refer to names that identify them from competitors.<sup>2</sup> Brands are required to have a "history" and "culture," product quality, reliability, and excellence, and to provide consumers with (i) a sense of exclusivity, (ii) a widely recognized brand identity, and (iii) high sales and customer loyalty (Thomas 2007). European fashion brands steered the massification of luxury in the late 1980s by targeting customer segments with diverse income levels, lifestyles, and purchasing motives. Owing to the restructuring and globalization of the luxury industry, the luxury market grew from EUR 73 billion in 1994 to EUR 230 billion in 2014.<sup>3</sup> Recently, sales through online channels

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<sup>2</sup> Please see <https://en.wikipedia.org/wiki/Brand>

<sup>3</sup> Please see <https://www.consultancy.uk/news/937/bain-top-11-luxury-markets-and-cities-of-the-globe>

have increased for branded companies. New brands have grown with the widespread use of advertising-based branding in multimedia environments. While the traditional luxury brand strategy involves high prices, high costs, restrained production, and limited distribution, as opposed to mass marketing, the massification of increased sales quantities creates problems that reduce the scarcity of premium prices.

BMW is the driving brand, whereas Lexus is the quality and hospitality brand. Lexus's global advertising says, "Experience the Amazing. It is imagination that turns the ordinary into extraordinary." Luca di Montezemolo, former chairman of Ferrari, said, "We are not selling an ordinary product. We are selling a dream."<sup>4</sup> The importance of branding is illustrated by the fact that the biggest contributors to profits at Volkswagen AG, famous for its mass-market Beetle car, are Audi, a stronger brand than mass-market cars, and Porsche, a sports car brand.<sup>5</sup>

In the Interbrand Best Global Brands published by Interbrand Inc., USA, Apple has been ranked number one for ten consecutive years since 2012. Its brand value exceeds USD 480 billion.<sup>6</sup> Apple's branding strategy is centered on differentiation, with (1) uniqueness that no other firm can imitate, (2) a simple design, (3) easy-to-understand usability, and (4) a premium feel. For example, Apple Watch advertising focuses not only on the functionality of the watch or smartphone but also on the product's appearance, satisfying consumers' desire for self-expression and increasing new demand. Emphasizing this difference, Apple purchases a product that is special to the consumer's post-purchase image.<sup>7</sup>

Steve Jobs said, "Some people say, 'give customers what they want.' However, this was not my

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<sup>4</sup> Please see [https://www.itmedia.co.jp/makoto/articles/1401/08/news007\\_4.html](https://www.itmedia.co.jp/makoto/articles/1401/08/news007_4.html)

<sup>5</sup> Please see <https://www.pymnts.com/news/ipo/2022/strong-2021-profits-drive-volkswagens-porsche-closer-to-ipo/#:~:text=Volkswagen%20posted%20group%20operating%20profit,Audi%20adding%205.55%20billion%20euro>

<sup>6</sup> Please see <https://chainstoreage.com/apple-retains-top-spot-worlds-best-brand>

<sup>7</sup> Please see <https://www.forbes.com/sites/christinemooman/2018/01/12/why-apple-is-still-a-great-marketer-and-what-you-can-learn/?sh=73726d1a15bd>

approach. Our job is to determine what they want before they do.” Having an Apple product satisfies a customer’s unacknowledged desire for stylish design and luxury and makes consumers aware that it is a status. It makes consumers aware of their status. The value of the brand is that when people hear the company name “Apple,” they remember well-designed, easy-to-use products like iPhones and iPads. Apple's 1997 TV commercial “Think Different” narrates the story of people who have been derided as crazy yet became great. They have changed the world and moved forward. It resonated with many people with the message that only those who believe they can change the world can do so.<sup>8</sup>

With reference to the results of empirical studies, this study analyzes whether the firm strategy is price or quantity when firms selling differentiated goods utilize branding in advertising in a duopoly model. Singh and Vives (1984) conducted a comparative analysis of Bertrand and Cournot competition in an oligopolistic market. They first analyzed the difference between profitability and efficiency and showed that when goods are substitutive, firms are more profitable when competing for quantity. How are firms' strategies affected, and how do they change under recent digital technologies, advertising differentiation, and branding?

The analysis shows that if advertising expenditure under price competition is lower than that under quantity competition and the degree of differentiation is greater, both firms choose the price strategy. However, if advertising expenditure on price competition is high and the degree of differentiation is low, both firms choose the quantity strategy. However, suppose product differentiation is significantly higher, and the advertising expenditure used in price competition is higher than that in quantity competition. In that case, there will be an equilibrium in which one firm chooses a price strategy, and the other chooses a quantity strategy, or both firms adopt a

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<sup>8</sup> However, it also generates other problems, as Grossman and Shapiro (1988) have analyzed how luxury brands as a signal of wealth can promote the growth of counterfeit goods.

mixed quantity and price strategy. These results illustrated the actual situation. For example, Toyota has a mixed quantity and price strategy. They used a combination of different types of advertising to suit each strategy. Tremblay and Tremblay (2011) examine an asymmetric equilibrium in a Cournot-Bertrand of firms with differentiated. Tremblay et al. (2013b) show an asymmetric equilibrium in a dynamic Cournot-Bertrand model of firms with asymmetric fixed costs. In contrast, our results, which focus on discriminatory goods and advertising costs, find asymmetric equilibria in a static quantity pricing model affected by advertising costs and effects.<sup>9</sup>

The remainder of this paper is organized as follows. Section 2 reviews prior research relevant to the present study. Section 3 explores three patterns for establishing an optimal sales strategy. Section 4 discusses finding an equilibrium for both firms. Section 5 explains the social welfare. Section 6 examines the types of advertising that align with sales strategy. Finally, Section 7 concludes the paper.

## **2. Related literature review**

Studies that have been helpful in modeling the differentiation strategies of firms using advertising include Tremblay et al. (2013a), who analyzed how advertising influences a firm's strategy of quantity or price and stated that firms choose different advertising in price and quantity competition. Matsumura and Ogawa (2012) show that under various economic settings, firms choose between price or quantity competition strategies, and Li and Ji (2010) present a useful model of how investment and investment effects affect firm strategy. Pepall and Reiff (2016) analyzed the effects of advertising when monopolies use digital technology for advertising and consumer grouping. They found that consumer grouping results in a narrower and more fragmented market than in the standard monopoly model, where fewer products are sold at higher

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<sup>9</sup> Please see <https://forbesjapan.com/articles/detail/31176/page1?s=ns>

prices. However, they did not analyze the relationship with mass media advertising, which is the focus of this study.

Based on an analysis of repeated games of implicit collusion in the distribution channel, Bian et al. (2018) showed a situation in which, in equilibrium, retailers engage in Cournot-Bertrand competition. In the situation in which Cournot-Bertrand competition is chosen in this study, which does not use discount rates, costs serve as an alternative to the discount rate, which is helpful for the analysis. Regarding differences in advertising effectiveness, Johnson and Myatt (2006), referring to Arislabie and Tisdell (1988), classified advertising into mass media advertising, which targets “mass markets,” and online advertising, which targets “niche markets,” based on changes in demand and price elasticities. They categorized advertising into two types and analyzed their impacts on firm revenue.

Regarding brand advertising, Guitart and Stremersch (2021) observed that emotional advertising on television increases online searches but not informational advertising. They also found that managers of high-priced and high-quality cars are more effective in using advertisements with emotional content, as increased emotional advertising leads to sales of higher-priced cars rather than lower-priced cars.

Joo et al. (2014) provided a useful reference for the mutual effects of mass media and digital advertising. They point out that mass media image advertising increases consumers' online search and digital advertising but does not have that effect on information advertising. Goldfarb and Tucker (2011) focused on the substitution effect of the two types of advertising. Sahni and Nair (2020) referred to the advertising effects of branding, the creation of a brand image through image advertising in consumer durables such as branded cars and bags, and the signaling effects of advertising. They tested Nelson's (1974) idea of the "Signaling Hypothesis" in a field experiment using a large restaurant search platform and showed that in experience goods such as

food, the use of advertising by firms with superior quality has been shown to increase repeat purchases after consumption and make more profit.

The following were helpful in terms of the contribution of signaling and advertising to intangible investment and corporate value. (i) US firms invested more than USD 500 billion in intangible brands in 2021, more than 12% of their GDP, and (ii) the amount invested by US firms in intangible brands in 2021 was over USD 500 billion, more than 12% of their GDP. Bronnenberg et al. (2022) analyzed data on the social benefits and costs of advertising and promotion, the main means of intangible brand investment, and the impact of brand capital on productivity, pointing to the effect of intangible brand investment on firm growth.

Buil et al. (2013) studied the effects of advances in digital technology on brand equity in advertising. They focused on advertising expenditure and individuals' attitudes towards advertising. They noted from a survey of 302 UK consumers that advertising expenditure improves brand awareness and plays a vital role in brand equity but is insufficient to positively impact brand associations and quality. Therefore, we believe that a different model of brand association and quality is required.

## 2. Model

Using the methods of Matsumura and Ogawa (2012) and Li and Ji (2010), if firm  $i$  and firm  $j$  produce differentiated goods to each other through advertising, the quasi-linear utility function of the representative consumer is explained by  $CS(q_i, q_j) = (a + be_i)q_i + (a + be_j)q_j - (q_i^2 + 2bq_iq_j + q_j^2)/2 - (p_iq_i - p_jq_j)$  which provides the demand. Variables  $q_i$  and  $p_i$  represent the quantity and price of good  $i$  for firm  $i$ . The value of  $a$  ( $> 0$ ) represents consumers' initial willingness to pay for good  $i$ . When exposed to advertising information, consumers obtain an additional value  $e_i$ , where  $e \in (0, 1)$ . In this case,  $b$  serves as the measure of complementarity, where  $b \in (0, 1)$ . Their



supplementary valuation is influenced by the differentiation of the goods, taking the form of  $be$ . Hence, the consumer's final value is given as  $a + be_i$ . The more  $b$  approaches 1, the stronger the differentiation between the two goods, whereas the closer  $b$  is to 0, the weaker the degree of differentiation. The inverse demand function for good  $i$  ( $i = 1, 2, i \neq j$ ) is given as follows:

$$p_i^{qq}(q_i, q_j) = a + be_i - q_i - bq_j \quad (1)$$

The superscript  $qq$  indicates that both firms opted for quantity strategy with advertising.

Assuming that the goods' marginal cost is  $c = 0$ , and the firm's advertising costs are  $te_i^2/2$ , then  $e$  is endogenous. Here, the advertising cost of quantity setting is standardized and  $t = 1$ .

When both firms opt for quantity using advertising, the profit function of firm  $i$  (associated with the second stage sub-game) is:

$$\max_{q_i} \pi_i^{qq} = p_i^{qq} q_i - e_i^2/2 = (a + be_i - q_i - bq_j)q_i - e_i^2/2 \quad (2)$$

The game runs as follows. In the first stage: both firms simultaneously choose quantity or price. In the second stage: each firm chooses advertising, considering advertising effectiveness. In the third stage: both firms maximize own profit.

### 3. Second-stage games

We discuss three possible subgames: 1) both choose quantity with advertising ( $q$ - $q$  game), 2) both choose price with advertising ( $p$ - $p$  game), and 3) only one firm chooses quantity with advertising ( $p$ - $q$  game). In this study, the solutions to the three games are assumed to be internal, that is., the equilibrium prices and quantities of the firms are strictly positive.

#### 3.1. $q$ - $q$ game

The second-order conditions are satisfied. From the first-order conditions, we obtain

the following reaction function for the firms.

$$R_i^{qq}(q_j) = (a + be_i - bq_j)/2. \quad (3)$$

Standard calculation yields the equilibrium outcome  $q_i^{qq*}$ ,  $\pi_i^{qq*}$ ,  $e^{qq}$  as follows:

$$e_i^{qq*} = 4ab/(8 + 4b - 6b^2 - b^3) \quad (4)$$

$$q_i^{qq*} = a(2 + b)(2 - b)/(8 + 4b - 6b^2 - b^3). \quad (5)$$

$$\pi_i^{qq*} = a^2(16 - 16b^2 + b^4)/(8 + b(4 - (6 + b)b))^2. \quad (6)$$

### 3.2. $p$ - $p$ game

When both firms opt for price with advertising, the demand function for good  $i$  is given as follows:

$$q_i^{pp}(p_i, p_j) = (a(1 - b) - b^2e_j - p_i + b(e_i + p_j))/(1 - b^2) \quad (7)$$

The firms' profit function is as follows:

$$\max_{p_i} \pi_i^{pp} = p_i (a(1 - b) - b^2e_j - p_i + b(e_i + p_j))/(1 - b^2) - t(e_i)^2/2 \quad (8)$$

The superscript  $pp$  indicates that both firms opt for price. Unlike advertising costs, online advertising costs are assumed to be  $t \in (0.5, 2.0)^{10}$ . The second-order conditions are satisfied.

From the first-order conditions, we obtain the following reaction function for the firms.

$$R_i^{pp}(p_j) = (a(1 - b) + b(e_i - be_j + p_j))/2. \quad (9)$$

The equilibrium outcome  $q_i$ ,  $p_i$  and  $e$  are derived using standard calculation as follows:

$$e^{pp*} = 2ab(2 - b^2)/((2 - b)^2(1 + b)(2 + b)t - 2b^2(2 - b^2)) \quad (10)$$

$$p_i^{pp*} = a(4 - b^2)(1 - b^2)t/((2 - b)^2(1 + b)(2 + b)t - 2b^2(2 - b^2)). \quad (11)$$

$$\pi_i^{pp*} = a^2t((4 - b^2)^2(1 - b^2)t - 2(2b - b^3)^2)/((2 - b)^2(1 + b)(2 + b)t - 2b^2(2 - b^2))^2 \quad (12)$$

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<sup>10</sup> This paper considers that when using mass media advertising as a benchmark, it is closer to reality to set it at the limited cost difference of digital advertising.

### 3.3. $p - q$ game

If firm  $j$  employs price with advertising and firm  $i$  opts for quantity with advertising, the price and quantity functions for goods  $i$  and  $j$  are formulated as follows:

$$p_i^{aq}(q_i, p_j) = a(1 - b) - (1 - b^2)q_i + b(e_i - be_j) + bp_j \quad (13)$$

$$q_j^{ap}(q_i, p_j) = a + be_j - p_j - bq_i \quad (14)$$

Each firm's profit function are as follows.

$$\max_{q_i} \pi_i^{aq} = p_i(a(1 - b) - (1 - b^2)q_i + b(e_i - be_j) + bp_j) - (e_i)^2/2 \quad (15)$$

$$\max_{p_j} \pi_j^{ap} = (a + be_j - p_j - bq_i)q_j - t(e_j)^2/2 \quad (16)$$

Superscript  $ap$  and  $aq$  denote firms' choices of price and quantity using advertising, respectively. The second-order conditions are satisfied. From the first-order conditions, we obtain the following reaction function for firms.

$$R_i^{aq}(p_j) = (a(1 - b) + b(e_i - be_j) + bp_j)/2(1 - b^2). \quad (17)$$

$$R_j^{ap}(q_i) = (a + be_j - bq_i)/2. \quad (18)$$

The equilibrium outcome  $q_i$ ,  $p_i$ ,  $e^{aq}$  and  $e^{ap}$  are derived using standard calculation as follows:

$$e^{aq*} = 4ab(1 - b^2)(-2b^2(2 - b^2) + (2 - b)(4 - 3b^2)t)/D_1 \quad (19)$$

$$e^{ap*} = (2a(1 - b)b(2 - b^2)(8 + b(4 - b(10 + 7b))))/D_1 \quad (20)$$

$$q_i^{aq*} = (a(2 - b)(4 - 3b^2)^2t - (2ab^2(8 - 10b^2 + 3b^4)))/D_1 \quad (21)$$

$$p_j^{ap*} = ((a(4 - 3b^2)(8 - 4b - 14b^2 + 3b^3 + 7b^4)t)/D_1 \quad (22)$$

$$\pi_i^{aq*} = (a^2(16 - 48b^2 + 49b^4 - 17b^6)(2b^4 + 8t - 4bt + 3b^3t - 2b^2(2 + 3t))^2)/D_1^2 \quad (23)$$

$$\pi_j^{ap*} = (a^2(1 - b)^2(8 + b(4 - b(10 + 7b)))^2t((4 - 3b^2)^2t - 2b^2(2 - b^2)^2))/D_1^2 \quad (24)$$

$$D_1 \equiv (14b^8 + 64t - 16b^2(2 + 11t) + 4b^4(18 + 41t) - b^6(56 + 51t)) > 0$$

## 4. Result

The boundary  $t_1(b)$  and  $t_2(b)$  are defined as follows.  $t_1(b) \equiv \text{def}\{t(b): \pi_i^{aq}(t, b) = \pi_i^{pp}(t, b)\}$  and  $t_2(b) \equiv \text{def}\{t(b): \pi_i^{ap}(t, b) = \pi_i^{qq}(t, b)\}$ .

Case 1: if  $t(b) \leq t_1(b)$ , since advertising effect in pricing are bigger than in quantity setting,  $e^{aq*} < e^{pp*}$  and  $e^{qq*} < e^{ap*}$ . In equilibrium, quantities and prices are  $q_i^{aq*} < q_i^{pp*}$ ,  $q_i^{qq*} < q_i^{ap*}$ ,  $p_i^{aq*} < p_i^{pp*}$  and  $p_i^{qq*} < p_i^{ap*}$ . Therefore,  $\pi_i^{aq} < \pi_i^{pp}$  and  $\pi_i^{ap} > \pi_i^{qq}$ . That is, price setting leads higher price and quantity than quantity setting.

Case 2: if  $t(b) > t_2(b)$ , since advertising effect in quantity are bigger than in pricing setting,  $e^{aq*} > e^{pp*}$  and  $e^{qq*} > e^{ap*}$ . In equilibrium, quantities and prices are  $q_i^{aq*} > q_i^{pp*}$ ,  $q_i^{qq*} > q_i^{ap*}$ ,  $p_i^{aq*} > p_i^{pp*}$  and  $p_i^{qq*} > p_i^{ap*}$ . Therefore,  $\pi_i^{aq} > \pi_i^{pp}$  and  $\pi_i^{qq} > \pi_i^{ap}$ . That is, quantity setting leads higher price and quantity than pricing setting.

Case 3: if  $t_1(b) < t(b) < t_2(b)$ , since advertising effect in quantity are bigger than in pricing setting,  $e^{aq*} > e^{pp*}$  and  $e^{qq*} < e^{ap*}$ . In equilibrium, quantities and prices are  $q_i^{aq*} < q_i^{pp*}$ ,  $q_i^{qq*} > q_i^{ap*}$ ,  $p_i^{aq*} > p_i^{pp*}$  and  $p_i^{qq*} < p_i^{ap*}$ . Therefore,  $\pi_i^{aq} > \pi_i^{pp}$  and  $\pi_i^{ap} > \pi_i^{qq}$ . In this case, it is the result of a firm's expectation that a rival's advertising would have a positive impact on its own sales as an external effect. The following results are shown as an example calculation with  $t = 0.7$ . When  $b = 0.41$ ,  $\pi_i^{aq}(= 0.17835) > \pi_i^{pp}(= 0.17833)$  and  $\pi_i^{ap}(= 0.1821) > \pi_i^{qq}(= 0.1819)$ , when  $b = 0.35$ ,  $\pi_i^{aq}(= 0.1869) < \pi_i^{pp}(= 0.1878)$  and  $\pi_i^{ap}(= 0.1900) > \pi_i^{qq}(= 0.1890)$ , when  $b = 0.15$ ,  $\pi_i^{aq}(= 0.1647) > \pi_i^{pp}(= 0.1618)$  and  $\pi_i^{ap}(= 0.1695) < \pi_i^{qq}(= 0.1719)$ .

**Proposition 1:** There are three equilibriums depending on  $t$  and  $b$ .

If  $t(b) \leq t_1(b)$ , price setting is the dominant strategy for both firms.

If  $t_2(b) < t(b)$ , then quantity setting is the dominant strategy for both firms.

If  $t_1(b) < t(b) < t_2(b)$ , one firm chooses the quantity setting, and the other chooses the price setting.

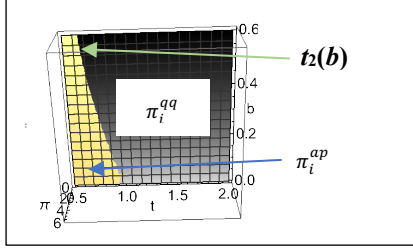


Fig. 1.  $a = 1$ , vertical axis:  $t$ , horizontal axis:  $b$ ,  
When firm  $j$  chooses quantity, does firm  $i$   
choose quantity or price?

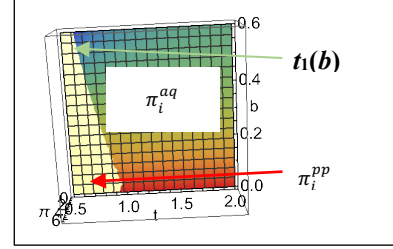


Fig. 2.  $a = 1$ , vertical axis:  $t$ , horizontal axis:  $b$ ,  
When firm  $j$  chooses price, does firm  $i$   
choose quantity or price?

#### 4.1. Mix strategy.

In the absence of a dominance strategy, firms choose quantity-price competition. In such cases, do firms have only asymmetric choices? We now consider the firm's mix strategy. The strategy of firm  $i$  chooses quantity with probability  $x$  and price with probability  $(1-x)$ . Firm  $j$ 's strategy chooses quantity with probability  $y$  and price with probability  $(1-y)$ . The expected profit of the firms is as follows:

$$E\pi_i^{mix} = x(y\pi_i^{qq} + (1-y)\pi_i^{aq}) + (1-x)(y\pi_i^{ap} + (1-y)\pi_i^{pp}) \quad (25)$$

$$E\pi_j^{mix} = y(x\pi_j^{qq} + (1-x)\pi_j^{aq}) + (1-y)(x\pi_j^{ap} + (1-x)\pi_j^{pp}) \quad (26)$$

When  $t_1(b) < t(b) < t_2(b)$ , there is no strong dominance strategy, and one chooses price and the other quantity. Numerical example, when  $b = 0.41$  and  $t = 0.70$ , then, the expected gain is  $E\pi_i^{mix} = x(0.1819y + (1-y)0.17835) + (1-x)(0.1821y + (1-y)0.17833) = 0.17835 + x(0.00380 - 0.000227y) + 0.000019y$ . If  $y = 0.087$ , then  $0 \leq x \leq 1$ ,  $x = 1$  if  $y < 0.087$ ,  $x = 0$  if  $y > 0.087$ . Similarly,  $0 \leq y \leq 1$  if  $x = 0.087$ ,  $y = 0$  if  $x < 0.087$  and  $y = 1$  if  $y > 0.087$ . The expected profits are  $\{(1, 0), (0, 1)\} = \{\pi_i^{aq}(= 0.17835), \pi_j^{ap}(= 0.1821)\}$ ,  $\{(0.087, 0.913), (0.087, 0.913)\} = (0.1786, 0.1786)$ ,  $\{(0, 1), (1, 0)\} = \{\pi_i^{ap}(= 0.1821), \pi_j^{aq}(= 0.17835)\}$ .

If  $b = 0.44$  and  $t = 0.69$ , each profit is  $\pi_i^{qq} = 0.17854$ ,  $\pi_i^{aq} = 0.17375$ ,  $\pi_i^{ap} = 0.17857$  and  $\pi_i^{pp} = 0.17344$ . Then, the expected profit is  $E\pi_i^{mix} = 0.17344 + x(0.00031 - 0.00034y) + 0.005137y$ . If  $y = 0.90$ , then  $0 \leq x \leq 1$ ,  $x = 1$  when  $y < 0.90$ , and  $x = 0$  when  $y > 0.90$ . Similarly, if  $x = 0.90$ ,  $0 \leq y \leq 1$ , when  $x < 0.90$ ,  $y = 0$  and when  $y > 0.90$ ,  $y = 1$ . The respective expected profits yield  $\{(1, 0), (1, 0)\} = \{\pi_i^{aq}(= 0.17375), \pi_j^{ap}(= 0.17857)\}$ ,  $\{(0.90, 0.10), (0.90, 0.10)\} = (0.17806, 0.17806)$ .

**Proposition 4:** When  $t_1(b) < t(b) < t_2(b)$ , three equilibria exist.

One firm chooses quantity competition, and the other chooses price competition.

And each firm chooses a mixed strategy of quantity and price competition.

The fact that neither strategy is dominant means that there is not much difference in terms of cost-effectiveness. Here, if firms take a "mixed price-quantity strategy" that uses different types of advertising, as Guitart and Stremersch (2021) showed, consumers who see image ads in the mass media will search online, acquire information through online advertising, and purchase high quality, high price products. Companies can achieve high prices and high demand by using the external effects of two types of advertising, rather than specializing in one type of advertising. The effectiveness of this mixed strategy is demonstrated when using advertising.<sup>11</sup>

## 5. Social welfare

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<sup>11</sup> For an example, please see Guitart and Stremersch (2021)

The producer surplus is denoted by  $PS = \pi_i^{\square} + \pi_j^{\square}$  and the total surplus by  $TS = PS + CS$ . The boundary  $t_3(b)$ ,  $t_4(b)$  and  $t_5(b)$  are defined as follows.  $t_3(b) \equiv_{\text{def}} \{t_3(b): TS_i^{pp}(t, b) = TS_i^{ap+aq}(t, b)\}$ ,  $t_4(b) \equiv_{\text{def}} \{t_4(b): CS_i^{pp}(t, b) = CS_i^{ap+aq}(t, b)\}$ ,  $t_5(b) \equiv_{\text{def}} \{t_5(b): CP_i^{qq}(t, b) = CS_i^{ap+aq}(t, b)\}$ . The magnitude of borderline shows  $t_3(b) < t_4(b)$ .

If  $t(b) < t_3(b)$ ,  $TS^{pp} > TS^{ap+aq} > TS^{qq}$ . If  $t(b) > t_3(b)$ ,  $TS^{ap+aq} > TS^{pp} > TS^{qq}$

If  $t(b) < t_4(b)$ ,  $CS^{pp} > CS^{ap+aq} > CS^{qq}$ . If  $t(b) > t_4(b)$ ,  $CS^{ap+aq} > CS^{pp} > CS^{qq}$

The size of the surplus depends on advertising costs and differentiation: if  $t(b) > t_3(b)$ , then high advertising costs and low differentiation make the total surplus ( $TS$ ) of asymmetric choice high. If  $t(b) \leq t_3(b)$ , then price competition has a higher  $TS$ . The use of advertising also increases consumers' willingness to pay, so producer surplus is higher.

### Proposition 3

If  $t(b) < t_3(b)$ , price setting is the highest strategy for total and consumer surplus.

If  $t_3(b) < t(b) < t_4(b)$ , the asymmetric setting is the highest strategy for total surplus, but consumer surplus is lower than price setting.

If  $t_4(b) < t(b)$ , the asymmetric setting is the highest strategy for total and consumer surplus.

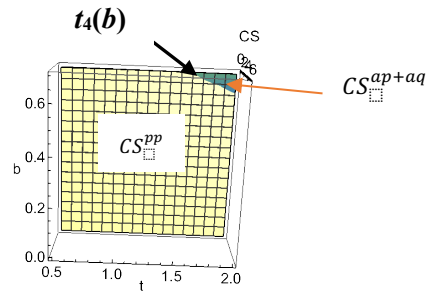
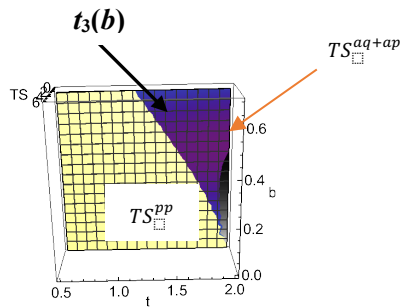


Fig. 3. vertical axis:  $t$ , horizontal axis:  $b$ . Fig. 4. vertical axis:  $t$ , horizontal axis:  $b$ .

Total surplus in quantity or price.

Consumer surplus in quantity or price.<sup>12</sup>

<sup>12</sup> Figure 1to 4 are created by Mathematica.

When firms do not use an advertising, firms' profits are: if both firms choose quantity set,  $\pi_i^{nqq}$ . If both firms choose price set,  $\pi_i^{npp}$ . If each firm sets asymmetry choice,  $\pi_i^{naq}$  and  $\pi_i^{nap}$ . The superscripts  $nqq$ ,  $npp$ ,  $nap$  and  $naq$  indicate that the two firms choose quantity set, price set, asymmetric price set and asymmetric quantity set in respectively. If the profits of the ad-supported and ad-free models are compared, when  $t_2(b) < t(b)$ ,  $\pi_i^{qq} > \pi_i^{nqq}$ , When  $t(b) \leq t_1(b)$ ,  $\pi_i^{pp} > \pi_i^{npp}$ . The social surplus shows  $TS^{pp} > TS^{npp}$  and  $TS^{qq} > TS^{nqq}$ . Consumer surplus also shows  $CS^{pp} > CS^{npp}$  and  $CS^{qq} > CS^{nqq}$ .<sup>13</sup> The reason for this is that the high valuation of goods through advertising increase consumers' willingness to pay, even at higher prices.

## 6. The relation between firms' strategy and advertising type

Johnson and Myatt (2006) found that mass media advertising, such as television and billboards, targets an unspecified audience. As a result, there is wide variation in advertising effectiveness on demand. Image strategy is an important tool for this purpose. On the other hand, online advertising is highly effective in targeting people who gather price and information about products through online searches. Therefore, price is more important than product image. Guitart and Stremersch (2021) analyze automobile manufactures' advertising effects. They find that emotional advertising on television increases online searches, but informational ads do not increase online searches. Such emotional advertising's effect leads in selling high-priced and high-quality cars than low-priced cars. This will be the division of roles when TV and online advertising are used together. The company's strategy is to take advantage of the relationship between the characteristics of online and mass advertising and consumer behavior. The following

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<sup>13</sup> Please see Appendix B(1)~B(3)



corollary can be obtained from the effectiveness of each company's strategy and advertising type:

**Corollary 1:**

In quantitative competition is used primarily image-oriented mass media advertising.

In price competition is used mainly price-oriented Internet advertising.

## 7. Conclusion

When companies consider whether to compete on price or quantity, advertising plays an effective role. Differentiation strategies using advertising for branding purposes do not decrease demand because they increase consumers' willingness to pay. Differentiated branded goods increase satisfaction not only from the purchase itself but also from the external effect of increased satisfaction in comparison to neighbors. In other words, because consumers are more willing to pay for products that represent their social status, it increases corporate profits. This brand effect increases consumer surplus and total surplus even as prices rise. Additionally, in recent years, the development of communication technology has led to the widespread use of AI. Analyses of corporate branding strategies using advertising, such as those in this paper, may also be examined with the use of AI, potentially significantly altering the relationship between corporate strategy and advertising. It is essential to continue researching the impact of AI utilization in the future.

## Appendix: A

$$CS_{\square}^{pp} = a^2(1+b)(4-b^2)^2 t^2 / (8t + 4bt - b^3t + b^4(2+t) - 2b^2(2+3t))^2 \quad A-1$$

$$CS^{qq} = a^2(1+b)(4-b^2)^2 / (8 + 4b - 6b^2 - b^3)^2 \quad A-2$$

$$CS^{aq+ap} = a^2(4 - 3b^2)^2(4b^4(2 - b^2)^2 - 4b^2(2 - b^2)D_3t + D_2t^2/2D_1^2) \quad A-3$$

$$TS^{pp} = a^2t(48t + 16bt - 8b^3t + b^5t - 2b^6(2 + t) - 8b^2(2 + 7t) + b^4(16 + 19t))/D_4^2 \quad A-4$$

$$TS^{qq} = a^2(48 + 16b - 40b^2 - 8b^3 + 3b^4 + b^5)/(8 + 4b - 6b^2 - b^3)^2 \quad A-5$$

$$TS^{aq+ap} = a^2(4b^4(2 - b^2)^2(48 - 120b^2 + 107b^4 - 34b^6) - 4b^2(2 - b^2)(512 - b(192 + b(1792 - b(592 + b(2496 - b(708 + b(1680 - b(387 + b(516 - b(81 + 49b))))))))))t + (4 - 3b^2)^2(384 - b(256 + b(1184 - b(672 + b(1416 - b(616 + b(766 - b(196 + 155b))))))))t^2)/2D_1^2 \quad A-6$$

$$D_2 \equiv (128 - b^2(416 + b(32 - b(552 + b(56 - b(354 + b(24 - 91b)))))) > 0$$

$$D_3 \equiv (8 - b(4 + b(10 + b(11 - b(3 + 7b)))) > 0$$

$$D_4 \equiv ((2 - b)^2(1 + b)(2 + b)t - 2b^2(2 - b^2)) > 0$$

$$\text{when } b = 0.41 \text{ and } t = 0.7, TS^{pp} (= 0.704) > TS^{ap+aq} (= 0.674) > TS^{qq} (= 0.642) \quad A-7$$

$$CS^{pp} (= 0.348) > CS^{ap+aq} (= 0.314) > CS^{qq} (= 0.282) \quad A-8$$

$$\text{when } b = 0.45 \text{ and } t = 0.7, TS^{pp} (= 0.7151) > TS^{ap+aq} (= 0.678) > TS^{qq} (= 0.644) \quad A-9$$

$$CS^{pp} (= 0.372) > CS^{ap+aq} (= 0.329) > CS^{qq} (= 0.289) \quad A-10$$

$$\text{when } b = 0.41 \text{ and } t = 1.0, TS^{pp} (= 0.674) > TS^{ap+aq} (= 0.660) > TS^{qq} (= 0.646) \quad A-11$$

$$CS^{pp} (= 0.325) > CS^{ap+aq} (= 0.304) > CS^{qq} (= 0.282) \quad A-12$$

$$\text{when } b = 0.45 \text{ and } t = 1.8, TS^{ap+aq} (= 0.646) > TS^{qq} (= 0.644) > TS^{pp} (= 0.642) \quad A-13$$

$$CS^{pp} (= 0.316) > CS^{ap+aq} (= 0.306) > CS^{qq} (= 0.289) \quad A-14$$

#### Appendix B(1): Quantity and price of two firms when not using advertising.

$$q^{nqq} (= p^{nqq}) = a/(2 + b) < a(2 + b)(2 - b)/(8 + 4b - 6b^2 - b^3) = q^{qq} (= p^{qq}) \quad B-1$$

$$p^{npp} = a(1 - b)/(2 - b) < a(4 - b^2)(1 - b^2)t/D_4 = p^{pp} \quad B-2$$

$$q^{npp} = a/(2 - b)(1 + b) > a(4 - b^2)t/D_4 = q^{pp} \quad B-3$$

$$q^{naq} = a(2 - b)/(4 - 3b^2) < (a(2 - b)(4 - 3b^2)^2t - (2ab^2(8 - 10b^2 + 3b^4)))/D_1 = q_i^{aq*} \quad B-4$$

$$q^{nap} = a(2+b)(1-b)/(4-3b^2) < a(1-b)(4-3b^2)(8+b(4-b(10+7b)))t/D_1 = q_j^{ap*} \quad \text{B-5}$$

$$p^{naq} = a(2-b)(1-b^2)/(4-3b^2) < a(4-7b^2+3b^4)(2b^4+8t-4bt+3b^3t-2b^2(2+3t))/D_1 \\ = p_j^{aq*} \quad \text{B-6}$$

$$p^{nap} = a(2+b)(1-b)/(4-3b^2) < ((a(4-3b^2)(8-4b-14b^2+3b^3+7b^4)t)/D_1 = p_j^{ap*}$$

$$\pi_i^{nqq} = a^2/(2+b)^2, \quad \pi_i^{npp} = a^2(1+b)/(2-b)^2(1+b),$$

$$\pi_i^{naq} = a^2(2-b)^2(1-b^2)/(4-3b^2)^2 \text{ and } \pi_i^{nap} = a^2(1-b)^2(2+b)^2/(4-3b^2)^2$$

$$q^{nqq} \geq q^{naq} > q^{npp} \geq q^{nap}, \quad p^{nqq} \geq p^{naq} > p^{npp} \geq p^{nap}$$

**Appendix B(2):** The welfare without advertising.

$$TS_{\square}^{nqq} = a^2(3+b)/(2+b)^2, \quad CS_{\square}^{nqq} = a^2(1+b)/(2+b)^2, \quad \text{B-4}$$

$$TS_{\square}^{npp} = a^2(3-2b)/(2-b)^2(1+b), \quad CS_{\square}^{npp} = a^2/(2-b)^2(1+b) \quad \text{B-5}$$

$$TS_{\square}^{n(ap+aq)} = a^2(6-4b-b^2)/(8-6b^2), \quad CS_{\square}^{n(ap+aq)} = a^2(2-b^2)/(8-6b^2) \quad \text{B-6}$$

$$TS_{\square}^{npp} > TS_{\square}^{n(ap+aq)} > TS_{\square}^{nqq}, \quad CS_{\square}^{npp} > CS_{\square}^{n(ap+aq)} > CS_{\square}^{nqq}$$

**Appendix B(3):** Comparison of welfare without and with advertising.

$$CS_{\square}^{pp*} - CS_{\square}^{npp*} = 8a^2(1-b)b^2(2-2b^2+b^3)/(2-b)^2(1+b)(4-5b^2+3b^3)^2 \geq 0 \quad \text{B-7}$$

$$TS_{\square}^{pp*} - TS_{\square}^{npp*} \\ = 4a^2b^2(-2+b^2)D_5/((1+b)(2(2-b)b^2(2-b^2)-(2-b)^3(1+b)(2+b)t)^2) > 0$$

$$CS_{\square}^{npp} - CS_{\square}^{n(ap+aq)} = a^2(1-b)b^2(4+2b-b^2)/2(2-b)^2(1+b)(4-3b^2) \geq 0 \quad \text{B-9}$$

$$CS_{\square}^{n(ap+aq)} - CS_{\square}^{nqq} = a^2b^2(4+2b-b^2)/2(2+b)^2(4-3b^2) > 0 \quad \text{B-10}$$

$$CS_{\square}^{npp} \geq CS_{\square}^{n(ap+aq)} > CS_{\square}^{nqq}, \quad TS_{\square}^{npp} \geq TS_{\square}^{n(ap+aq)} \geq TS_{\square}^{nqq*}$$

$$D_5 \equiv (b^2(3-2b)(2-b^2)-(2-b)^2(1+b)(4-b-b^2)t) < 0$$

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This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

The manuscript was checked for grammar and wording by native Edtage company editors.