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How should durable goods firms combine online and mass media advertisements to promote sales?

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Abstract

We develop an advertising strategy for durable goods firms applying a dual time-period model while considering three-stage game in a Cournot competition. We assume that firms employ two advertising approaches; one is online advertising, which escalates consumers' willingness to purchase goods and the other is conventional mass media advertising, including television and radio, which presents a limited 'evoked set' of goods. The term evoked set implies that consumers only consider a small group of brands prior to making a purchase. As firms understand the character of each advertisement, sales strategy is devised to target a heterogeneous consumer through advertising. Should firms only choose one type of advertisement or a combination of the two kinds of ads available? In this model we assume that firms directly consider both types of advertising. Our analysis demonstrates that online advertisement raises the total number of consumer-product matches in the competitive equilibrium. We also show that firms combine the two types of advertisement to apply the differing effects of each format. Moreover, firms increase revenue through an appropriate mix of advertising strategy, although the cost of advertising might increase. Regarding the future direction of advertising, we anticipate that the combination of both online and conventional strategies will persist, maintaining the growth of a diverse product market.

JEL classification: D15, D43, L13, D82

Keywords:

Durable goods; Online media advertising; mass media advertising; targeting; media strategy

Highlight:

Advertising effect and pricing strategy for durable goods firms.

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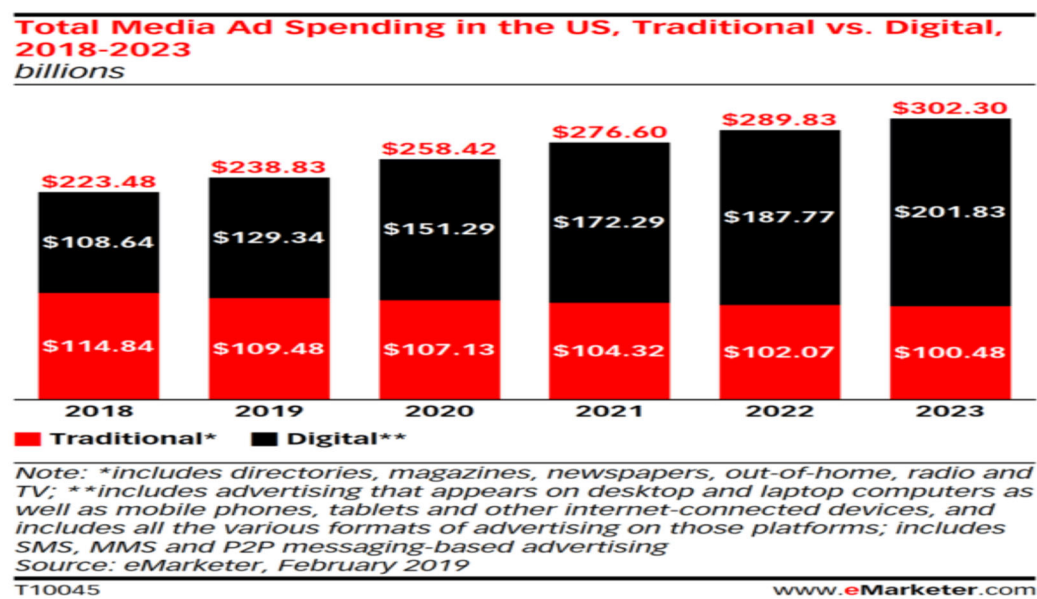
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Introduction

The development and proliferation of Internet technology has pushed the online media advertising market to expand year after year, surpassing mass media advertising in momentum. Google, a subsidiary of Alphabet, reported a 22% increase in revenue in its financial statements for the fourth quarter of 2018 from \$39.12 billion in revenue in the fourth quarter of last year, while Alphabet's revenue was only 99% of the previous year's. Digital platform companies such as Google and Amazon are trying to provide targeted consumers with the advertising information they want from data such as the articles they read, videos they watch, searches they perform, and websites they visit. If a consumer browses a car website with the intention of purchasing a car, the digital platform company will provide customized car advertisements for those who may be interested in or considering purchasing a car. This kind of advertising is also called targeted advertising. This targeted advertising is acceptable to rational consumers who gather the necessary information and use it in their consumption choices. On the other hand, persistent targeted advertising gives consumers a rejection of online advertising, so personalization is being promoted by attaching advertisements that anticipate users' consumption preferences to free delivery services. Mass media such as TV commercials and traditional advertising provide goods information to a wide range of viewers through sensory methods. The effect is to create an evoked set of goods that consumers are willing to buy. The evoked set refers to the target group of brand purchases that consumers consider before making a purchase. Many brand companies spend millions of dollars on advertising to enter the evoked set of consumers. Mass media advertising revenue has not declined much in the past few years, as shown in Figure 1. This seems to suggest that rather than digital advertising replacing traditional advertising (mass media advertising), the

two types of advertising may develop a complementary relationship in the future. In the case of durable goods such as tableware and clothing, the external effects of reputation and advertising are important for long-term demand growth. In recent years, mass media advertising revenue did not reduce much, as displayed in Figure 1.

Figure 1



From <https://www.lyfemarketing.com/blog/-marketing-vs-traditional-marketing/>

In this study, we use a two-period model to analyze the advertising strategy of a durable goods firm that tries to maximize its profits by using two types of advertising in a multi-period market. Since durable goods are classified as "exploratory goods" and are more dependent on advertising than "experiential goods" or "trust goods," it is important for the firm to be among the candidate brands that consumers are willing to buy based on their information gathering. We analyzed the advertising strategies of firms competing in the Cournot competition in a three-stage game to see how firms combine or do not combine the two types of advertising to maximize profits. The first

strategy combines the two types of advertising. The second strategy uses only media advertising or online advertising.

Our results show that a firm's advertising strategy depends on advertising cost and advertising effectiveness. Firms' online advertising choices are selected when there is a large degree of additional consumer goods valuation due to customized advertising. Therefore, if there is a gap between the goods information and the consumer's goods evaluation, firms will use mass media advertising in the first period to disseminate general goods information to consumers. When there is a high degree of congruence between consumers' evaluations and the goods information provided by advertising, firms employ online advertising to stimulate the purchasing motivation of the target consumers by conveying the goods information. Therefore, if firms use the two types of advertising appropriately, social surplus will increase due to increased demand. In the first period one firm will adopt mass media advertising and the other firm will adopt online advertising if the additional consumer valuation due to advertising is moderate. However, in the second period, both firms adopt online advertising in order to stimulate the residual demand of consumers who are already aware of additional goods information. These results show that even with the development and growth of the Internet, traditional media remain an important means of advertising for companies.

The remainder of this paper is organized as follows. In Section 2, we have reviewed the previous researches that are related to our theoretical model. In Section 3, we have described our model and assumptions to analyze the firms' advertising strategy. In Section 4, we have tried to explore optimal means for both firms to maximize their profit with advertising strategy. In Section 5, we have discussed two types of advertising effect regarding durable goods. In Section 6, we

conclude the paper.

2. Literature review

Until now, there have been numerous studies regarding the relationship between advertisement and manufacturing. Boerman et al. (2017) suggested that online behavioral advertising is advertiser-controlled with regards to the level of personalization and consumer-controlled by knowledge. Crampes et al. (2009) found out that media operators are financed both from advertisers and customers regarding media competition with free entry. Goldfarb (2014) found out that the fundamental economic difference between online and offline advertising is a substantial reduction in the cost of targeting. Goldfarb and Tucker (2011) presented online advertising substitutes for offline advertising, in their study. Johnson (2013) examined how the increasing ability of firms targeting their advertisements towards particular individuals influences market outcomes regarding consumers' advertising avoidance. Bergemann and Bonatti (2011) characterized the competitive equilibrium in the advertising markets by distinguishing offline and online on the basis of targeting ability, and further investigated the interaction of offline media and online media. The results of their study revealed that the revenue of offline media decreases. Grossman and Shapiro (1984) investigated why firms in the context of product differentiated market focus more on advertising than others. However, in their model, consumers' choice does not impact by the type of advertising. Dukes (2004) investigated a differentiated product market competition regarding the prices and advertising, and found out that lesser differentiated product markets have higher market levels with respect to advertising levels. He assumed that the producer's purpose regarding advertising is to increase the demand for its product by informing

consumers about the product's existence, availability or price. Esteban and Hernández (2017) studied the market interaction of pricing and informative advertisings, which basically comprises of two types of direct advertising, such as opt-in advertising and without permission direct advertising. Chen and Whinston (2011) found out that with respect to advertising endogenously evaluated within the product market competition, a prominent advertising position might not be desirable for a firm with competitive advantage. Iyer et al. (2005) analyzed the strategic advertising choices regarding firms with respect to imperfect competition (firms selling differentiated product). In their model, the consumers are divided into two groups that the firms target through advertising messages. Esteves (2009) paid attention to the informative effect in advertising. He further examined the dynamic effects of customer poaching regarding the homogeneous product markets, in which firms evaluate the effect of price discrimination on the efficiency properties of advertising. Chen et al. (2019) analyzed consumers' reactance to online personalized advertising and found that consumers' reactance is mediated by individuals' rational choice factors. Chutani and Sethi (2012) and Crampes et al. (2009) conducted studies regarding the durable goods market. They investigated the dynamic durable-goods duopoly with respect to manufacturing along with two independent and competing retailers using advertisement. The present study is related to Dukes (2004), Iyer et al. (2005) and Athey and Gans (2010), who analyzed the impact of targeting on supply and price of advertising. On the other hand, we have examined how firms adopt different advertising for profit maximization with reference to Chutani and Sethi (2012) and Crampes et al. (2009).

3. Model

In this section, we have described the basic set up of our model and presented our assumptions about the product, firms, advertising and consumers. It was assumed that the firm ' i ' ($=1, 2$) has adopted effective advertising and sells Good ' i ', which are durable goods, such as cars and bags. We have used a two-period model where durable goods produced by the firms last for two-periods. The reasoning behind the assumption with respect to two periods is that it simplifies the analysis and facilitates comparisons with most of the existing literature. Further, both firms have the same marginal cost, c , and have adopted Cournot competition. As both the firms face production capacity constraints for their goods, the assumption regarding the Cournot competition seems reasonable. Moreover, it was assumed that the goods do not depreciate over time to avoid the influence of durability and upgrade,¹ thus Good ' i ' provided in both the periods are identical. That is, in the second period, the current Good ' i ' and used Good ' i ' are considered perfect substitutes. There is no time for discounting regarding the firms and customers as the value of the good with respect to both firms has the same spillover. We have also assumed that mass media advertisement, such as television advertisements, creates evoked set by a growing recognition of goods, and online advertising increases consumers' eagerness to buy goods. In such situation, firms attempt to raise demand with the help of such advertisements. The effectiveness of the two advertisements is different regarding mass media and online advertisement, and costs are different as well. When one firm anticipates a rival firm's advertising strategy, the firm concerned corresponds to such strategy to earn a higher degree of consumer's evaluation and sales. Firm ' i ' adopts mass media or online advertisement to stimulate a consumer's willingness to buy with the

¹ Bulow (1986) studied the influence of durability in the selling market.

help of advertising. Online media advertisement requirements depend on the advertising cost and stimulates a consumer's desire to buy with respect to the Good ' i 's distinctive feature. We also assume that the consumer, who is a rational being, accepts the effectiveness of online advertisement as well as the mass media advertisement effect (Chen et al., 2019). Further, we assume a linear inverse demand function and consider a three-stage game with the following time structure:

- Stage 1: Firms ' i ' and ' j ' decide mass media or online media advertisement in the first period and the second period in order to maximize their own profit.
- Stage 2: In the first period, both firms provide their goods simultaneously.
- Stage 3: In the second period, given the sales of first period, both firms provide respective products simultaneously using the advertisement.

To find the best choice for firms, we have used the backward induction method.

3.1 Demand side

We consider that the consumers' willingness to pay increases through the evaluation of customers with the help of advertising. How much can the firms increase a consumers' willingness to pay? We assume consumers are rational because they can anticipate the future value of the goods purchased today. We have considered δ as a consumers' basic willingness to pay for Good ' i ', and it is deemed as the valuation of Good ' i ' for a given period. Further, we assume a continuum of consumers who are heterogeneous. Therefore, δ varies across consumers and is

assumed to be uniformly distributed between $-\infty$ and a (where $a > 0$) with a density of one.² Following Føros (2004), we have allowed negative values of δ to avoid corner solution when all the consumers enter the market. Consumers' additional evaluation $e (> 0)$ by the advertisement homogeneity is related to externality. When Firm ' i ' adopts mass media advertisement, b is the external effect and when Firm ' i ' adopts online advertisement, g is the external effect. The parameters of demand side externality b and g are based on Good ' i 's additional evaluation ' e '. Moreover, we assume $b, g \in (0, 1)$. Hence, when both firms use mass media advertising, consumers' valuation of quality is $\delta + be$. When both firms adopt online advertising, consumers' valuation of quality will be $\delta + ge$. This demand structure is similar to that in Føros (2004) and the quality of durable goods depends on the number of expected consumers connected to firm ' i '. Consumers consider the timing of purchase in order to determine, whether first or the second period provides a better value of Good ' i ' for consumers. When a consumer buys Good ' i ' in the first period, he or she retains it until the end of the second period. When both firms adopt mass media advertisement in the first period and online advertisement in the second period, type δ consumers who buy Good 1 at price p_{11} gain a surplus in both the periods, which is denoted by $2\delta + be + ge - p_{11} > \delta + ge - \hat{p}_{21} > 0$. Where, p_{1i} denotes the price charged for Good ' i ' in the first period, and \hat{p}_{2i} denotes the expected price for Good ' i ' in the second period. If a type δ consumer buys Good 2 at price p_{12} , it is denoted by $\delta + be - p_{11} + \hat{p}_{21} > 0$. If $\delta + be - p_{11} + \hat{p}_{21} < 0$, then the consumer will not buy Good ' i '. If both the firms are active in the first period, in equilibrium, the prices adjusted by be must be:³

² Katz and Shapiro (1985) show that the consumers' valuation at $s + v(q^e_i)$ depends on the number of consumers who are expected to be connected to the firm.

³ If firms are active in the second period, in equilibrium, the price is $\hat{p}_{21} - ge = \hat{p}_{22} - ge$.

$$p_{11} - be - \hat{p}_{21} = p_{12} - be - \hat{p}_{22} = P_1. \quad (1)$$

Equation (1) is formed as long as both firms are active and externality⁴ exists. Thus, the two firms generate a total output of $z_1 = q_{11} + q_{12}$ ($q_{1i} > 0$) in the first period, where q_{1i} is the demand for Good 'i' in the first period. P_1 denotes consumer's willingness to pay for goods in the first period. For a given P_1 , type δ consumers with willingness to pay for two periods as $\delta \geq P_1$, enter the market.⁵ As we assume a uniform distribution, the prices must ensure that $z_1 = a - P_1$, as long as both firms are active in the first period. Considering equation (1), the inverse demand function with respect to the first period is given by:

$$p_{1i} = a + be - q_{11} - q_{12} + \hat{p}_{2i} \quad i = 1, 2 \quad (2)$$

If Firm 'i' adopts online advertisement in the first period, the inverse demand function regarding the first period is given by:

$$p_{1i} = a + ge - q_{11} - q_{12} + \hat{p}_{2i} \quad (3)$$

Given the sales with respect to the first period, if both firms are active and adopt online ads in the second period, the prices adjusted by ge must be the same, that is, $p_{21} - ge = p_{22} - ge = P_2$, where, p_{2i} denotes the price charged for Good 'i' in the second period, and P_2 denotes the consumer's basic willingness to pay for goods in the second period. For P_2 , consumers with $a - z_1 \geq P_2$ will enter the market. If both firms adopt mass media advertisement in the second period, the prices adjusted by be must be the same, that is, $p_{21} - be = p_{22} - be = P_2$. As we have assumed a uniform distribution, there are active consumers in the second period. They generate a total output of $z_2 =$

⁴ If Firm 1 adopts net ads and Firm 2 adopts mass media ads, $p_{11} - ge - \hat{p}_{21} = p_{12} - be - \hat{p}_{22} = P_1$

⁵ The demand for goods in the first period is represented by $z_1 = \int_{\beta}^a d\phi = a - P_1$.

$q_{21} + q_{22} (q_{2i} > 0)$, where q_{2i} denotes the demand for Good 'i' in the second period.⁶ When the two firms supply the total quantity $Q = z_1 + z_2$, prices regarding each period must ensure that $z_1 = a - P_1$ and $z_2 = a - z_1 - P_2$. When firm 'i' adopts online or mass media advertisement, the inverse demand function with respect to the second period is given by:

$$p_{2i} = a + g e - q_{11} - q_{12} - q_{2i} - q_{2j} \quad (4)$$

Or

$$p_{2i} = a + b e - q_{11} - q_{12} - q_{2i} - q_{2j}. \quad (5)$$

3.2 Supply side

Given the consumers' demand, both firms decide with respect to mass media advertisement or online advertisement in the first and second period, and play an output game to maximize their profits. When firm 'i' adopts mass media advertisement for Good 'i' in the first period, the total cost is $f e^2$, where f denotes a coefficient of mass media advertising. We assume f to guarantee that $\pi_{2i} > 0$. If firm 'i' adopts online advertisement, cost of single good is $\gamma (> 0)$.⁷ When firm 'i' adopts mass media advertisement in both periods, firm 'i' faces maximization problem in the first period, which is as follows:

$$\max_{q_{1i}} \Pi_i = q_{1i} (a + b e - q_{11} - q_{12} + \hat{p}_{2i}) + \hat{q}_{2i} \cdot \hat{p}_{2i} - 2f e^2 \quad (6)$$

⁶ This equation is as follows: $z_2 = \int_p^{a-z_1} d\phi = a - z_1 - P_2$.

⁷ Bulow (1982) pointed out that high marginal costs are a signal of lower future output, and thus, higher future prices. However, the current study does not investigate this impact. Hence, we set $c=0$.

Here, \hat{q}_{2i} denotes demand at expected price \hat{p}_{2i} under $q_{11} + q_{12}$. fe^2 denotes Firm 'i's mass advertising cost. When firm 'i' adopts online advertisement in both periods, it faces maximization problem in the first period, which is as follows:

$$\max_{q_{1i}} \Pi_i = q_{12} (a + e g - q_{11} - q_{12} + \hat{p}_{2i} - \gamma) + \hat{q}_{22} (\hat{p}_{22} - \gamma). \quad (7)$$

When firm 'i' adopts mass media advertisement in the first period, and adopts online advertisement in the second period, Firm 'i' faces maximization problem in the first period, which is as follows:

$$\max_{q_{1i}} \Pi_i = q_{12} (a + e g - q_{11} - q_{12} + \hat{p}_{2i}) + \hat{q}_{22} (\hat{p}_{22} - \gamma) - fe^2. \quad (8)$$

Thus, for a given q_{2j} and $q_{11} + q_{12}$, Firm 'i's maximization problem in the second period is as follows:

$$\max_{q_{2i}} \pi_{2i} = q_{2i} (p_{2i} - \gamma) = q_{2i} (a + e g - q_{11} - q_{12} - q_{2i} - q_{2j} - \gamma) \text{ or} \quad (9)$$

$$\max_{q_{2i}} \pi_{2i} = q_{2i} \cdot p_{2i} - fe^2 = q_{2i} (a + b e - q_{11} - q_{12} - q_{2i} - q_{2j}) - fe^2. \quad (10)$$

4. An optimal advertising strategy for both Firms

In this section we investigate, optimal media advertisement for durable goods firms. Firm 'i' considers three strategies. First, Firm 'i' adopts mass media advertisement for two periods. Second, Firm 'i' adopts mass media advertisement in the first period, and adopts online advertisement in the second period. Third, Firm 'i' adopts online advertisement for two periods. There six strategy combinations can be formulated. The firms' media strategy has been presented in Figure 1. Therefore, we have examined the six combinations as follows.

4.1. Case 1: Both Firms choose mass media advertisement in both periods (*mm*)

Third stage: Maximization problem in the second period

When both firms adopt the same mass media advertising firms', the maximization problem have been represented as follows:

$$\max_{q_{2i}} \pi_{2i}^{mm} = q_{2i} \cdot p_{2i} - fe^2 = q_{2i} (a + b e - q_{11} - q_{12} - q_{2i} - q_{2j}) - fe^2. \quad (11)$$

'*mm*' denotes that both firms adopt online ads. After solving the maximization problem regarding Firm '*i*', we have:

$$q_{2i}^{mm} = (a + b e - q_{1i} - q_{1j})/3. \quad (12)$$

On substituting q_{2i}^{mm} into Equation (5), we get

$$p_{2i}^{mm} = (a + b e - q_{11} - q_{12})/3 \quad (13)$$

The equations (12) and (13) are dependent on q_{11}, q_{12} .

Second stage: Maximization problem in the first period

When both firms are active during the second period, expectation price is denoted by $\hat{p}_{2i} = p_{2i}$ ⁸.

Substituting p_{2i}^{mm} into Equation (2), we get:

$$p_{1i}^{mm} = a_i - q_{1i} - q_{1j} + \hat{p}_{2i} = (4a + 4b - 4(q_{11} - q_{12}))/3. \quad (14)$$

Regarding a given q_{1j} , from Equation (12), (13) and (14), Firm '*i*' solves the following problem:

$$\max_{q_{11}} \Pi_1^{mm} = q_{11} \cdot p_{11}^{mm} + q_{21}^{mm} \cdot p_{21}^{mm} - 2fe^2 \quad (15)$$

$$\max_{q_{12}} \Pi_2^{mm} = q_{12} \cdot p_{12}^{mm} + q_{22}^{mm} \cdot p_{22}^{mm} - 2fe^2. \quad (16)$$

⁸ Xue and Su (2011) noted that to complete the model, it was necessary to assume that consumers correctly anticipate the prices charged in the second period: $\hat{p}_2 = p_2$ by Tirole (1988, pp. 81).

$$\text{s.t } \prod_i^{mm} \geq 0$$

Solving Firm 'i's maximization problems from Equation (15) and (16), we get:

$$q_{1i}^{mm} = (10a + 10b e)/32. \quad (17)$$

The abovementioned equilibrium values are presented in Table 1.

4.2. Case 2: Both firms adopt online advertisement in both periods (*nn*)

Third stage: Maximization problem in the second period

When both firms adopt the same online advertisement, firms' maximization problems are represented as follows:

$$\max_{q_{2i}} \pi_{2i}^{nn} = q_{2i} (p_{2i} - \gamma) = q_{2i} (a + e g - q_{11} - q_{12} - q_{2i} - q_{2j} - \gamma). \quad (18)$$

'nn' denotes that both firms have adopted online ads. Solving Firm 'i's maximization problem, we have:

$$q_{2i}^{nn} = (a + 2eg - q_{11} - q_{1j} - \gamma)/3. \quad (19)$$

Substituting q_{2i}^{nn} into Equation (4), we get:

$$p_{2i}^{nn} = (a + eg - q_{11} - q_{12} + 2\gamma)/3 \quad (20)$$

Second stage: Maximization problem in the first period

When both firms are active during the second period, expectation price is $\hat{p}_{2i} = p_{2i}$ ⁹. Substituting p_{2i}^{nn} into Equation (3), we get:

$$p_{1i}^{nn} = a + eg - q_{11} - q_{12} + \hat{p}_{2i} = (4a + 4eg - 4(q_{11} - q_{12}) + 2\gamma)/3. \quad (21)$$

⁹ Xue and Su (2011) noted that to complete the model, it was necessary to assume that consumers correctly anticipate the prices charged in the second period: $\hat{p}_2 = p_2$ by Tirole (1988, pp. 81).

Considering the equations (19), (20) and (21), for a given q_{ij} , Firm 'i' solves the following problem in the first period.

$$\max_{q_{12}} \Pi_1^{nn} = q_{11} (p_{11}^{nn} - \gamma) + q_{21}^{nn} (p_{21}^{nn} - \gamma) \quad (22)$$

$$\max_{q_{12}} \Pi_2^{nn} = q_{12} (p_{12}^{nn} - \gamma) + q_{22}^{nn} (p_{22}^{nn} - \gamma). \quad (23)$$

Solving Firm 'i's maximization problems regarding Equation (21) and (22), we have:

$$q_{1i}^{nn} = (10a + e10g - \gamma)/32. \quad (24)$$

The abovementioned equilibrium values are presented in Table 1.

4.3. Case 3: Firm 'i' adopts mass media (*am*), Firm *j* adopts online advertisement (*an*) in both periods

Third stage: Maximization problem in the second period

Solving firms' maximization problems from Equation (9) and (10), we have:

$$q_{2i}^{am} = (a + (2b - g)e - q_{1i} - q_{1j} + \gamma)/3. \quad (25)$$

$$q_{2j}^{an} = (a + (2g - b)e - q_{1i} - q_{1j} - 2\gamma)/3. \quad (26)$$

Here, '*am*' denotes firm 'i's mass media advertising choice and '*an*' denotes firm '*j*'s online advertising in both periods. We assume $2b_i - g_j \geq 0$ and $2g_j - b_i \geq 0$, where $i, j = 1, 2, i \neq j$. After substituting q_{2i}^{am} and q_{2i}^{an} into Equation (3), we get:

$$p_{2i}^{am} = (a + (2b - g)e - q_{1i} - q_{12} + \gamma)/3 \quad (27)$$

$$p_{2i}^{an} = (a + (2g - b)e - q_{1i} - q_{12} - 2\gamma)/3 \quad (28)$$

From $\hat{p}_{2i} = p_{2i}^*$ and $\hat{p}_{2j} = p_{2j}^*$, Firm 'i's price in the first period is as follows:

$$p_{1i}^{am} = a + eb - q_{1i} - q_{1j} + \hat{p}_{2i} = (4a + (5b - g)e - 4(q_{1i} - q_{1j}))/3. \quad (29)$$

From Equation (29), Firm '*j*'s price is as follows:

$$p_{1j}^{an} = (4a + (5g - b)e - 4(q_{1i} - q_{1j}) + \gamma) / 3. \quad (30)$$

The maximization problem for Firm 'i' in the first period is as follows:

$$\max_{q_{1i}} \Pi_i^{am} = q_{1i} \cdot p_{1i}^{am} + q_{2i}^{am} \cdot p_{2i}^{am} - 2fe^2 \text{ and} \quad (31)$$

$$\max_{q_{1j}} \Pi_j^{an} = q_{1j} (p_{1j}^{an} - \gamma) + q_{2j}^{an} (p_{2j}^{an} - \gamma). \quad (32)$$

Solving Firm 'i's maximization problems with respect to Equation (31) and (32), we have:

$$q_{1i}^{am} = (20a + 2(21b - 11g)e + 7\gamma) / 64. \quad (33)$$

$$q_{1i}^{an} = (20a - (21g - 11b)e - 9\gamma) / 64. \quad (34)$$

The abovementioned equilibrium values are presented in Table 1.

4.4. Case 4: Both Firms adopt mass media advertisement in the first period and adopt online advertisement in the second periods (*mo*)

Third stage: Maximization problem in the second period

The Firms' maximization problems are represented by Equation (9) in three cases. Solving Firm 'i's maximization problem, we have:

$$q_{2i}^* = (a + ge - q_{1i} - q_{1j} - \gamma) / 3. \quad (35)$$

We assume $2g_i - g_j \geq 0$, where $i, j = 1, 2, i \neq j$. On substituting q_{2i}^* into Equation (4), we get

$$p_{2i}^* = (a + ge - q_{1i} - q_{1j} + 2\gamma) / 3 \quad (36)$$

Second stage: Maximization problem in the first period

When both firms are active during the second period, the expectation price is $\hat{p}_{2i} = p_{2i}^{10}$.

Substituting p_{2i}^* into Equation (3), we get:

¹⁰ Xue and Su (2011) noted that to complete the model, it was necessary to assume that consumers correctly anticipate the prices charged in the second period: $\hat{p}_2 = p_2$ by Tirole (1988, pp. 81).

$$p_{1i}^{mo} = a_i - q_{1i} - q_{1j} + \hat{p}_{2i} = (4a + (3b + 2g)e - 8(q_{11} - q_{12}) + 2\gamma)/3. \quad (37)$$

Here, ‘mo’ denotes that both firms adopt mass media ads in the first period.

Considering the given q_{1j} , with respect to Equation (35), (36) and (37), Firm ‘i’ solves the following problem:

$$\max_{q_{11}} \Pi_1^{mo} = q_{11} \cdot p_{11}^{mo} + q_{21}^{mo} (p_{21}^{mo} - \gamma) - fe^2 \quad (38)$$

$$\max_{q_{12}} \Pi_2^{mo} = q_{12} \cdot p_{12}^{mo} + q_{22}^{mo} (p_{22}^{mo} - \gamma) - fe^2. \quad (39)$$

$$\text{s.t } \Pi_t^{mo} \geq 0$$

After solving Firm ‘i’'s maximization problems regarding Equation (38) and (39), we have:

$$q_{1i}^{mo} = (20a + (8b + 2g)e + 16\gamma)/64. \quad (40)$$

The abovementioned equilibrium values are presented in Table 1.

4.5. Case 5: Firm ‘i’ adopts mass media and advertisement (amo) in each period, Firm ‘j’ adopts online advertisement (ann) in both periods

Third stage’s maximization problem regarding both firms in the second period is the same with respect to Equation (35) and (36). Therefore, from $\hat{p}_{2i} = p_{2i}^*$ and $\hat{p}_{2j} = p_{2j}^*$, Firm ‘i’'s price in the first period is as follows:

$$p_{1i}^{amo} = a + b e - q_{1i} - q_{1j} + \hat{p}_{2i} = (4a + (2b + 2g)e - 4(q_{1i} - q_{1j}) + 2\gamma)/3. \quad (41)$$

Here, ‘amo’ denotes ‘Firm ‘i’ choosing mass media advertisement’, and ‘ann’ denotes Firm ‘j’ selecting online advertisement’ in both periods. Considering Equation (3), Firm ‘j’'s price is as follows:

$$p_{1j}^{ann} = (4a + 4eg - 4(q_{1i} - q_{1j}) + 2\gamma)/3. \quad (42)$$

The maximization problem for Firm ‘i’ in the first period is as follows:

$$\max_{q_{1i}} \Pi_i^{amo} = q_{1i} \cdot p_{1i}^{amo} + q_{2i}^{amo} (p_{2i}^{amo} - \gamma) - fe^2 \text{ and} \quad (43)$$

$$\max_{q_{1j}} \Pi_j^{ann} = q_{1j} (p_{1j}^{ann} - \gamma) + q_{2j}^{ann} (p_{2j}^{ann} - \gamma). \quad (44)$$

Solving Firm ‘i’'s maximization problems from Equation (43) and (44), we have:

$$q_{1i}^{amo} = (20a + (33b - 13g)e + 31\gamma)/64. \quad (45)$$

$$q_{1i}^{ann} = (20a - (15b - 35g)e - 17\gamma)/64. \quad (46)$$

The abovementioned equilibrium values are presented in Table 1.

4.6. Case 6: Firm ‘i’ adopts both periods mass media (*amm*) and firm ‘j’ adopts mass media and online advertisement (*Amo*) in each period

Third stage’s maximization problems with respect to both firms in the second period are the same regarding Case 3. Therefore, considering $\hat{p}_{2i} = p_{2i}^*$ and $\hat{p}_{2j} = p_{2j}^*$, Firm ‘i’'s price in the first period is as follows:

$$p_{1i}^{amm} = a + be - q_{1i} - q_{1j} + \hat{p}_{2i} = (4a + 2(b + g)e - 4(q_{1i} - q_{1j}) + \gamma)/3. \quad (47)$$

‘*amm*’ denotes ‘Firm ‘i’ choosing mass media advertisement in both periods’ and ‘*amo*’ denotes ‘Firm ‘j’ choosing mass media advertisement in the first period and online advertisement in the second period’. Considering equation (4), Firm ‘j’'s price is as follows:

$$p_{1j}^{Amo} = (4a + (5b - g)e - 4(q_{1i} - q_{1j}) + \gamma)/3. \quad (48)$$

The maximization problem with respect to Firm ‘i’ in the first period is as follows:

$$\max_{q_{1i}} \Pi_i^{amm} = q_{1i} \cdot p_{1i}^{amm} + q_{2i}^{amm} \cdot p_{2i}^{amm} - 2fe^2 \text{ and} \quad (49)$$

$$\max_{q_{1j}} \Pi_j^{Amo} = q_{1j} \cdot p_{1j}^{Amo} + q_{2j}^{Amo} (p_{2j}^{Amo} - \gamma) - fe. \quad (50)$$

Solving Firm 'i's maximization problems regarding Equation (49) and (50), we have

$$q_{1i}^{amm} = (20a + (11b + 9g)e + 24\gamma)/64. \quad (51)$$

$$q_{1i}^{Amo} = (20a + (27b - 7g)e - 8\gamma)/64. \quad (52)$$

The abovementioned equilibrium values are presented in Table 1.

5. The acceptance condition of advertisement fee for firms and firms' decision

Firm 'i's production condition $q_{2i}^{nn} > 0$ regarding the second period requirement is as follows:

$$\hat{\gamma}_i = 2(a + eg)/5 \quad (53)$$

Therefore, online advertising fee has to be $\gamma (< \hat{\gamma}_i)$ with regards to Firm 'i'.

Similarly, from $\pi_{2i}^{mm} > 0$, the condition of an investment coefficient f for the durable goods firm is as follows:

$$f^* = (a + be)^2 / 128e^2. \quad (54)$$

Therefore, the investment coefficient has to be $f(< f^*)$ for Firm i .

Figure 2

Both firms' advertisement strategy in online and mass media

Firm $i \setminus$ Firm j	mm	mo	nn
mm	Π_i^{mm}, Π_j^{mm}	Π_i^{amm}, Π_j^{Amo}	Π_i^{am}, Π_j^{an}
mo	Π_i^{Amo}, Π_j^{amm}	Π_i^{mo}, Π_j^{mo}	Π_i^{amo}, Π_j^{ann}
nn	Π_i^{an}, Π_j^{am}	Π_i^{ann}, Π_j^{amo}	Π_i^{nn}, Π_j^{nn}

Under these condition of two fee, such advertising fee condition, We set $e^* \equiv_{\text{def}} \{e: \Pi_i^{mn}(b, e, f) > 0\}$, $\hat{e} \equiv_{\text{def}} \{e: \Pi_i^{Amo}(b, g, e, f) = \Pi_i^{an}(b, g, e)\}$ and $\check{e} \equiv_{\text{def}} \{e: \Pi_i^{mo}(b, g, e, f) = \Pi_i^{ann}(b, g, e)\}$, $\bar{e} \equiv_{\text{def}} \{e: \Pi_i^{amo}(b, g, e, f) = \Pi_i^{nn}(b, g, e)\}$. It shows $\check{e} < \bar{e}$. When Firm 'j' adopts mass media advertisement in two periods (mm), if $0 < e < \hat{e}$, $\Pi_i^{mm} < \Pi_i^{an} < \Pi_i^{Amo}$ then, Firm 'i' adopts mass media advertisement in the first period and chooses online advertisement in the second period (mo). If $\hat{e} < e < e^*$, $\Pi_i^{mm} < \Pi_i^{Amo} < \Pi_i^{an}$, Firm 'i' adopts online advertisement for both the periods (nn). When Firm 'j' adopts 'mo', if $0 < e < \check{e}$, $\Pi_i^{amm} < \Pi_i^{ann} < \Pi_i^{mo}$, then, Firm 'i' also adopts 'mo'. If $\check{e} < e < e^*$, $\Pi_i^{amm} < \Pi_i^{mo} < \Pi_i^{ann}$, then Firm 'i' adopts 'nn'. When Firm 'j' adopts 'nn', if $0 < e < \bar{e}$, $\Pi_i^{mm} < \Pi_i^{nn} < \Pi_i^{amo}$ then Firm i adopts 'mo'. If $\bar{e} < e < e^*$, $\Pi_i^{am} < \Pi_i^{amo} < \Pi_i^{nn}$, then Firm 'i' adopts 'nn'. In view of the symmetry, Firm 'j' gains same choice. Therefore, the following proposition was presented:

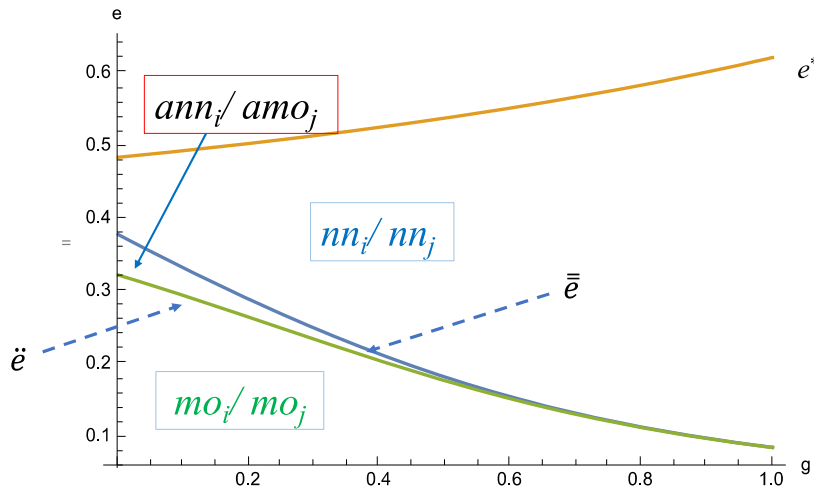
Proposition 1. In equilibrium, if $0 < e < \check{e}$, then both firms adopt 'mo'. If $\check{e} \leq e \leq \bar{e}$, then each firm adopts a different media, i.e. Firm 'i' adopts 'mo' and Firm 'j' adopts 'nn'. If $\bar{e} \leq e \leq e^*$, then both firms adopt 'nn'.

The Firms' choice is dependent upon 'e'. If the advertising message effect 'e' is small, as both firms primarily attempt to impress a thing on an unspecified majority consumers' mind regarding good 'i' by offering lower costs in the first period, such as television ads. Moreover, as firms target specified consumer with the help of monitoring data in the second period, firms adopt 'mo'. On the other hand, if 'e' is large, as both firms attempt to impress a thing on a specific consumer's

mind through online ads, both firms adopt ‘nn’ from the beginning. If ‘e’ is medium level, then each firm adopts an inverse choice. Furthermore, we pay attention to the change of the price elasticity regarding the different the advertisement. In the first period, consumer is more sensitive to the price than the second period. In addition, when ‘e’ is higher, price elasticity of demand due to the online advertising becomes higher than mass media. Especially, in the second period, as price elasticity under the online advertising is higher than mass media, durable-goods firm get additional demand by a small price change. It means that the first period’s price also is higher than mass media advertising.¹¹

The following Figure 3 shows that when "b" is fixed, the area selected by a company changes according to "e" and "g". In this figure, we set $a = 1, f = 1, c = 0.05, b = 0.6$.

Figure 3



¹¹ When $a = 1, b = 0.6, g = 0.8, e = 0.5, \gamma = 0.05$, the price elasticity ($= (p/q)/(dp/dq)$) in the second period is 1.43 with ‘nn’ and 0.77 with ‘mo’. The price elasticity ($= (p/q)/(dp/dq)$) in the first period is 1.29 with ‘nn’ and 1.20 with ‘mo’.

If $b > g$, as Firm i 's boundary is higher, $\tilde{e} > \bar{e}$. Therefore, when Firm j adopts 'mm', if $0 < e < \hat{e}$, $\Pi_i^{mm} < \Pi_i^{an} < \Pi_i^{Amo}$, Then, Firm i adopts 'mo'. If $\hat{e} < e < e^*$, $\Pi_i^{mm} < \Pi_i^{Amo} < \Pi_i^{an}$, then Firm i adopts 'nn'. When Firm j adopts 'mo', if $0 < e < \tilde{e}$, $\Pi_i^{amm} < \Pi_i^{ann} < \Pi_i^{mo}$, then Firm i adopts 'mo'. If $\tilde{e} < e < e^*$, $\Pi_i^{amm} < \Pi_i^{mo} < \Pi_i^{ann}$, then Firm i adopts 'nn'. When Firm j adopts 'nn', if $0 < e < \bar{e}$, $\Pi_i^{am} < \Pi_i^{nn} < \Pi_i^{amo}$, then Firm i adopts 'mo'. If $\bar{e} < e < e^*$, $\Pi_i^{am} < \Pi_i^{amo} < \Pi_i^{nn}$, then Firm i adopts 'nn'. Therefore, we have the following lemma:

Lemma 1. If $b > g$, in equilibrium, if $0 < e < \tilde{e}$, both firms adopt 'mm'. if $\tilde{e} < e < \bar{e}$, both firms adopt 'mo'. If $\bar{e} \leq e \leq e^*$, both firms adopt 'nn'.

6. Concluding remarks

In the present study, we examine how firms use advertising properly to the specified and unspecified majority consumers to keep up sales for long periods with the help of two types of advertising. From results, firms make proper use of advertising and stimulate their buying intention with mass and online media advertising to spread demand in each period. As online media advertisement is more important tool than mass media advertisement for increasing a firm's profitability, firms would like to increase online media advertisement, but it seems excess online media advertisement sometimes leads consumers' negative response. It explains mass media advertisement is an important tool in the progressive Internet society as usual. We have a think as online and mass media advertising have different abilities, the two media have complementary

or reciprocal relations regarding firms, as well. That is, the combination of online and mass media advertising is a useful form of advertising for the growth of product market. In future study, we would like to examine the relationship of consumer's negative advertisement effect and firms' advertisement strategy using two types advertisement.

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TABLE 1

Equilibrium Values Duopoly market in the three case

Firm i (Firm j)	q_{1i}	p_{1i}	q_{2i}	p_{2i}
$mo (mo)$	$(20a+2e(9b+g)+16\gamma)/64$	$(4a+2e(b+g))/8$	$(4a+e(6b-10g)-16\gamma)/32$	$(4a+e(6b-10g)+16\gamma)/32$
$mm (nn)$	$(20a+e(33b-13g)+31\gamma)/64$	$(4a+e(5b-g)+3\gamma)/8$	$(4a-e(3b-7g)-13\gamma)/32$	$(4a-e(3b-7g)-13\gamma)/32$
$nn (mo)$	$(20a-e(15b-35g)-17\gamma)/64$	$(4a+e(3b-7g)+3\gamma)/8$	$(4a-e(3b+7g)-13\gamma)/32$	$(4a-e(3b+7g)-13\gamma)/32$
$nn (nn)$	$(10a+10eg-\gamma)/64$	$(2a+2eg+3\gamma)/4$	$(2a+2eg-5\gamma)/16$	$(2a+2eg+11\gamma)/64$
$mm(mo)$	$(20a+e(10b+9g)+24\gamma)/64$	$(4a+e(5g-6b))/8$	$(4a+e(-11b+21g)-24\gamma)/32$	$(4a-e(17b+21g)+8\gamma)/64$
$mm (mm)$	$(10a+10eb)/32$	$(2a+2eb)/4$	$(2a+2eb)/64$	$(2a+e(9b-7g))/64$
$mo(nn)$	$(20a-5e(3b+7g)-17\gamma)/64$	$(4a+e(5b-g)+3\gamma)/8$	$(4a-e(3b-7g)-13\gamma)/32$	$(4a-e(3b-7g)+26\gamma)/32$
Revenue	$\Pi_i^{moi} = (44a^2 + 64\gamma^2 + 44ae(b+g) + 64\gamma e(b-g) + e^2(27b^2 + 27g^2 - 10bg))/256 - e^2f$ $\Pi_i^{mmo} = (11a^2 + 22abe + e^2b^2)/256 - 2e^2f$ $\Pi_i^{Amo} = (176a^2 + 576\gamma^2$	$\Pi_i^{ami} = (176a^2 + 163\gamma^2 + \gamma e(788b - 524g) + 88a(3\gamma + 10be - 6eg) + 4e^2(291b^2 - 362bg + 115g^2))/1024 - 2e^2f$ $\Pi_i^{amm} = (176a^2 + 64\gamma^2 + 128e\gamma(b-g) + 88ae(3\gamma - 7b) + e^2(603b^2 - 590bg + 163g^2))/1024 - 2e^2f$	$\Pi_i^{amo} = (176a^2 + e\gamma(586b - 322g) + 88a(3\gamma + 5be - eg) + e^2(339b^2 - 238bg + 75g^2) + 355\gamma^2)/1024 - e^2f$ $\Pi_i^{ann} = (176a^2 + 339\gamma^2 + 110\gamma e(3b - 7g) - 88a(5\gamma + 3be - 7eg) + 11e^2(3b - 7g)^2)/1024$	$\Pi_i^{ani} = (176a^2 - 88a(5\gamma + 3e(2b + 5g)) - 4e^2(115b^2 - 362bg + 1291g^2) + 4e\gamma(229b - 339g) + 531\gamma^2)/1024$ $\Pi_i^{nn} = (44a^2 + 27\gamma^2 - 44e^2g^2 - 44\gamma eg - 44a(\gamma - 2eg))/256$

$$+ 768e\gamma(b-g) + 88ae(-$$

$$b + 5g) + e^2(267b^2 -$$

$$622bg + 531g^2))/1024 -$$

$$e^2f$$

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