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Forward advertising: A competitive analysis of new product preannouncement

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ABSTRACT

This paper develops a game-theoretical model wherein duopolistic firms launch a new product and invest in informative advertising. We allow firms to adopt new product preannouncement (NPP), which is a strategy of forward advertising for a future product. The results show that NPP relaxes market competition and that firms with different advertising costs have different incentives to apply NPP. We also allow firms to adopt retaliatory preannouncement as a response to NPP, and find that NPP is always good for the high-cost firm but may be bad for the low-cost firm. We further investigate the welfare effects of NPP, showing that NPP makes customers worse off while has ambiguous effects on total welfare.

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1. Introduction

New product preannouncement (NPP) is a marketing communication that forward advertises for future products. It is reported that 51% of U.S. companies launch NPP programs in their marketing efforts (Robertson, 1993). NPP is becoming increasingly pervasive in most highly competitive industries, such as consumer electronics, telecommunications, automobiles, and airlines. Well-known examples include Apple's iPhone and iPad series, Microsoft's Windows series, Warner Bros.' movies, BMW's new cars, Boeing's 787 Dreamliner, and Amazon's upcoming businesses.

Why are firms likely to preannounce their products? Previous research in marketing and economics attributes it to the following reasons. First, NPP is helpful in preempting a product or market position (Calantone and Schatzel, 2000; Robertson et al., 1995). Second, NPP can deter potential entry by signaling the incumbent's advantage on product development costs, thereby leaving potential entrants unprofitable or with too small segments (Bayus et al., 2001; Eliashberg and Robertson, 1988). Third, NPP creates brand loyalty when customers wait and prepare for preannounced goods (Kohli, 1999). Fourth, NPP saves advertising costs because it accelerates the creation of market base through word-of-mouth (Homburg et al., 2009). NPP also has other strategic effects, such as seeking alliances or encouraging complementary product design (Robertson, 1993), providing supply chain partners with the opportunity to better plan (Schatzel and Calantone, 2006), and providing information to the stock market (Eddy and Saunders, 1980).

This paper provides an exception case where conventional rationales for the use of NPP are absent. We establish a model wherein two firms simultaneously and non-cooperatively invest in advertising and compete on prices. Using a game-theoretical method, we find that NPP (i.e., forward advertising) can be beneficial if there is no benefit from market preemption, entry deterrence, brand loyalty, or word-of-mouth. We attempt to demonstrate that the change in the advertising sequence may be an important factor in the popularity of NPP.

Another phenomenon of interest in this paper is that different firms react differently in the presence of NPP. For example, Tmall.com, the largest B2C online retailer in China, preannounces its upcoming products and services (e.g., the Singles' Day online shopping festival). One of its major competitors, JD.com, always follows by preannouncing similar goods or services. In contrast, Suning.com rarely makes retaliatory preannouncements, although it also plans to provide the same offerings. More examples include Ford and General Motors with regard to CD-quality radios and PPG and EIC Laboratories with regard to new lenses for sunglasses (Lilly and Walters, 2000). Robertson et al. (1995) provide some data on the incidence of NPP reactions, showing that 50.4% of the firms in their sample make retaliatory preannouncements and 49.6% do not.

This paper studies firms' responses to NPP and shows that firms may optimally use retaliatory preannouncements to influence competition or remain inactive to free ride on the benefits of NPP. This potentially explains why different firms react differently to NPP.

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Related literature. The literature on NPP has been developed in three directions — why firms engage in NPP, the timing and content of NPP, and the effects of NPP.

In the first branch of research, scholars have identified several benefits of NPP, which we have already shown. In the second branch, the timing of NPP is a widely studied problem. Kohli (1999) shows that NPP timing is contingent on product-, design-, and industry-related factors. Su and Rao (2011) establish a game-theoretic model of NPP timing and provide conditions under which NPP should be made earlier, made later, or postponed. Bayus et al. (2001) and Jung (2011) claim that firms can intentionally omit the preannounced products or delay the preannounced date to deter entry. In contrast, Hendricks and Singhal (1997) and Herm (2013) find empirical evidence that firms who delay launches risk a loss of brand trust and face significant penalties.

The content of NPP is another important problem in the second branch of study. Popma et al. (2006) empirically verify that the content of NPP in the DRAM memory chip industry is generally product- and time-related. They claim that the content of NPP can affect competitive interaction, change perceptions of competitors, and provoke competitive reaction. Homburg et al. (2009) claim that to improve NPP effectiveness, the content of NPP designed by pioneers should focus on the reduction of perceived product risk, whereas the content adopted by late followers should emphasize the relative product advantage.

In the third branch, scholars have discovered various effects of NPP. Among these studies, Dahlén et al. (2011) study how NPP affects consumers' responses or valuations; Dranove and Gandal (2003) discuss how NPP influences the adoption of complementary products; and Sorescu et al. (2007) examine the relationship between NPP and the benefits to other market participants such as suppliers, distributors, investors, and shareholders. Regarding the effects of NPP on competitors, Robertson et al. (1995) find that competitive reactions are positively related to perceived hostility, the credibility of NPP signal, and the strength of patent protection.

To our best knowledge, this article is the first to investigate the competitive effects of NPP in a game-theoretic framework. It contributes to the first branch by proposing an additional explanation of NPP, to the second branch by proving the determinants of NPP timing, and to the third branch by showing how competitors optimally react to NPP.

This paper is also close to the literature on informative advertising. This literature considers advertising as an informative tool without which consumers cannot be aware of the existence of products. Among these studies, Narasimhan (1988); Varian (1980), and Koçaş and Bohlmann (2008) set the information structure as exogenous and focus on how firms engage in mixed price competition. Another approach used by Grossman and Shapiro (1984); Hamilton (2009); Soberman (2004), and Zhang et al. (2012) allows firms to sell differentiated products, under which firms optimally set pure advertising and pure pricing strategies.

Our current paper is most closely related to the research that focuses on homogenous products and analyzes how firms compete on pure strategies in advertising and mixed strategies in price. In this field, Butters (1977); Stahl (1994), and Esteves (2009) assume that advertising and price are simultaneously decided by competing firms, and Ireland (1993); McAfee (1994), and De Nijs (2013) assume that advertising and price are sequentially decided. We contribute to this field of study by considering the possibility of NPP, which refers to the case where one firm chooses its advertising strategy prior to the other, who decides its advertising level at the same time as the price competition. We also compare the NPP model to the simultaneous or sequential advertising-pricing model, thereby identifying the competitive effects of NPP.

Findings. We establish a simple model in which two firms produce a new product and compete for homogeneous consumers along dimensions of price and informative advertising. When NPP is not applicable, firms simultaneously choose the level of advertising and price at the product launch time. When NPP is applicable, one or both firms can advertise before the product launch time.

We first discuss the case where only one firm uses NPP, from which we find that NPP has an anti-competition effect because if firms advertise simultaneously, they do not know what level their competitor will choose. The optimal decision for each firm is to set the advertising level as high as possible provided that the cost can be balanced. In contrast, if one firm adopts NPP, the preannouncing firm decides the amount of advertising based on the expectation of the follower's response function. As a forward-looking entity, the preannouncing firm will reduce its advertising level so that the competition can be alleviated. As such, NPP not only improves the preannouncing firm's profit but also enables the follower to free ride from the relaxed competition.

Furthermore, we show that NPP can be an endogenous outcome and firms with different advertising costs have different motives to use NPP. This is because NPP requires the preannouncing firm to "sacrifice" itself by not informing too many customers. This requirement is more acceptable to the high-cost firm who can save more advertising expenditures through NPP relative to the low-cost firm.

We also extend the model to incorporate firms' reactions to NPP. It is found that if a firm is inactive in the presence of NPP, the advertising game between competitors will be characterized by the second-mover advantage; while if the firm makes a retaliatory preannouncement, the game will be characterized by the first-mover advantage. Thus, it is possible that firms make retaliatory preannouncements or do not take any action depending on the advertising costs they are endowed with. If NPP and the reactions to NPP are endogenously determined, we find that the high-cost firm is always better off, while the low-cost firm may lose its cost advantage and become worse off.

This paper finally investigates the pricing and welfare effects of NPP. It is shown that when NPP is applicable, firms charge higher prices in most cases. As to welfare issues, NPP may increase or decrease the total welfare depending on the number of actual buyers and the total advertising expenditures. Additionally, NPP is always bad for consumers, who may be charged higher prices or receive less advertising information.

The reminder of this paper is organized as follows. Section 2 introduces the model. Section 3 analyzes the non-NPP model as a benchmark. Section 4 analyzes the NPP model without allowing NPP retaliation. Section 5 extends the model by allowing NPP retaliation. Section 6 analyzes the pricing and welfare effects of NPP. Section 7 concludes the paper.

2. The model

Two firms, denoted by $i \in \{1, 2\}$, launch a new homogeneous product with zero production cost. They invest in informative advertising and compete on price, denoted by p_i. A continuum of consumers with total measure one desire at most one unit of the good. They care only about the price and have a common reservation price for the product, which is normalized to one.

Consumers are initially unaware of the existence of the new product (Esteves, 2009). The only way they are informed about the product is through advertising. Let $\phi_i \in [0, 1]$ be the advertising intensity, which can be interpreted as the fraction of consumers exposed to product i's ad. The cost of reaching fraction ϕ_i of consumers is assumed to be $\frac{c_i}{2}\phi_i^2$, where c_i is the cost parameter. Without loss of generality, let $c_1 = 0 < c_2 = c$. That is, firm 1 (the low-cost firm) is more efficient than firm 2 (the high-cost firm) in informing consumers through advertising. This assumption is reasonable because, in practice, firms' advertising expenditures usually differ from each other; for example, firms have different capabilities to target advertising toward consumers (Iyer et al., 2005; Zhang et al., 2016) or their cooperating media platforms have different efficiencies in broadcasting (Peitz and Valletti, 2008). As two NPP-firm examples that we have mentioned, Suning ranked second in terms of outdoor advertisement placement in 2010, while Tmall did not rank among top 20 advertisers (CTR Market Research, 2011). Indeed, as will soon become clear, the assumption of asymmetric advertising costs is helpful to explain why some firms have stronger incentives to embrace NPP than others.

The imperfect information provision described above segments the market as follows: a fraction $\phi_i\phi_j$ of consumers receives ads from both brands, a fraction $\phi_i(1-\phi_j)$ receives advertising from only one brand, and a fraction $(1-\phi_i)(1-\phi_j)$ receives no ad and stays out of the market ($j = 1, 2,\ j \neq i$). The captive segment $\phi_i(1-\phi_j)$ patronizes firm i as long as $p_i \leq 1$. The selective segment $\phi_i\phi_j$ patronizes firm i as long as $p_i < p_j$ and $p_i \leq 1$.

The timing of the game is as follows:

- Stage 1 (NPP time): Firms decide whether to advertise prior to the launch of the product. If firm i does so, it also sets the volume of advertising, ϕ_i.[1]
- Stage 2 (product launch time): Firms set p_1 and p_2 simultaneously, and at the same time, the firm who does not advertise in stage 1 also chooses its advertising intensity.[2]

The sequence above implicitly assumes that price decisions are made close to the product launch time. This assumption is acceptable because price setting is short run and prices can vary from day to day (Ireland, 1993). Furthermore, if neither firm uses NPP, our model will degenerate to the simultaneous advertising-pricing game analyzed by Butters (1977); Stahl (1994), and Esteves (2009). If both firms preannounce their goods, the model will be the same as the sequential game in which firms first invest in advertising and then compete on price, as analyzed by Ireland (1993); McAfee (1994), and De Nijs (2013). However, the NPP game where one firm forward advertises and the other advertises at the time of product launch has not been well studied.

3. No preannouncement benchmark

This section analyzes the benchmark case in which NPP is not available to either firm. Each firm simultaneously chooses (independent of its rival) an intensity of advertising ϕ_i and a single price p_i. As customers are imperfectly informed, a pure strategy price equilibrium fails to exist because if such an equilibrium exists, any deviant firm can undercut the equilibrium price by an infinitesimal degree to capture the entire selective segment and thereby earn a higher profit. Thus, the price equilibrium can only occur in mixed strategies (Narasimhan, 1988; Varian, 1980).

Suppose that firm i selects a price randomly from CDF $F_i(p)$, which is the probability that firm i's price is less than p. Let $\bar{F}_i(p) = 1 - F_i(p)$; then, firm i wins the selective segment (at price p) with a probability of $\bar{F}_j(p)$. Thus, firm i's expected profit is given by

$$\pi_i = p\phi_i(1-\phi_j) + p\phi_i\phi_j\bar{F}_j(p) - \frac{c_i}{2}\phi_i^2, \tag{1}$$

where the first (second) term is the revenue obtained from the captive (selective) segment and the third term is the cost of advertising. Let R_i be firm i's revenue (equal to the profit plus the cost):

$$R_i = p\phi_i(1-\phi_j) + p\phi_i\phi_j\bar{F}_j(p). \tag{2}$$

Table 1
Equilibrium results under the benchmark.

Variable	ϕ_1	ϕ_2	π_1	π_2
Equilibrium	1	$\frac{1}{1+c}$	$\frac{c}{1+c}$	$\frac{c}{2(1+c)^2}$

To derive the equilibrium prices, we should assume that $\phi_L > \phi_S$ ($L, S = 1, 2,\ L \neq S$), where L (S) refers to the relatively larger (smaller) firm. Following Narasimhan (1988), the larger firm is indifferent between setting $p = 1$ and $p = p_{\min}$, where $p_{\min}$ is the minimum possible price. Thus, $R_L = \phi_L(1-\phi_S) = \phi_L p_{\min}$, i.e., $p_{\min} = 1 - \phi_S$. By charging $p = p_{\min}$, the smaller firm obtains the revenue $R_S = \phi_S(1-\phi_S)$. Each firm must receive the same revenue within the price support $[p_{\min},\ 1]$. Therefore, $\phi_L(1-\phi_S) = p\phi_L(1-\phi_S) + p\phi_L\phi_S\bar{F}_S(p)$ and $\phi_S(1-\phi_S) = p\phi_S(1-\phi_L) + p\phi_L\phi_S\bar{F}_L(p)$, from which we have

$$F_L(p) = \frac{1}{\phi_L} - \frac{1-\phi_S}{\phi_L}\cdot\frac{1}{p}, \quad p \in [1-\phi_S, 1], \tag{3}$$

$$F_S(p) = \frac{1}{\phi_S} - \frac{1-\phi_S}{\phi_S}\cdot\frac{1}{p}, \quad p \in [1-\phi_S, 1], \tag{4}$$

where the larger firm has a mass $1 - \frac{\phi_S}{\phi_L}$ and the smaller firm has zero density at price 1.

The profits of the larger firm and the smaller firm are given by, respectively,

$$\pi_L = \phi_L(1-\phi_S) - \frac{c_L}{2}\phi_L^2, \tag{5}$$

$$\pi_S = \phi_S(1-\phi_S) - \frac{c_S}{2}\phi_S^2. \tag{6}$$

Because ϕ_i and $F_i(p)$ are decided simultaneously, the optimal ϕ_i should maximize the profit in Eq. (1). The partial derivative of π_i with respect to ϕ_i is $\frac{\partial\pi_i}{\partial\phi_i} = p(1-\phi_j) + p\phi_j\bar{F}_j(p) - c_i\phi_i$, from which we obtain the first-order condition $\frac{\partial\pi_i}{\partial\phi_i} = 0 \Leftrightarrow R_i - c_i\phi_i^2 = 0$. The second-order condition is $\frac{\partial^2\pi_i}{\partial\phi_i^2} = -c_i$. Therefore, if $c_i > 0$, firm i will choose

$$\phi_i = \sqrt{\frac{R_i}{c_i}}, \tag{7}$$

where

$$R_i = \begin{cases} \phi_i(1-\phi_j), & if\ \phi_i \geq \phi_j, \\ \phi_i(1-\phi_i), & if\ \phi_i < \phi_j. \end{cases} \tag{8}$$

It is easy to prove that $\phi_i > \phi_j$ as long as $c_i < c_j$.[3] In our model, $c_1 = 0 < c_2 = c$, so we have $\phi_2 = \sqrt{\frac{R_2}{c}} < \phi_1 = 1$ ($\frac{\partial\pi_1}{\partial\phi_1} > 0$). Substituting $R_2 = \phi_2(1-\phi_2)$ into $\phi_2 = \sqrt{\frac{R_2}{c}}$ yields $\phi_2 = \frac{1}{1+c}$. Thus, we can obtain the equilibrium in Table 1.

Table 1 implies that the benchmark has a unique equilibrium, which is consistent with the simultaneous advertising-pricing model developed by Butters (1977); Stahl (1994), and Esteves (2009). Our model differs from theirs in that we assume asymmetric advertising costs, and we therefore find the possibility of

[1] If a firm is indifferent between NPP and non-NPP, we assume that it will choose not to apply NPP. An alternative assumption is that firms who launch NPP programs incur a fixed cost f, which is small (ensuring a positive equilibrium profit) but not zero.

[2] In Section 5, we will extend the game sequence by incorporating firms' reactions to NPP.

[3] Suppose that $c_1 < c_2$ and $\phi_1 \leq \phi_2$. Then, $R_2 = \phi_2(1-\phi_1)$ and $R_1 = \phi_1(1-\phi_1)$. Substituting $\phi_i = \sqrt{\frac{R_i}{c_i}}$ into these equations yields $\phi_1 = \frac{1}{1+c_1}$ and $\phi_2 = \frac{c_1}{c_2}\frac{1}{1+c_1}$, which implies that $\phi_2 < \phi_1$, a contradiction. Therefore, the high-cost firm must set a lower level of advertising than the low-cost firm.

an asymmetric equilibrium where the low-cost firm provides more advertising information than the high-cost firm, i.e., $\phi_1 > \phi_2$.

Table 1 does not list the equilibrium prices that can be easily obtained by substituting ϕ_1 and ϕ_2 into $F_L(p)$ and $F_S(p)$ as shown in Eqs. (3) and (4) ($L = 1,\ S = 2$). By algebra,

$$E_L(p) = \int_{1-\phi_S}^{1} p dF_L(p) = \frac{1-\phi_S}{\phi_L}\left(1 + \ln\frac{1}{1-\phi_S}\right), \tag{9}$$

$$E_S(p) = \int_{1-\phi_S}^{1} p dF_S(p) = \frac{1-\phi_S}{\phi_S}\ln\frac{1}{1-\phi_S}, \tag{10}$$

and $E_L(p) > E_S(p)$ as long as $\phi_S < \phi_L$. This implies that firm 1, who captures a larger loyal segment, will face less competition and be more ready to allow firm 2 to take the price advantage.

The equilibrium price density functions $F_L(p)$ and $F_S(p)$ have several commonalities to those in Narasimhan (1988): the upper bound of the price support is the monopoly price; the lower bound is the price at which the larger firm is indifferent between serving only its captive segment at the monopoly price and serving all of the customers who know of it at the lower bound; and all firms randomize over a common set of prices except that the larger (smaller) firm has a mass point (zero density) at the upper bound. As a result, the larger firm expects to earn a higher profit than the smaller firm, i.e., $\pi_1 > \pi_2$.

4. Simultaneous preannouncement

In this section, we first analyze the game in which one firm forward advertises while the other advertises at the product launch time. Then, we discuss the game where the two firms simultaneously adopt NPPs, based on which the endogenous NPP decision of each firm is obtained.

4.1. NPP by low-cost firm

Suppose that firm 1 adopts NPP while firm 2 does not. The game involves two stages: in the first stage, firm 1 chooses ϕ_1; in the second stage, firms 1 and 2 decide p_1, p_2, and ϕ_2 simultaneously. Analogous to the benchmark, a pure price equilibrium fails to exist in the market with imperfect information provision (see the Appendix for the detailed proof). Thus, firm i's profit function is given by Eq. (1).

In the second stage, $F_1(p)$, $F_2(p)$, and ϕ_2 are decided conditional on ϕ_1. The price competition results in the same CDFs as in Eqs. (3) and (4). From the first-order condition $\frac{\partial \pi_2}{\partial \phi_2} = 0$, we obtain $\phi_2 = \sqrt{\frac{R_2}{c}}$, where R_2 is given by Eq. (8). By algebra, we obtain the optimal ϕ_2 conditional on ϕ_1:

$$\phi_2 = \begin{cases} \frac{1}{1+c}, & if\ \phi_1 > \frac{1}{1+c}, \\ \min\{\frac{1-\phi_1}{c}, 1\}, & if\ \phi_1 \le \frac{1}{1+c}. \end{cases} \tag{11}$$

In the first stage, firm 1's profit is given by

$$\pi_1 = \begin{cases} \phi_1(1 - \frac{1}{1+c}), & if\ \phi_1 > \frac{1}{1+c}, \\ \phi_1(1 - \phi_1), & if\ \phi_1 \le \frac{1}{1+c}, \end{cases} \tag{12}$$

from which we have firm 1's optimal advertising decision

$$\phi_1 = \begin{cases} 1, & if\ c \ge \frac{1}{3}, \\ \frac{1}{2}, & if\ c < \frac{1}{3}. \end{cases} \tag{13}$$

Until now, we can obtain the equilibrium of this subgame, as shown in Table 2.

Comparing Table 2 and Table 1, we have the next proposition.

Proposition 1. *When NPP retaliation by firm 2 is not possible, firm 1 will engage in NPP if $c < \frac{1}{3}$. If so, both firms will be better off.*

Tables 2 and 1 yield the same results when $c \ge \frac{1}{3}$. This is because firm 2's advertising cost is much higher than firm 1's, and no matter whether firm 1 pre-advertises or not, firm 1 always sets a higher advertising level than firm 2. In this case, firm 1 has no reason to introduce NPP.

Surprisingly, when $c < \frac{1}{3}$, the high-cost firm (firm 2) will sponsor more advertising than the low-cost firm (firm 1). Doing so makes both firms better off; that is, $\pi_1 = \frac{1}{4} > \frac{c}{1+c}$ and $\pi_2 = \frac{1-c}{2} > \frac{c}{2(1+c)^2}$. What is the rationale behind this counter-intuitive result? When firms advertise simultaneously, neither knows what level the competitor will choose. Each firm's optimal decision is to set the advertising level as high as possible as long as the cost can be balanced, i.e., $\phi_1 = 1$ and $\phi_2 = \frac{1}{1+c} > \frac{3}{4}$. This is a "race" for competition. Nevertheless, when firm 1 decides its advertising volume prior to firm 2, firm 1 can expect firm 2's motivation for winning the race. As a rational entity, firm 1 will refrain from heavy advertising so as to exit the race, i.e., $\phi_1 = \frac{1}{2}$ and $\phi_2 = 1$. As such, NPP is helpful in alleviating competition. Interestingly, firm 2, who makes zero effort to alleviate competition, gets a free ride and also experiences an increase in profit.

4.2. NPP by high-cost firm

Now, suppose that firm 2 adopts NPP while firm 1 does not. This case is much easier to discuss because firm 1's profit increases with ϕ_1. Since $F_1(p)$, $F_2(p)$ and ϕ_1 are decided conditional on ϕ_2, in the second stage, firm 1 will choose ϕ_1 to be as large as possible, i.e., $\phi_1 = 1$. In the first stage, firm 2 (the smaller firm) expects a profit of $\phi_2(1 - \phi_2) - \frac{c}{2}\phi_2^2$, maximizing which yields $\phi_2 = \frac{1}{2+c}$. Thus, we obtain the equilibrium results in Table 3.

Next proposition is obtained by comparing Tables 3 and 1.

Proposition 2. *When NPP retaliation by firm 1 is not possible, firm 2 will always engage in NPP and both firms will be better off.*

Proposition 2 shows that, similar to the case of low-cost firm NPP, NPP by the high-cost firm can also soften competition and benefit both firms. However, ceteris paribus, the high-cost firm is always willing to introduce NPP (Proposition 2), whereas the low-cost firm has this motive only if $c < \frac{1}{3}$ (Proposition 1). This indicates that the high-cost firm is more efficient than the low-cost firm in deploying the NPP strategy. The reason lies in that NPP requires the preannouncing firm to "sacrifice" itself by informing fewer customers, which is more acceptable to the high-cost firm who can save more ad spending than the low-cost firm.

4.3. Simultaneous NPPs by both firms

If both firms apply NPPs, the profit function of firm i is still given by Eq. (1). The two firms first set their levels of advertising and then engage in price competition.

In the period of price competition, $F_1(p)$ and $F_2(p)$ are decided conditional on ϕ_1 and ϕ_2. Given any $\phi_L > \phi_S$, the CDFs of prices are always given by Eqs. (3) and (4).

In the period of advertising competition,

$$\pi_i = \begin{cases} \phi_i(1 - \phi_j) - \frac{c_i}{2}\phi_i^2, & if\ \phi_i \ge \phi_j, \\ \phi_i(1 - \phi_i) - \frac{c_i}{2}\phi_i^2, & if\ \phi_i < \phi_j. \end{cases} \tag{14}$$

Solving the advertising game yields two perfect strategy Nash equilibria: (a) $\phi_1 = 1$ and $\phi_2 = \frac{1}{2+c}$, and (b) $\phi_1 = \frac{1}{2}$ and $\phi_2 = \min\left\{\frac{1}{2c}, 1\right\}$. Comparing the equilibrium profits under (a) and (b), we obtain the equilibrium of this subgame in Table 4.

The results in Table 4 are consistent with Chioveanu (2008) and De Nijs (2013) who claim that the sequential advertising-pricing model will result in an asymmetric advertising equilibrium wherein one firm chooses a higher advertising level than the other

Table 2
Equilibrium results for firm-1 NPP without retaliation.

Condition	ϕ_1	ϕ_2	π_1	π_2
$c \geq \frac{1}{3}$	1	$\frac{1}{1+c}$	$\frac{c}{1+c}$	$\frac{c}{2(1+c)^2}$
$c < \frac{1}{3}$	$\frac{1}{2}$	1	$\frac{1}{4}$	$\frac{1-c}{2}$

Table 3
Equilibrium results for firm-2 NPP without retaliation.

Variable	ϕ_1	ϕ_2	π_1	π_2
Equilibrium	1	$\frac{1}{2+c}$	$\frac{1+c}{2+c}$	$\frac{1}{2(2+c)}$

Table 4
Equilibrium results for simultaneous NPPs by firms 1 and 2.

Condition	ϕ_1	ϕ_2	π_1	π_2
$c > 0$	1	$\frac{1}{2+c}$	$\frac{1+c}{2+c}$	$\frac{1}{2(2+c)}$
$c < \frac{1}{2}$	$\frac{1}{2}$	1	$\frac{1}{4}$	$\frac{1-c}{2}$
$\frac{1}{2} \leq c < \frac{2}{3}$	$\frac{1}{2}$	$\frac{1}{2c}$	$\frac{1}{4}$	$\frac{1}{8c}$

even when they incur the same advertising costs.[4] The asymmetric equilibrium follows from the fact that if there exists a symmetric equilibrium $\tilde{\phi}$, both firms would earn profit equal to their monopoly profit from the captive segment, i.e., $\tilde{\phi}(1-\tilde{\phi}) - \frac{c_i}{2}\tilde{\phi}^2$. A deviant firm can boost its profit either by increasing $\tilde{\phi}$ by an infinitesimal degree ε to earn $(\tilde{\phi}+\varepsilon)(1-\tilde{\phi}) - \frac{c_i}{2}(\tilde{\phi}+\varepsilon)^2$ profit or by decreasing $\tilde{\phi}$ by ε to earn $(\tilde{\phi}-\varepsilon)(1-\tilde{\phi}+\varepsilon) - \frac{c_i}{2}(\tilde{\phi}-\varepsilon)^2$ profit.[5] Thus, the equilibrium advertising levels are asymmetric.

Furthermore, Table 4 implies that if $c < \frac{2}{3}$, there exist two equilibria and either firm could be the larger firm. This conforms to Ireland (1993). However, in contrast to Ireland's model that ignores any possible cost, in our model, firm 2 cannot afford the race for advertising competition if $c \geq \frac{2}{3}$. In this case, firm 2 has to allow firm 1 to "poach" more customers via advertising. This follows a unique equilibrium wherein firm 1 advertises to all customers while firm 2 covers less than half.

4.4. Endogenous NPP without retaliation

To derive the endogenous NPP decisions, we need to analyze 2 × 2 subgames: neither firm uses NPP, only one firm uses NPP, and the two firms use NPPs simultaneously. We have derived the equilibria of these subgames, as shown in Tables 1– 4, based on which we have the following proposition.

Proposition 3. *When NPP retaliation is not possible, the two firms' NPP decisions are given as follows: (a) If $c \geq \frac{1}{3}$, there is a unique equilibrium wherein firm 2 chooses NPP while firm 1 does not; (b) If $c < \frac{1}{3}$, there are two equilibria wherein only one firm (firm 1 or firm 2) chooses NPP. The equilibrium results are given by Table 5.*

Proof. See the Appendix. □

Proposition 3 indicates that NPP can also be an endogenous outcome, which explains why so many firms are enthusiastic about preannouncing their future products. In contrast to the literature that ascribes NPP to the benefits of market preemption, entry deterrence, brand loyalty, and word-of-mouth, we explore the anti-competition effect of NPP.

Table 5
Equilibrium results for endogenous NPP without retaliation.

Condition	Firm 1	Firm 2	ϕ_1	ϕ_2	π_1	π_2
$c > 0$	Inaction	NPP	1	$\frac{1}{2+c}$	$\frac{1+c}{2+c}$	$\frac{1}{2(2+c)}$
$c < \frac{1}{3}$	NPP	Inaction	$\frac{1}{2}$	1	$\frac{1}{4}$	$\frac{1-c}{2}$

A problem not tackled in this paper is that if there exist two equilibria wherein one firm adopts NPP and the other does not, how can the identity of the preannouncing firm be selected? One approach that can avoid multiple equilibria is to assume that firms are quite different from each other ($c \geq \frac{1}{3}$). An alternative approach used in the abundant literature that involves asymmetric equilibria is assuming that one firm is able to move first. One firm may be able to move first because it has provided a credible commitment. Take the Singles' Day online shopping festival in China as an example. Tmall.com has led the advertising game for several years (since 2009, the first year of Singles' Day), which is a powerful commitment in that it always chooses NPP regardless of what its competitors choose.

5. Retaliatory preannouncement

In this section, we focus on the role of retaliatory preannouncement. To this end, we first analyze the scenario where one firm forward advertises while the other chooses between retaliatory NPP and non-NPP, on the basis of which we can obtain each firm's endogenous decisions on NPP and reaction to NPP.

5.1. Retaliatory NPP by low-cost firm

We first study the low-cost firm's reaction to NPP. Consider the following sequence of events: in the first stage, firm 2 sponsors NPP with an intensity of ϕ_2. Then, firm 1 decides whether to apply retaliatory preannouncement. If it chooses retaliation, ϕ_1 is determined in the second stage, and p_1 and p_2 are selected in the third; if firm 1 chooses inaction, the two firms simultaneously decide ϕ_1, p_1, and p_2 in the second stage.

If firm 1 chooses inaction, as shown in the previous section, the CDFs of the prices are given by Eqs. (3) and (4), and firm 1 optimally responds with

$$\phi_1 = 1. \quad (15)$$

[4] There is also an advertising equilibrium in mixed strategies that is not analyzed for simplicity. As stated by Ireland (1993) and quoting his explanation, "market penetration by advertising" is "long run" and "cannot be quickly changed," and thus pure strategy in advertising is a "reliable" equilibrium.

[5] By algebra, $(\tilde{\phi}+\varepsilon)(1-\tilde{\phi}) - \frac{c_i}{2}(\tilde{\phi}+\varepsilon)^2 > \tilde{\phi}(1-\tilde{\phi}) - \frac{c_i}{2}\tilde{\phi}^2 \Leftrightarrow \varepsilon < \frac{(2+c_i)\tilde{\phi}-1}{1+\frac{c_i}{2}}$ and $(\tilde{\phi}-\varepsilon)(1-\tilde{\phi}+\varepsilon) - \frac{c_i}{2}(\tilde{\phi}-\varepsilon)^2 > \tilde{\phi}(1-\tilde{\phi}) - \frac{c_i}{2}\tilde{\phi}^2 \Leftrightarrow \varepsilon < \frac{1-(1+c_i)\tilde{\phi}}{\frac{c_i}{2}}$. There always exists an infinitesimal value $0 < \varepsilon < \max\{\frac{(2+c_i)\tilde{\phi}-1}{1+\frac{c_i}{2}}, \frac{1-(1+c_i)\tilde{\phi}}{\frac{c_i}{2}}\}$ that can increase the deviant firm's profit.

Table 6
Equilibrium results for firm-2 NPP with competitor reaction.

Condition	Firm-1 reaction	ϕ_1	ϕ_2	π_1	π_2
$c \geq \frac{2}{3}$	Inaction	1	$\frac{1}{2+c}$	$\frac{1+c}{2+c}$	$\frac{1}{2(2+c)}$
$c < \frac{1}{2}$	Retaliation	$\frac{1}{2}$	1	$\frac{1}{4}$	$\frac{1-c}{2}$
$\frac{1}{2} \leq c < \frac{2}{3}$	Retaliation	$\frac{1}{2}$	$\frac{1}{2c}$	$\frac{1}{4}$	$\frac{1}{8c}$

If firm 1 chooses retaliation, in the third stage, $F_1(p)$ and $F_2(p)$ are given by Eqs. (3) and (4). In the second stage, firm 1's profit equals $\phi_1(1-\phi_2)$ if $\phi_1 > \phi_2$, or $\phi_1(1-\phi_1)$ if $\phi_1 \leq \phi_2$. Maximizing profit yields

$$\phi_1 = \begin{cases} \frac{1}{2}, & if\ \phi_2 \geq \frac{3}{4}, \\ 1, & if\ \phi_2 < \frac{3}{4}. \end{cases} \tag{16}$$

Comparing Eqs. (15) and (16), it is clear that firm 1 will choose retaliation with $\phi_1 = \frac{1}{2}$ if $\phi_2 \geq \frac{3}{4}$, under which $\pi_1 = \frac{1}{4}$. Otherwise, firm 1 has no reason to implement preannouncement, and it will set $\phi_1 = 1$ and earn a profit of $\pi_1 = 1 - \phi_2$.

Expecting firm 1's response, in the first stage, firm 2 optimally chooses ϕ_2. Clearly,

$$\pi_2 = \begin{cases} \phi_2(1-\phi_2) - \frac{c}{2}\phi_2^2, & if\ \phi_2 < \frac{3}{4}, \\ \phi_2(1-\frac{1}{2}) - \frac{c}{2}\phi_2^2, & if\ \phi_2 \geq \frac{3}{4}. \end{cases} \tag{17}$$

Maximizing π_2, we have

$$\phi_2 = \begin{cases} \frac{1}{2+c}, & if\ c \geq \frac{2}{3}, \\ \min\{\frac{1}{2c}, 1\}, & if\ c < \frac{2}{3}. \end{cases} \tag{18}$$

Substituting ϕ_2 back into π_1, π_2, and firm 1's choices between inaction and retaliation, we can obtain the equilibrium results in Table 6.

Table 6 shows that when encountering NPP by firm 2, firm 1 may respond with a retaliatory preannouncement or remain inactive. To illustrate, we note that if firm 1 chooses retaliation, the advertising game will be characterized by the second-mover advantage (see the last two rows of Table 6), while if firm 1 chooses inaction, the game will be characterized by the first-mover advantage (see the second row of Table 6). The reasons are as follows:

If firm 1 remains inactive until the product launch time, it has no information about prices. The optimal decision is to set the advertising level as high as possible, as shown in Eq. (15). In this case, firm 1 commits itself to a sufficiently high level of advertising, thereby forcing firm 2 to refrain from heavy advertising. This is the second-mover advantage.

However, if firm 1 responds with retaliation, at the time of choosing the advertising level, it forms a rational expectation about future prices. Firm 1 has to decrease its advertising level (in stage 2) to avoid fierce competition (in stage 3) if firm 2 sponsors heavy advertising (in stage 1), as shown in Eq. (16). Expecting this, firm 2 will optimally choose a large advertising reach as long as the cost can be balanced. This is the first-mover advantage.

Next proposition is obtained by comparing Tables 6 and 1.

Proposition 4. *When NPP retaliation by firm 1 is possible, firm 2 always engages in NPP, which makes firm 1 better off if $c \in (0, \frac{1}{3}) \bigcup (\frac{2}{3}, +\infty)$ and worse off if $c \in (\frac{1}{3}, \frac{2}{3})$.*

Proposition 4 shows that the high-cost firm (firm 2) is always likely to use NPP, even when the low-cost firm (firm 1) can respond with a retaliatory preannouncement. Ironically, NPP by firm 2 is always beneficial to firm 1 if firm 1 has no choice but to keep inaction (see Proposition 2); in contrast, it may make firm 1 worse off if firm 1 has more choices.

By comparison, we find that when c is sufficiently large ($c > \frac{2}{3}$), although firm 2 moves first by launching NPP, it always sets a low advertising level. In this case, firm 1 can enjoy the second-mover advantage just by keeping inaction. When c is sufficiently small ($c < \frac{1}{3}$), firms 1 and 2 do not differ substantially, and they would engage in fierce competition if the advertising and prices are simultaneously decided. In this case, the anti-competition effect of NPP is so prominent that firm 1 can still earn a higher profit. When c is medium ($\frac{1}{3} < c < \frac{2}{3}$), however, firm 1 not only loses its low-cost advantage but also receives little from the relaxed competition. In this case, firm 1 is inevitably worse off.

5.2. Retaliatory NPP by high-cost firm

Now suppose that firm 1 forward advertises and firm 2 chooses between retaliation and inaction.

If firm 2 chooses inaction, as shown in the previous section, the CDFs of the prices are given by Eqs. (3) and (4) and ϕ_2 is given by

$$\phi_2 = \begin{cases} \frac{1}{1+c}, & if\ \phi_1 \geq \frac{1}{1+c}, \\ \min\{\frac{1-\phi_1}{c}, 1\}, & if\ \phi_1 < \frac{1}{1+c}. \end{cases} \tag{19}$$

If firm 2 responds with a retaliatory preannouncement, the CDFs of the prices are given by Eqs. (3) and (4). Upon setting ϕ_2, firm 2 expects the profit shown in Eq. (14). Maximizing firm 2's profit, we have

$$\phi_2 = \begin{cases} \frac{1}{2+c}, & if\ \phi_1 \geq \bar{c}, \\ \min\{\frac{1-\phi_1}{c}, 1\}, & if\ \phi_1 < \bar{c}, \end{cases} \tag{20}$$

where $\bar{c}$ is defined as

$$\bar{c} = \begin{cases} 1 - \sqrt{\frac{c}{2+c}}, & if\ c \geq \sqrt{2} - 1, \\ \frac{3-c^2}{2(2+c)}, & if\ c < \sqrt{2} - 1. \end{cases} \tag{21}$$

Comparing the response functions Eqs. (19) and (20) and by algebra, we obtain firm 2's best response: If $\phi_1 \geq \bar{c}$, firm 2 will choose retaliation with a low intensity $\phi_2 = \frac{1}{2+c}$; if $\phi_1 < \bar{c}$, firm 2 will choose inaction with a high intensity $\phi_2 = \min\{\frac{1-\phi_1}{c}, 1\}$.

Expecting firm 2's response, in the first stage, firm 1 receives the following expected profit:

$$\pi_1 = \begin{cases} \phi_1(1 - \frac{1}{2+c}), & if\ \phi_1 \geq \bar{c}, \\ \phi_1(1-\phi_1), & if\ \phi_1 < \bar{c}. \end{cases} \tag{22}$$

Solving firm 1's maximization problem, we have $\phi_1 = 1$, from which we can also obtain other equilibrium results as shown in Table 7.

Table 7 appears simpler than Table 6. If the low-cost firm leads the advertising game, it will advertise to the entire market. Then, the follower has to choose retaliation with a relatively low intensity. Accordingly, the game is always characterized by the first mover advantage.

Comparing Table 7 with Table 1, we have the next proposition.

Proposition 5. *If NPP retaliation by firm 2 is possible, firm 1 will always engage in NPP and both firms will be better off.*

In contrast to Proposition 1, where firm 1 uses NPP only if $c < \frac{1}{3}$, Proposition 5 shows that firm 1 is always ready to use NPP when its competitor endogenously reacts to NPP. In this case, firm 1 not only has the low-cost advantage but also gains the first-mover advantage.

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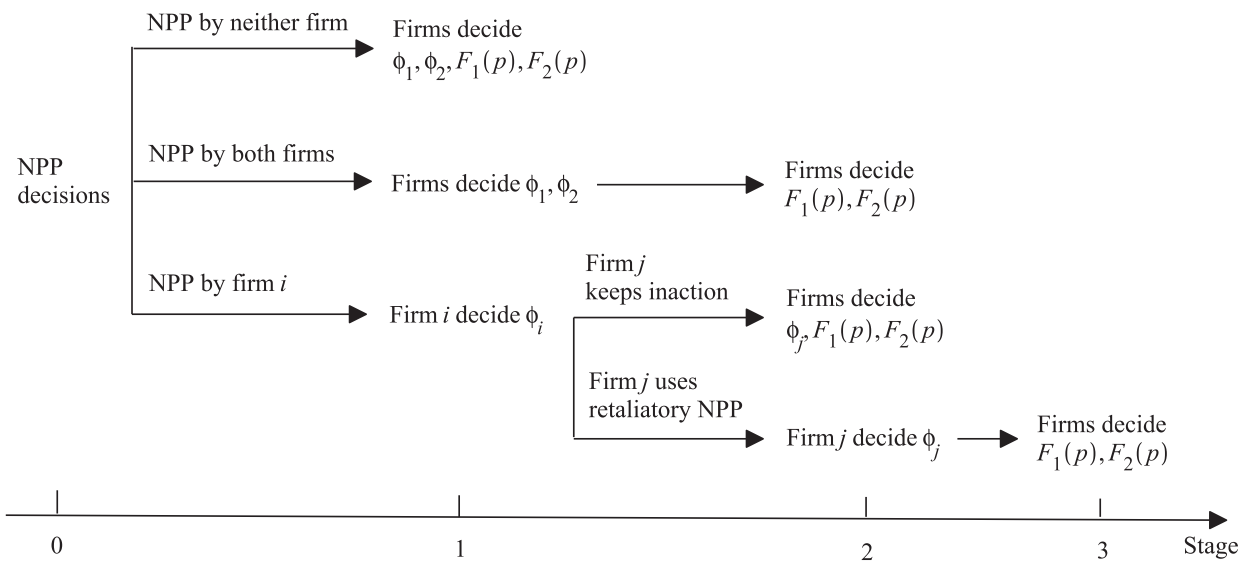

Fig. 1. Timeline for endogenous NPP with competitor reaction.

Table 7
Equilibrium results for firm-1 NPP with competitor reaction.

Variable	Firm-2 reaction	ϕ_1	ϕ_2	π_1	π_2
Equilibrium	Retaliation	1	$\frac{1}{2+c}$	$\frac{1+c}{2+c}$	$\frac{1}{2(2+c)}$

Proposition 5 also indicates that the competitor's NPP strategy always benefits the high-cost firm, which is in contrast with Proposition 4 that shows that it may be harmful for the low-cost firm. This is because NPP done by the high-cost firm damages the low-cost firm's cost advantage (the low-cost firm does only a little advertising), while NPP by the low-cost firm exerts a cost-savings effect on the high-cost firm (the high-cost firm sponsors fewer ads).

5.3. Endogenous NPP with competitor reaction

Finally, we investigate whether our claims on NPP and retaliatory preannouncement still hold when the firms' decisions on NPP and reaction to NPP are both endogenously determined.

The sequence of events is depicted in Fig. 1. In the initial stage (stage 0), firms simultaneously decide whether to implement NPP programs. If neither firm chooses NPP, firms simultaneously set ϕ_1, ϕ_2, $F_1(p)$, and $F_2(p)$; if both firms apply NPPs, they simultaneously set ϕ_1 and ϕ_2 in the first stage and then select $F_1(p)$ and $F_2(p)$ in the second stage; if only one firm, say, firm *i*, chooses NPP with a density of ϕ_i in the first stage, then firm *j* will decide its response to NPP. If firm *j* responds with a retaliatory preannouncement, it chooses ϕ_j in the second stage, and the two firms set $F_1(p)$ and $F_2(p)$ in the third; if firm *j* chooses inaction, firms simultaneously set ϕ_j, $F_1(p)$, and $F_2(p)$ in the second stage.

The timeline implicitly assumes that only when one firm has implemented NPP does retaliatory preannouncement make sense. This assumption is in accordance with the definition of retaliatory preannouncement. From the subgame results in Tables 1, 4, 6, and 7, we can obtain the equilibria of the game, as shown in the next proposition.

Proposition 6. *When NPP retaliation is possible, there are two equilibria: (a) firm 1 chooses NPP and firm 2 chooses retaliation; and (b) firm 2 chooses NPP, while firm 1 chooses inaction if $c \geq \frac{2}{3}$ or chooses retaliation if $c < \frac{2}{3}$. The equilibrium results are given by Table 8.*

Proof. See the Appendix. □

Proposition 6 shows that the main results of this paper can also be an endogenous outcome: (1) firms with different advertising costs have different incentives to embrace NPP; (2) the high-cost firm will always retaliate when its competitor deploys NPP, while the low-cost firm may choose retaliation or inaction; (3) compared with the benchmark case, the occurrence of NPP is always good for the high-cost firm; and (4) the low-cost firm may be worse off when NPP is applicable.

The findings above not only explain why so many firms are fond of preannouncing their future products but also explain why some firms use retaliatory preannouncements in the presence of NPP while other firms are more likely to keep silent until the product launch time. We demonstrate that these phenomena may be a result of anti-competition considerations. However, firms with different advertising efficiencies may hold different attitudes toward NPP: the high-cost firm welcomes NPP more enthusiastically than the low-cost firm.

6. Pricing and welfare effects of NPP

Previous sections have discussed the effects of NPP on advertising and profit. In this section, we further analyze the pricing and welfare effects of NPP.

6.1. Pricing issues

When NPP is not applicable, substituting the equilibrium advertising levels ϕ_1 and ϕ_2 (listed in Table 1) into Eqs. (3) and (4), we can obtain the average price for each firm:

$$E_1^b(p) = \frac{c}{1+c}\left(1+\ln\frac{1+c}{c}\right),\ E_2^b(p) = c\ln\frac{1+c}{c}, \tag{23}$$

where the superscript "*b*" refers to the benchmark case.

When NPP is applicable and $c \geq \frac{2}{3}$, Table 8 shows that $\phi_1 = 1$ and $\phi_2 = \frac{1}{2+c}$. Let the superscript "*" denote the equilibrium; then, we have

$$E_1^*(p) = \frac{1+c}{2+c}\left(1+\ln\frac{2+c}{1+c}\right),\ E_2^*(p) = (1+c)\ln\frac{2+c}{1+c}. \tag{24}$$

Table 8
Equilibrium results for endogenous NPP with competitor reaction.

Condition	Firm 1	Firm 2	ϕ_1	ϕ_2	π_1	π_2
$c > 0$	NPP	Retaliation	1	$\frac{1}{2+c}$	$\frac{1+c}{2+c}$	$\frac{1}{2(2+c)}$
$c < \frac{1}{2}$	Retaliation	NPP	$\frac{1}{2}$	1	$\frac{1}{4}$	$\frac{1-c}{2}$
$\frac{1}{2} \le c < \frac{2}{3}$	Retaliation	NPP	$\frac{1}{2}$	$\frac{1}{2c}$	$\frac{1}{4}$	$\frac{1}{8c}$
$c \ge \frac{2}{3}$	Inaction	NPP	1	$\frac{1}{2+c}$	$\frac{1+c}{2+c}$	$\frac{1}{2(2+c)}$

By algebra, $E_1^*(p) > E_1^b(p)$ and $E_2^*(p) > E_2^b(p)$. This comparison directly proves the anti-competition effect of NPP.

When NPP is applicable and $c < \frac{2}{3}$, Table 8 shows that there are two equilibria: $(\phi_1, \phi_2) = (1, \frac{1}{2+c})$ and $(\phi_1, \phi_2) = (\frac{1}{2}, \min\{\frac{1}{2c}, 1\})$. Let the superscript "$\ell$" refer to the latter equilibrium. Then,

$$E_1^\ell(p) = \ln 2, \;\; E_2^\ell(p) = \max\left\{(1+\ln 2)c, \frac{1+\ln 2}{2}\right\}. \tag{25}$$

By comparison, $E_2^\ell(p) > E_2^0(p)$, while $E_1^\ell(p) \gtreqless E_1^0(p)$ if $c \lesseqgtr c^\ell$, where $c^\ell \approx 0.49$ is determined by

$$\frac{c^\ell}{1+c^\ell}\left(1 + \ln\frac{1+c^\ell}{c^\ell}\right) = \ln 2. \tag{26}$$

Next proposition summarizes the pricing effects of NPP.

Proposition 7. *NPP always increases the high-cost firm's average price. When $c \in (c^\ell, \frac{2}{3})$ and firm 2 is the NPP leader, NPP decreases the low-cost firm's average price; under other cases, NPP increases the low-cost firm's average price.*

Proposition 7 tells that when NPP is applicable, firms will charge higher prices in most cases, and only under some special circumstances may the low-cost firm quote a lower price. This result also conforms to our finding that NPP is always good for the high-cost firm but may be harmful for the low-cost firm.

6.2. Welfare issues

Consider now the welfare effects of NPP. The total welfare, denoted as w, comprises two components: consumers' gross utilities from consuming products and firms' total advertising expenditures. Thus,

$$w = 1 - (1-\phi_1)(1-\phi_2) - \frac{c}{2}\phi_2^2. \tag{27}$$

The optimal amounts of advertising that maximize the total welfare are $\phi_1 = 1$ and $\phi_2 = 0$. In this case, the total welfare reaches the maximum value $w = 1$. This case also means that firm 2 stays out of the market and consumers pay their reservation price.

Under the benchmark case, plugging the equilibrium ϕ_1 and ϕ_2 into Eq. (27), we have

$$w^b = 1 - \frac{c}{2(1+c)^2}. \tag{28}$$

A similar argument for the case when NPP is applicable yields

$$w^* = 1 - \frac{c}{2(2+c)^2}, \tag{29}$$

$$w^\ell = \begin{cases} \frac{1}{2} + \frac{1}{8c}, & \text{if } \frac{1}{2} \le c < \frac{2}{3}, \\ 1 - \frac{c}{2}, & \text{if } c < \frac{1}{2}. \end{cases} \tag{30}$$

It is easily calculated that $w^* > w^b > w^\ell$, and therefore, the next proposition holds.

Proposition 8. *NPP has ambiguous effects on total welfare. When $c < \frac{2}{3}$ and firm 2 is the NPP leader, the total welfare is worse off; under other cases, the total welfare is better off.*

The total welfare depends critically on the number of consumers who buy the products and the total expenditures on advertising. When NPP is not available to either firm, $\phi_1 = 1$ and $\phi_2 = \frac{1}{1+c}$ (see Table 1). The cost-efficient firm fully exploits its cost advantage and all latent customers become actual buyers. When firms have access to NPPs, it is possible that $\phi_1 = 1$ and $\phi_2 = \frac{1}{2+c} < \frac{1}{1+c}$ (see the second and fifth rows of Table 8). If this equilibrium occurs, the total welfare will be improved because of cost savings. Nevertheless, there exists another equilibrium wherein $\phi_1 = \frac{1}{2} < 1$ and $\phi_2 = \min\{\frac{1}{2c}, 1\} > \frac{1}{1+c}$ (see the third and fourth rows of Table 8). In this case, the total welfare will be hurt, not only because there are more uninformed customers but also because of the inefficient advertising investment.

It is still of interest whether consumers can benefit from NPP. Denote consumer surplus by s, which is equal to the total welfare minus the industry profits, i.e.,

$$s = w - \pi_1 - \pi_2. \tag{31}$$

Using Eqs. (28)–(30) and Tables 1 and 8, we have

$$s^b = \frac{1}{(1+c)^2}, \tag{32}$$

$$s^* = \frac{1}{(2+c)^2}, \tag{33}$$

$$s^\ell = \frac{1}{4}. \tag{34}$$

Since s^ℓ can be the equilibrium only if $c < \frac{2}{3}$, we easily have $s^b > s^\ell > s$. Therefore, we obtain the next proposition.

Proposition 9. *NPP is bad for the customers.*

Consumers can be better off only when firms set lower prices or launch more advertising. However, these conditions are not satisfied when NPP is applicable. In particular, if, in the equilibrium, firm 1 is the NPP leader or just keeps inaction, firms will charge higher prices on average (see the second and fifth rows of Table 8). If firm 2 leads the NPP game and firm 1 launches NPP as a follower, a proportion of customers will be excluded from the market (see the third and fourth rows of Table 8). Either case will result in a lower consumer surplus.

7. Conclusion

In this paper, we investigate the competitive effects of new product preannouncement and retaliatory preannouncement in a model where firms compete on advertising and pricing. A key finding is that NPP can relax competition and firms with different advertising costs have different attitudes toward NPP. Another important finding is that firms with different advertising costs react differently (making retaliation versus keeping inaction) in the presence of NPP. When NPP and reaction to NPP are endogenously decided, we find that NPP is good for the high-cost firm, is bad for customers, and may be good or bad for the low-cost firm as well as the total welfare.

Our findings rule out the conventional rationales for the use of NPP such as the benefits of market preemption, entry deterrence, brand loyalty, and word-of-mouth. Factually, our model can be extended to contain some of the rationales. For instance, we may assume that NPP creates brand loyalty with a degree of α, which means that fully informed consumers will patronize the preannouncing firm, say, firm i, as long as $p_i - p_j < \alpha$. Alternatively, we may assume that NPP gives rise to an intensity β of information communication among customers, which means that at the product launch time, there will be a $\phi_i + (1-\phi_i)\beta$ proportion of consumers who know of the preannouncing firm. Under these assumptions, we find that firms are more willing to introduce NPPs with the increase of α or β.[6] These results conform to the conventional rationales.

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Appendix

Proof of the non-existence of a pure pricing strategy under the NPP game.. The proof follows the same logic as in Varian (1980) and Narasimhan (1988). Take the case where firm 1 uses NPP as an example. Suppose that there exists a pair of pure prices denoted by (p_1^*, p_2^*). Assume that $p_1^* \le p_2^*$ without loss of generality. By definition, if p_1^* is firm 1's equilibrium price, there would not exist a price, denoted by p_1^ℓ, such that $\pi_1(p_1^\ell) > \pi_1(p_1^*)$.

When $p_1^* < p_2^*$, all of the switchers purchase from firm 1, and we have $\pi_1(p_1^*) = \phi_1 p_1^*$. Let $p_1^\ell = p_1^* + \varepsilon < p_2^*$, where ε is infinitely small but positive. Then, all of the switchers still purchase from firm 1, and we have $\pi_1(p_1^\ell) = \phi_1(p_1^* + \varepsilon) > \pi_1(p_1^*)$, a contradiction.

When $p_1^* = p_2^*$, the switchers randomly purchase from firm 1 or firm 2. Assume that a fraction $\lambda_i \in (0, 1)$ of switchers choose firm i, where $\sum_{i=1}^{2} \lambda_i = 1$; then, we have $\pi_1(p_1^*) = \phi_1(1 - \phi_2 + \lambda_1\phi_2)p_1^*$. Let $p_1^\ell = p_1^* - \varepsilon < p_2^*$, where $\varepsilon > 0$. Then, all of the switchers purchase from firm 1, and $\pi_1(p_1^\ell) = \phi_1(p_1^* - \varepsilon)$. Clearly, $\pi_1(p_1^\ell) > \pi_1(p_1^*) \Leftrightarrow \varepsilon < (1-\lambda_1)\phi_2 p_1^*$. The inequality holds as long as ε is sufficiently small, a contradiction. This completes the proof. □

Proof of Proposition 3. When $c > \frac{1}{3}$, Proposition 2 shows that firm 2 will apply NPP if firm 1 does not, and Proposition 1 shows that firm 1 will does not apply NPP if firm 2 does not either. Suppose that firm 2 chooses NPP. If firm 1 also chooses NPP, its profit will be $\frac{1+c}{2+c}$ or $\frac{1}{4}$ (see Table 4); if firm 1 chooses inaction, its profit is $\frac{1+c}{2+c} > \frac{1}{4}$ (see Table 3). Thus, firm 1 has no motive to apply NPP. That is, firm 1 always keeps inaction regardless of whether firm 2 chooses NPP or not. Therefore, the equilibrium is that firm 1 chooses inaction and firm 2 chooses NPP.

When $c \le \frac{1}{3}$, Table 4 shows that if both firms apply NPPs, there are two equilibria. Thus, the endogenous NPP decisions can be derived from Figs. A.1 and A.2 (in each cell, the first value refers to π_1 and the second value refers to π_2):

		Firm 2: NPP	Firm 2: non-NPP
Firm 1	NPP	$\frac{1+c}{2+c}, \frac{1}{2(2+c)}$	$\frac{1}{4}, \frac{1-c}{2}$
	non-NPP	$\frac{1+c}{2+c}, \frac{1}{2(2+c)}$	$\frac{c}{1+c}, \frac{c}{2(1+c)^2}$

Fig. A.1. Firm payoffs under NPP without retaliation: case (a).

		Firm 2: NPP	Firm 2: non-NPP
Firm 1	NPP	$\frac{1}{4}, \frac{1-c}{2}$	$\frac{1}{4}, \frac{1-c}{2}$
	non-NPP	$\frac{1+c}{2+c}, \frac{1}{2(2+c)}$	$\frac{c}{1+c}, \frac{c}{2(1+c)^2}$

Fig. A.2. Firm payoffs under NPP without retaliation: case (b).

		Firm 2: NPP	Firm 2: non-NPP
Firm 1	NPP	$\frac{1+c}{2+c}, \frac{1}{2(2+c)}$	$\frac{1+c}{2+c}, \frac{1}{2(2+c)}$
	non-NPP	$\frac{1}{4}, \pi_2^\ell$	$\frac{c}{1+c}, \frac{c}{2(1+c)^2}$

Fig. A.3. Firm payoffs under NPP with competitor reaction: case (a).

		Firm 2: NPP	Firm 2: non-NPP
Firm 1	NPP	$\frac{1}{4}, \pi_2^\ell$	$\frac{1+c}{2+c}, \frac{1}{2(2+c)}$
	non-NPP	$\frac{1}{4}, \pi_2^\ell$	$\frac{c}{1+c}, \frac{c}{2(1+c)^2}$

Fig. A.4. Firm payoffs under NPP with competitor reaction: case (b).

In both matrices, it is clearly seen that if one firm chooses NPP, its rival has no motive to choose NPP (we have assumed that if a firm is indifferent between applying NPP and not applying NPP, it will choose not to apply NPP). If one firm chooses non-NPP, its rival can always improve profit by applying NPP. Therefore, there are two pure strategy Nash equilibria — one firm chooses NPP and the other does not. □

Proof of Proposition 6. First consider the case where $c \ge \frac{2}{3}$. If both firms apply NPPs, Table 4 shows that $\pi_1 = \frac{1+c}{2+c}$ and $\pi_2 = \frac{1}{2(2+c)}$. If neither firm chooses NPP, Table 1 shows that $\pi_1 = \frac{c}{1+c}$ and $\pi_2 = \frac{c}{2(1+c)^2}$. If firm 1 chooses NPP and firm 2 does not, Table 7 shows that $\pi_1 = \frac{1+c}{2+c}$ and $\pi_2 = \frac{1}{2(2+c)}$ (firm 2 chooses retaliatory preannouncement). If firm 2 chooses NPP and firm 1 does not, Table 6 shows that $\pi_1 = \frac{1+c}{2+c}$ and $\pi_2 = \frac{1}{2(2+c)}$ (firm 1 keeps inaction). Thus, there will be two Nash equilibria: firm 1 chooses NPP and firm 2 chooses a retaliatory preannouncement, or firm 2 chooses NPP and firm 1 chooses inaction.

Then, consider the case in which $c < \frac{2}{3}$. If both firms apply NPPs, Table 4 shows that there may be two results: $\pi_1 = \frac{1+c}{2+c}$ and $\pi_2 = \frac{1}{2(2+c)}$, or $\pi_1 = \frac{1}{4}$ and $\pi_2 = \pi_2^\ell$, where we define

$$\pi_2^\ell = \begin{cases} \frac{1}{8c}, & if\ c \ge \frac{1}{2}, \\ \frac{1-c}{2}, & if\ c < \frac{1}{2}. \end{cases}$$

If neither firm chooses NPP, Table 1 shows that $\pi_1 = \frac{c}{1+c}$ and $\pi_2 = \frac{c}{2(1+c)^2}$. If firm 1 chooses NPP and firm 2 does not, Table 7 shows that $\pi_1 = \frac{1+c}{2+c}$ and $\pi_2 = \frac{1}{2(2+c)}$ (firm 2 chooses a retaliatory preannouncement). If firm 2 chooses NPP and firm 1

[6] Detailed extensions are available from the authors upon request.

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does not, Table 6 shows that $\pi_1 = \frac{1}{4}$ and $\pi_2 = \pi_2^{\ell}$ (firm 1 chooses a retaliatory preannouncement). Thus, firms' decisions on NPP and non-NPP (including retaliation and inaction) can be derived from the following two payoff matrices:

In Fig. A.3, the equilibrium is (NPP, non-NPP). In Fig. A.4, the equilibrium is (non-NPP, NPP). Thus, when $c < \frac{2}{3}$ there will exist two Nash equilibria: Firm 1 chooses NPP and firm 2 chooses retaliation, or firm 2 chooses NPP and firm 1 chooses retaliation. □

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