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Strategic pricing and advertising decisions under competition with long-term advertising effects☆

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ABSTRACT

This study examines how negative long-term advertising effects influence startups' strategic choices between myopic and far-sighted approaches in competitive markets. Using a two-period game model, it analyzes how firms balance the short-term benefits of advertising with its potential long-term drawbacks when making pricing and promotional decisions. The analysis shows that when advertising has positive long-term effects, far-sighted strategies are theoretically optimal regardless of the timing of advertising decisions. In practice, however, startups may struggle to sustain such approaches, as early-stage losses can create financial pressure that pushes them toward short-term survival strategies. When long-term advertising effects are negative, the optimal strategy becomes more sensitive to market conditions. The model shows that in markets with low product substitutability, far-sighted strategies continue to deliver better outcomes. As products become more similar, myopic strategies become more attractive—especially when the negative long-term effects are relatively mild. Furthermore, when the short-term impact of advertising is particularly strong, a myopic strategy can outperform a far-sighted one, even if long-term consequences are unfavorable. Under certain conditions, both firms choosing far-sighted strategies may also lead to a Prisoner's Dilemma, where mutual restraint results in lower overall profits. These findings highlight the complex trade-offs startups face between short-term gains and long-term viability. Startups must weigh immediate advertising returns against potential long-term costs and develop pricing and advertising strategies that reflect both market dynamics and sustainable growth objectives.

1. Introduction

In today's highly competitive markets, startups often pursue aggressive, capital-intensive advertising and promotional strategies, commonly known as cash-burning battles, to capture market share quickly. While these strategies can boost visibility and drive short-term sales, their long-term effectiveness remains uncertain and may lead to negative consequences.

A prominent example is China's ride-sharing market. Between 2014 and 2016, Didi Chuxing and Uber China engage in a prolonged and costly subsidy war. During this period, other competitors, including Yidao, Caocao, and Shenzhou, also adopt aggressive cash-burning strategies, offering substantial subsidies to both passengers and drivers. In extreme cases, customers ride for free or even receive payments for using the service. Although these tactics quickly attract users, the resulting financial losses prove unsustainable. Uber China exits the market in 2016 by selling its operations to Didi. Yidao experiences a financial crisis due to capital chain disruptions and gradually disappears from the market. Even Didi, the eventual market leader, faces significant financial pressure and later regulatory challenges. Clearly, the tension between rapid market expansion and long-term financial sustainability makes the effectiveness of aggressive promotional strategies in competitive markets an important question.

A similar scenario occurs in the coffee industry. Around 2017, Luckin Coffee enters the market with steep promotions, selling coffee for as little as CNY 9.9 (approximately $1.30) and offering substantial discount coupons. Coffee Box, another startup, adopts a comparable strategy, relying on heavy subsidies to quickly gain market share. However, these aggressive tactics lead to sustained financial losses. Luckin Coffee resorts to accounting fraud to conceal its losses and is

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delisted from NASDAQ in 2020, triggering a major crisis. Coffee Box also struggles to maintain operations, gradually closes its stores, and eventually disappears from the mainstream market.

The long-term negative effects of aggressive advertising promotions are well documented in consumer behavior theory. Frequent promotions and subsidies lower consumers' price expectations by creating a low-price anchor. When firms return to regular pricing, consumers often switch to competitors that continue offering discounts or delay purchases in anticipation of future deals. These behaviors weaken long-term profitability and erode brand loyalty. Sustained low-price promotions also damage a brand's premium image, leading consumers to associate it with low-quality or discount products, which further undermines long-term competitiveness. For example, the fashion brand Tommy Hilfiger extensively uses price discounts, which temporarily attract new customers but ultimately dilute brand equity among existing ones and weaken its premium positioning. These dynamics highlight the strategic challenge startups face in balancing short-term market share acquisition with long-term profitability, especially when advertising and promotions carry lasting negative consequences. This study analyzes how advertising investments and pricing strategies influence both the short-term performance and long-term growth of startups. By examining the immediate benefits and potential drawbacks of promotional activities, it aims to provide insights that help startups design more balanced and sustainable strategic approaches.

This study examines the strategic choices startups face in determining whether a myopic or far-sighted approach is more effective, given the short-term and long-term impacts of advertising. A myopic strategy prioritizes immediate returns, focusing on rapid market expansion, short-term profitability, and quick payback. Firms adopting this approach often use aggressive pricing to capture market share quickly. In contrast, a far-sighted strategy emphasizes long-term growth and sustainability, accepting early sacrifices in exchange for future profitability and competitive advantage. Although far-sighted strategies are theoretically optimal, they are often difficult to implement, particularly for startups with limited financial resources. Without near-term profitability, these firms may struggle to remain operational and risk market exit. By analyzing these trade-offs, this study offers insights to help startups align their strategic choices with changing market conditions and the evolving effectiveness of advertising. This research addresses the following questions:

(1) How do the intensity and duration of advertising effects shape the competitive dynamics between myopic and far-sighted firms in a duopoly?

(2) How do myopic and far-sighted pricing strategies affect firm profitability under different levels of product substitutability?

(3) When long-term advertising effects are predominantly negative, how do firms adjust their pricing and advertising strategies to maximize short-term gains while maintaining long-term stability?

(4) To what extent do initial advertising and pricing strategies influence the long-term sustainability of market presence for firms with different strategic orientations?

This paper develops a two-period game model to examine how firms make strategic decisions under varying conditions of product substitutability and advertising effects. The model captures the contrast between myopic and far-sighted strategies by incorporating both short-term and long-term advertising impacts on market dynamics and firm profitability. The analysis focuses on how firms respond to different levels of market substitutability and advertising effectiveness. The theoretical results show that the combined influence of short-term and long-term advertising effects plays a critical role in shaping strategic choices in competitive markets. Myopic pricing and advertising strategies may outperform far-sighted approaches when the long-term effects of advertising are negative but relatively weak.

The research findings provide guidance in two key areas. First, in strategic decision-making, when the long-term effects of advertising are positive or product substitutability is low, firms benefit from adopting a more conservative, far-sighted advertising and pricing strategy. This approach helps avoid anchoring effects and reduced reference prices, thereby supporting long-term profitability. However, when the long-term effects of advertising are negative, both conservative far-sighted and aggressive myopic strategies may emerge as equilibrium outcomes, depending on the degree of product substitution and the strategies adopted by competitors. Second, in the context of startups, the analysis offers important insights into aligning advertising and pricing strategies with broader business objectives and market dynamics. When the long-term negative effects of advertising are strong, conservative strategies generally lead to better outcomes. In contrast, when these effects are moderate or weak and product substitution is high, aggressive myopic strategies may outperform conservative far-sighted ones.

The paper is organized as follows. Section 2 reviews the relevant literature, and Section 3 presents the modeling framework. Section 4 derives equilibrium solutions for three strategic scenarios: both firms are myopic (M-M), both are far-sighted (F-F), and one firm is myopic while the other is far-sighted (M-F). Section 5 examines the managerial implications by analyzing how key parameters affect equilibrium outcomes and profitability. Section 6 investigates the equilibrium strategies under various parameter combinations. Section 7 extends the analysis to include second-period advertising decisions, offering additional insights into strategic behavior. Finally, Section 8 summarizes the main findings and contributions and outlines directions for future research. All proofs are provided in the appendix for clarity and ease of reference.

2. Literature review

Advertising is a commonly used promotional tool in marketing and can induce customers to make purchasing decisions. Comanor and Wilson [1] identify two main functions of advertising: to provide detailed and valuable product information to customers, and to persuade customers to purchase one product over others by emphasizing its differentiation. Previous research demonstrates that pricing and advertising are two important factors influencing profits and market share [2–8]. Advertising and pricing competition has been studied for decades. Three research streams examine the problem of competitive advertising and pricing [9–15]: advertising strategies, pricing strategies, and the effect of product substitutability on marketing strategy in a duopoly market.

The first research stream concerns advertising decisions and their impact on firms' operations. Advertising serves as a tool for conveying information to influence consumer behavior. In a broad sense, it encompasses various forms of market communication, including not only traditional media advertisements but also any activity aimed at boosting sales and enhancing brand impact. Advertising affects consumer behavior through a wide range of forms and strategies, whether through long-term brand building or short-term sales promotions. It typically enhances brand assets, increases customer loyalty, and raises brand awareness [16,17], although its direct long-term effect on sales remains unclear. Industry-specific studies reveal varied outcomes. For example, in the banking sector, advertising improves short-term financial performance but does not sustain long-term market value [18]. In the fast food industry, aggressive marketing and price promotions often erode brand equity [19]. Similar effects appear in the fashion and retail sectors, where strategies like Tommy Hilfiger's over-expansion into broader markets weaken the brand's luxury positioning [20].

Many studies indicate that promotions stimulate short-term sales but often undermine brand assets and customer loyalty, leading to unsustainable business practices [16,17,20]. The unclear long-term effects of advertising on sales partly stem from the diverse ways consumers respond to brand messages. Consumer interactions with advertising are complex [21]. For example, overt advertising typically reduces consumers' willingness to purchase [22], while negative publicity can, in some cases, increase brand awareness and purchase intention [21].

Consumers may also experience advertising fatigue [23] or react to ethical concerns in ad content [24]. In some instances, warning messages in advertisements enhance perceived trustworthiness and shape brand perception and long-term sales outcomes [25]. In summary, although advertising and promotions can effectively boost immediate sales, their long-term impact on brand equity is not always positive. Companies must consider the broader implications of their marketing strategies by integrating insights from consumer behavior, competitive dynamics, and ethical concerns to achieve sustainable growth and profitability [16,17].

The second stream of literature pertains to pricing strategies. A substantial body of research investigates pricing decisions in competitive markets, examining the implications of both myopic and far-sighted behaviors under varying market conditions [15,26–28]. This line of work identifies pricing as a critical strategic tool shaped by consumer behavior, competitive dynamics, and market structures. Dynamic pricing models, such as those proposed by Levin et al. [29] and Zhang et al. [30], illustrate how firms adjust prices in response to consumers' timing preferences and reference price effects. These studies demonstrate that pricing strategies evolve with consumer expectations shaped by past price histories and anticipated future prices. Other research explores how cooperative or coordinated relationships between manufacturers and retailers influence pricing decisions [31–33]. Choi and Fredj [34] examine interactions between national and store brands in retail channels, showing how vertical and horizontal competition jointly shape pricing strategies. Amaldoss et al. [15] further highlight the role of cross-externalities between consumers and advertisers, emphasizing the multifaceted nature of pricing in markets where advertising significantly affects consumer demand.

Despite extensive research on the direct effects of various dynamic factors on pricing strategies [12,35–37], few studies examine the long-term effects of advertising on pricing. The existing literature largely focuses on immediate outcomes, often overlooking how sustained advertising influences consumer price sensitivity and long-term brand loyalty [38–40]. However, long-term advertising effects can significantly reshape the pricing environment. Failing to consider these effects, particularly when they are negative, may lead to strategies that lose effectiveness over time. This study offers insights into the development of pricing strategies that not only respond to current market conditions but also remain effective in the long term, contributing to a more comprehensive understanding of how advertising influences consumer behavior and pricing outcomes.

The third stream of research examines the effect of product substitutability on marketing strategies in duopoly markets. Substitutability is frequently incorporated into studies on pricing and advertising [41–44]. Differences in products and distribution channels lead to substitution effects, which directly influence equilibrium outcomes among competing firms or within supply chains [11,43,45]. As product substitutability increases, price competition intensifies [43,46–48]. Substitutability plays a central role in shaping competitive strategies, particularly in pricing and marketing decisions across supply chains and competitive markets. Lus and Muriel [49] highlight its importance in pricing and capacity decisions, showing how firms adjust production flexibility and pricing to better balance supply and demand. Tang and Yin [50] support this view through an analysis of joint ordering and pricing strategies, suggesting that the degree of substitutability determines how flexibly retailers price substitutable products. Ceryan et al. [51] extend this perspective to dynamic pricing, noting that substitutability influences both pricing and inventory management, enabling firms to maintain stable price differences under market fluctuations. Xia [52] explores how substitutability affects market segmentation and competitive strategy, arguing that understanding product substitutability is essential for designing effective advertising strategies, refining market targeting, and strengthening competitive positioning.

While existing studies offer valuable insights into firms' immediate strategic responses to product substitutability, they often overlook the long-term impact of advertising in such contexts. Amaldoss et al. [15] point out that much of the current research fails to consider how sustained advertising shapes consumer perceptions and brand loyalty over time. Persistent advertising efforts can alter how consumers view product interchangeability, thereby influencing long-term pricing strategies. This study addresses that gap by incorporating the prolonged negative effects of advertising into the analysis of dynamic pricing under high product substitutability. It contributes to a deeper understanding of how long-term advertising influences consumer behavior and pricing effectiveness, and supports the development of pricing strategies that are both resilient and responsive to changing market dynamics.

Current literature highlights the complex interplay among advertising effects, product substitutability, and strategic pricing in competitive markets. Prior studies examine how advertising influences consumer perception and market positioning, capturing both its positive and negative effects. However, research remains limited in addressing the long-term negative consequences of advertising on pricing strategies and firm performance, particularly when product substitutability is high. To address this gap, this study develops a two-period game model that analyzes both the immediate and lasting impacts of advertising. The model further considers different levels of product substitutability and examines how these factors shape strategic behavior in a duopoly, distinguishing between myopic and far-sighted approaches. By integrating these dimensions, the research offers strategic insights that support firms in balancing short-term gains with long-term sustainability in competitive environments.

Table 1
Four cases of analysis.

Firm A	Firm B	
	Myopic	Far-sighted
Myopic	Case 1 (M-M)	Case 2 (M-F)
Far-sighted	Case 3 (F-M)	Case 4 (F-F)

3. Model framework

This study examines the competitive dynamics of a duopoly in which two firms, A and B, offer substitutable products and compete over two periods. The analysis focuses on firms' strategic decisions, where each firm adopts either a myopic or a far-sighted approach to pricing and advertising. A myopic firm maximizes profit in each period independently, while a far-sighted firm seeks to maximize total profit across both periods. The sequence of events is as follows:

In the first period, firms simultaneously choose their advertising and pricing strategies and observe the resulting sales along with the short-term effects of advertising.

In the second period, they adjust their prices based on updated sales outcomes and the lasting impact of their initial advertising efforts.

Assuming symmetry between firms A and B, and distinguishing between myopic and far-sighted strategies, the analysis considers four strategic scenarios. These cases are summarized in Table 1 for clarity.

In each case j ($j = 1, 2, 3, 4$), firm i ($i = A, B$) makes three decisions: two retail prices p_{ijk} for periods $k = 1, 2$, and one advertising effort level s_{ij}. Following prior studies [53,54], we assume that the demand for firm i in period k under case j follows a linear demand function, denoted by q_{ijk}:

$$q_{ijk} = 1 - p_{ijk} + \theta p_{hjk} + \gamma_k s_{ij} \quad (i, h = A, B \quad \& \quad h \neq i; \quad j = 1, 2, 3, 4; \quad k = 1, 2),$$

where $\theta \in [0, 1]$ represents the degree of product substitutability, and γ_k epitomizes the advertising's repercussion on demand within the k-th period. All variables and parameters are defined in Table 2. Assuming firms begin their advertising in period 1, γ_1 and γ_2 denote

the immediate and future advertising impacts. The advertising strategy considered in this study is known as promotion, which boosts initial sales, with γ_1 varying between 0 and 1. The first period's promotion success can positively or negatively influence second-period demand [55], leading to γ_2's fluctuation from −1 to 1. We do not impose any prior assumption on the relative strength of γ_1 and γ_2; either may have a dominant effect on demand.

To remain consistent with the literature, we assume that each firm incurs a convex advertising cost, described mathematically as $C_{ij} = s_{ij}^2$. In economics, marketing, and operations management, convex cost functions are commonly used when advertising affects demand linearly, reflecting increasing marginal costs of advertising [56–58]. By excluding production and other costs, we simplify our model. So, we can write out firm i's profit function in period k under case j, denoted by π_{ijk} as follows:

$$\pi_{ij1} = p_{ij1}(1 - p_{ij1} + \theta p_{hj1} + \gamma_1 s_{ij}) - s_{ij}^2,$$
$$\pi_{ij2} = p_{ij2}(1 - p_{ij2} + \theta p_{hj2} + \gamma_2 s_{ij}),$$

where $i, h = A, B; h \neq i; j = 1, 2, 3, 4; k = 1, 2$. Further, we define $\pi_{ij} = \pi_{ij1} + \pi_{ij2}$, which represents firm i's total profits across both periods.

4. Models and equilibrium solutions

This section derives the equilibrium solutions for the model across the four specified cases. All the detailed analysis and proofs are presented in Appendix.

4.1. Equilibrium solution in Case 1: M-M strategy

In Scenario 1, both firms adopt a short-term perspective, optimizing profits independently in each period. The equilibrium solution is derived using backward induction, beginning with pricing decisions in the second period. Given the initial advertising efforts ($s_{i1}, i = A, B$) and first-period retail prices (p_{i11}), each firm determines its optimal price for the second period (p_{i12}) to maximize its period-two profit (π_{i12}). Based on this approach, the expected payoffs for both firms in period 2 are as follows:

$$\pi_{i12}(p_{i12}) = p_{i12}(1 - p_{i12} + \theta p_{h12} + \gamma_2 s_{i1}).$$

Considering the derivatives $\frac{\partial^2 \pi_{i12}}{\partial p_{i12}^2} = -2 < 0$, it follows logically and straightforwardly that the equilibrium retail prices for the second period in Case 1 can be directly determined by the first-order conditions as follows:

$$p_{i12} = \frac{\gamma_2 \theta s_{\mathrm{h1}} + 2\gamma_2 s_{\mathrm{i1}} + \theta + 2}{4 - \theta^2}.$$

Given their short-term perspective, both firms focus solely on maximizing immediate profits, which guides their pricing and advertising decisions. The profit functions for each firm in the first period are presented below:

$$\pi_{i11}(p_{i11}, s_{i1}) = p_{i11}(1 - p_{i11} + \theta p_{h11} + \gamma_1 s_{i1}) - s_{i1}^2.$$

The equilibrium solution for the two-period scenario in Case 1 is derived through algebraic manipulation and is summarized in the following lemma.

Lemma 1. *In Case 1, assuming both firms adopt a myopic stance, their equilibrium strategic choices are as follows:*

$$p_{i11}^* = \frac{2}{4 - \gamma_1^2 - 2\theta},$$
$$s_{i1}^* = \frac{\gamma_1}{4 - \gamma_1^2 - 2\theta},$$
$$p_{i12}^* = \frac{4 - \gamma_1^2 + \gamma_2\gamma_1 - 2\theta}{(2 - \theta)\left(4 - \gamma_1^2 - 2\theta\right)}.$$

Lemma 1 indicates that firms' strategies are interdependent and influenced by both the short-term and long-term effects of advertising. However, because firms adopt a short-term perspective, the long-term impact of advertising is reflected only in their second-period decisions. Moreover, as product substitutability increases, firms compete more aggressively in pricing and advertising to gain an advantage in the market.

4.2. Equilibrium solutions in Case 2 and 3: M-F and F-M strategy

In our models for Case 2 and Case 3, we analyze scenarios where one firm is myopic and the other is forward-looking, necessitating only one scenario's examination due to symmetry. Specifically, we examine the situation where Firm A focuses on maximizing immediate profits, while Firm B adopts a comprehensive profit strategy across both periods. This particular focus pertains to Case 2. By using backward induction, we begin by solving the second-period problem. In other words, given the advertising effort levels ($s_{i2}, i = A, B$) and retail prices (p_{i21}) chosen by the firms in period 1, firm i chooses its optimal second-period retail price (p_{i22}) to maximize its second period profit (π_{i22}) as follows:

$$\pi_{i22}(p_{i22}) = p_{i22}(1 - p_{i22} + \theta p_{h22} + \gamma_2 s_{i2}).$$

Considering the derivatives $\frac{\partial^2 \pi_{i22}}{\partial p_{i22}^2} = -2 < 0$, it follows logically and straightforwardly that the equilibrium retail prices for the second period in Case 2 can be directly determined by the first-order conditions as follows:

$$p_{i22} = \frac{\gamma_2 \theta s_{\mathrm{h2}} + 2\gamma_2 s_{\mathrm{i2}} + \theta + 2}{4 - \theta^2}.$$

When we move backward to period 1, given firm A's myopic approach, it tailors its pricing and advertising to optimize first-period profits alone, whereas forward-looking firm B strategizes to enhance total profits over both periods. Based on maximizing the following profit functions, optimal first-period decisions can be made:

$$\begin{cases} \pi_{A21}(p_{A21}, s_{A2}) & = p_{A21}(1 - p_{A21} + \theta p_{B21} + \gamma_1 s_{A2}) - s_{A2}^2 \\ \pi_{B2}(p_{B21}, s_{B2}) & = p_{B21}(1 - p_{B21} + \theta p_{A21} + \gamma_1 s_{B2}) - s_{B2}^2 \\ & \quad + p_{B22}(1 - p_{B22} + \theta p_{A22} + \gamma_2 s_{B2}). \end{cases}$$

The equilibrium solution for the two-period scenario in Case 2 is derived through algebraic manipulation and is summarized in the following lemma.

Lemma 2. *In Case 2, assuming firm A is myopic and firm B is far-sighted, their equilibrium strategic choices are as follows:*

$$p_{A21}^* = \frac{2f_1(2-\theta)^2 + 8\gamma_1\gamma_2\theta - 16\gamma_2^2}{f_2},$$
$$s_{A2}^* = \frac{\gamma_1\left(4\gamma_1\gamma_2\theta + f_1(2-\theta)^2 - 8\gamma_2^2\right)}{f_2},$$
$$p_{A22}^* = \frac{\left(4 - \gamma_1^2 + \gamma_2\gamma_1 - 2\theta\right)\left(-\gamma_1^2\theta^2 + 4\gamma_1^2 + 4\gamma_2^2 + 2\theta^3 + 4\theta^2 - 8\theta - 16\right)}{f_3(\theta - 2)},$$
$$p_{B21}^* = \frac{2f_1(2-\theta)^2 - 4\left(4 - \gamma_1^2\right)\gamma_2^2 + 4\gamma_1\left(4 - \gamma_1^2\right)\gamma_2}{f_2},$$
$$s_{B2}^* = \frac{8\gamma_2\left(4 - \gamma_1^2 - \theta^2\right) + \gamma_1 f_1(2-\theta)^2 + 4\gamma_1\gamma_2^2\theta}{f_2},$$
$$p_{B22}^* = \frac{f_1\left(\gamma_1^2 - \gamma_2\gamma_1 + 2\theta - 4\right)}{f_3},$$

where
$$f_1 = (\theta + 2)\left(2\theta - \gamma_1^2 + 4\right),$$
$$f_2 = (2 - \theta)\left((\theta^2 - 4)\left(-\gamma_1^4 + 8\gamma_1^2 + 4\left(\theta^2 - 4\right)\right) + 4\left(\gamma_1^2 - 4\right)\gamma_2^2\right),$$
$$f_3 = \gamma_1^4\left(\theta^2 - 4\right) + 4\gamma_1^2\left(8 - \gamma_2^2 - 2\theta^2\right) - 4\left(\left(\theta^2 - 4\right)^2 - 4\gamma_2^2\right).$$

Lemma 2 shows that although Firm A is myopic and focuses only on maximizing immediate returns, since competitor B is far-sighted, in equilibrium the strategies of both firms are affected by both the long-term and short-term effects of advertisements as well as by the rate of substitution. In addition, since Cases 2 and 3 are symmetric, the equilibrium solution of Case 2 also applies to Case 3, except that in Case 3, firm A and firm B adopt opposite strategies to those in Case 2.

Table 2
Summary of major notation.

Symbol	Definition
p_{ijk}	Retail price for firm i in period k of case j, where $i = A, B$; $j = 1, 2, 3, 4$; $k = 1, 2$
s_{ij}	Advertising effort for firm i in period 1 of case j
γ_1	Short-term effects of advertising, $\gamma_1 \in [0, 1]$
γ_2	Long-term effects of advertising, $\gamma_2 \in [-1, 1]$
θ	Product substitution rate, $\theta \in [0, 1]$
q_{ijk}	Sales for firm i in period k of case j
π_{ijk}	Profits for firm i in period k of case j
π_{ij}	Total profits for firm i of case j

4.3. Equilibrium solution in Case 4: F-F strategy

In Case 4, both firms adopt a far-sighted approach, meaning their first-period decisions aim to maximize total profit over both periods. To find the optimal decisions, we use backward induction. Given the advertising effort levels ($s_{i4}, i = A, B$) and retail prices (p_{i41}) chosen by the firms in the first period, firm i then chooses its optimal second-period retail price (p_{i42}) to maximize its second-period profit (π_{i42}) as follows:

$$\pi_{i42}(p_{i42}) = p_{i42}(1 - p_{i42} + \theta p_{h42} + \gamma_2 s_{i4}).$$

Considering the derivatives $\frac{\partial^2 \pi_{i42}}{\partial p_{i42}^2} = -2 < 0$, it follows logically and straightforwardly that the equilibrium retail prices for the second period in Case 4 can be directly determined by the first-order conditions as follows:

$$p_{i42} = \frac{\gamma_2 \theta s_{\mathrm{h4}} + 2\gamma_2 s_{\mathrm{i4}} + \theta + 2}{4 - \theta^2}.$$

Since both firms are far-sighted, they set their retail prices and advertising efforts at the beginning of the first period to maximize total profit over both periods. The profit functions guiding these initial optimal decisions are outlined below:

$$\pi_{i4}(p_{i41}, s_{i4}) = p_{i41}(1 - p_{i41} + \theta p_{h41} + \gamma_1 s_{i4}) - s_{i4}^2 + p_{i42}(1 - p_{i42} + \theta p_{h42} + \gamma_2 s_{i4}).$$

The equilibrium solution for the two-period scenario in Case 4 is derived through algebraic manipulation and is summarized in the following lemma.

Lemma 3. *In Case 4, where both firms adopt a far-sighted approach, their equilibrium strategic decisions are as follows:*

$$p_{i41}^* = \frac{4\gamma_2 (\gamma_1 - \gamma_2) + 2(\theta - 2)^2(\theta + 2)}{(2 - \theta)\left(\left(4 - \theta^2\right)\left(4 - \gamma_1^2 - 2\theta\right) - 4\gamma_2^2\right)},$$

$$s_{i4}^* = \frac{4\gamma_2 + \gamma_1 \left(4 - \theta^2\right)}{\left(4 - \theta^2\right)\left(4 - \gamma_1^2 - 2\theta\right) - 4\gamma_2^2},$$

$$p_{i42}^* = \frac{(\theta + 2)\left(\gamma_1^2 - \gamma_2\gamma_1 + 2\theta - 4\right)}{\gamma_1^2\left(4 - \theta^2\right) + 4\gamma_2^2 - 2(\theta + 2)(\theta - 2)^2}.$$

Lemma 3 shows that when both firms are far-sighted, their decisions in each period are influenced by both the short- and long-term effects of advertising and the rate of product substitution.

5. Analyses

This section examines the impact of changes in model parameters—γ_1, γ_2, and θ—on the equilibrium decisions and profits of the two firms across all four cases. By understanding these dynamics, managers can gain valuable insights into competitive strategies, specifically in setting the most advantageous equilibrium prices and optimizing advertising efforts. Detailed proofs supporting this analysis are included in the appendix for further reference.

5.1. The effect of γ_1

First, we investigate how the immediate impact of advertising, represented by γ_1, influences three key aspects: equilibrium retail prices (p_{ijk}^*), advertising efforts (s_{ij}^*), and expected total profits (π_{ij}^*), where i stands for firms A or B, j denotes the case number (1 to 4), and k signifies the period (1 or 2). In the analysis in this subsection, we keep all other parameters fixed and only vary γ_1 within a range from 0 to 1. It is important to note that both a "decrease" and an "increase" are used loosely in this article; a "decrease" is an indication of a "nonincrease", while an "increase" indicates a "nondecrease". In addition, our following analysis is conducted within a specific valid region, defined by certain ranges of the parameters γ_1, γ_2, and θ, ensuring all key variables like the equilibrium retail prices (p_{ijk}^*), advertising effort levels (s_{ij}^*), and total profits (π_{ij}^*) are positive. This condition is crucial for maintaining the model's functionality, as negative values would make the analysis invalid. Adjusting γ_1 affects the firms' equilibrium decisions and profits, as detailed below.

Lemma 4. *With an increase in the short-term advertising effect γ_1 from 0 to 1, and considering γ_2 and θ within the valid region, we observe:*
(i) an increase in first-period equilibrium retail prices p_{ij1}^* for both firms A and B (i = A,B) across cases 1 to 4 (j = 1,2,3,4);
(ii) an increase in second-period equilibrium retail prices p_{ij2}^* when $\gamma_2 > 0$ and a decrease when $\gamma_2 < 0$;
(iii) an increase in equilibrium advertising effort levels s_{ij}^*;
(iv) an increase in equilibrium total profits π_{ij}^*, except in Case 1, where profits π_{i1}^* increase only when $\gamma_2 > 0$.

Lemma 4 shows that an increase in the short-term advertising effect (γ_1) raises equilibrium retail prices, advertising intensity, and profits, particularly when the long-term advertising effect (γ_2) is also positive. This aligns with the intuition that short-term advertising stimulates demand by capturing consumer interest, thereby enabling firms to charge higher prices and increase profits. In contrast, a negative γ_2 suggests that advertising may damage the brand over time, undermining brand value, consumer trust, and future sales. Such outcomes may result from market saturation, the spread of negative information, or early consumer exhaustion caused by aggressive advertising, all of which can suppress future demand. As a result, firms may be forced to lower prices to sustain sales, weakening long-term profitability. These findings highlight the need to balance short-term gains with long-term sustainability when designing pricing and advertising strategies. Furthermore, our numerical analysis shows that when both firms are myopic and γ_2 is negative, total equilibrium profits may either increase or decrease with rising γ_1. For instance, as illustrated in Fig. 1, when $\gamma_2 = -0.5$, total profits in Case 1 first decline and then rise as γ_1 increases.

5.2. The effect of γ_2

Lemma 5. *With an increase in the long-term advertising effect γ_2 from −1 to 1, considering γ_1 and θ within the valid region, we observe:*
(i) in the first period, equilibrium retail prices p_{ij1}^* remain unchanged when both firms are myopic (Case 1), increase when both are far-sighted (Case 4), and only rise in mixed-strategy scenarios (Cases 2 and 3) if $\gamma_2 > 0$;
(ii) in the second period, equilibrium retail prices p_{ij2}^* increase if both firms are myopic; however, if either firm adopts a far-sighted strategy, equilibrium retail prices only rise when $\gamma_2 > 0$;
(iii) equilibrium advertising effort levels s_{ij}^* remain unchanged when both firms are myopic, increase when both are far-sighted, and in cases of mixed strategies, they only rise if $\gamma_2 > 0$;
(iv) equilibrium total profits π_{ij}^* rise when firms adopt the same strategy; with differing strategies, they only increase if $\gamma_2 > 0$.

In analyzing the long-term advertising effect γ_2, which ranges from −1 to 1, we find that the equilibrium retail prices and advertising efforts

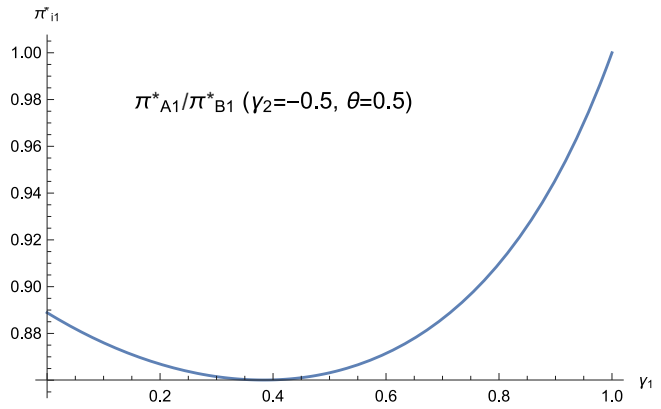

Fig. 1. Effects of γ_1 on the equilibrium total profits π^*_{i1} in Case 1 when $\gamma_2 < 0$.

in the first period remain unchanged when both firms are myopic. Since myopic firms focus only on immediate gains, they do not adjust their initial strategies based on the anticipated long-term impact of γ_2. In contrast, far-sighted firms, which consider future outcomes, increase both retail prices and advertising investments in the first period as γ_2 rises. These firms adjust early to capture the combined benefits of short- and long-term profits, rather than waiting to respond in the second period. When one firm is myopic and the other is far-sighted, first-period equilibrium prices and advertising levels increase with γ_2 only if it is positive. If γ_2 is negative, the equilibrium outcomes vary inconsistently. They may increase or decrease depending on the context, as shown in the numerical analysis in Fig. 2.

Lemma 5 shows that when both firms adopt myopic strategies, equilibrium retail prices in the second period tend to rise as γ_2 increases from −1 to 1. Since myopic firms focus on immediate returns, the weakening of negative effects or the emergence of positive effects from γ_2 makes higher pricing less likely to reduce sales volumes, potentially enhancing revenue. In contrast, when at least one firm is far-sighted, second-period prices increase with γ_2 only if $\gamma_2 > 0$. When $\gamma_2 < 0$, prices do not necessarily rise, even as the adverse effects diminish. Regarding total profits, when both firms adopt the same strategy, whether myopic or far-sighted, profits generally increase as γ_2 rises. However, when the firms follow different strategies, profit improvements occur only if γ_2 is positive. Numerical examples in Fig. 2 further demonstrate that when $\gamma_2 < 0$, increases in γ_2 from −1 to 0 do not consistently lead to higher equilibrium outcomes or profits.

5.3. The effect of θ

Lemma 6. *With an increase in the substitution intensity θ from 0 to 1, and considering γ_2 and θ within the valid region, we observe:*
(i) an increase in first-period equilibrium retail prices p^*_{ij1} for both firms A and B across cases 1 to 4;
(ii) an increase in second-period equilibrium retail prices p^*_{i42} when both firms are far-sighted, but an increase only occurs if either of them adopts a myopic strategy and $\gamma_2 > 0$;
(iii) the firm with a myopic strategy has an increase in advertising effort level, while the firm with a far-sighted strategy only sees an increase in advertising effort level when $\gamma_2 > 0$;
(iv) an increase in equilibrium total profits π^*_{ij} for both firms A and B across cases 1 to 4.

Lemma 6 indicates that an increase in the substitution rate generally benefits firms by intensifying competition, which encourages them to optimize pricing, improve product quality, and innovate in marketing to attract and retain customers. As a result, a higher substitution rate tends to increase first-period equilibrium prices and overall profits for both myopic and far-sighted firms. However, the effect of substitution on first-period equilibrium advertising efforts and second-period pricing is not consistently positive. When at least one firm is myopic, a higher substitution rate increases second-period prices only if $\gamma_2 > 0$. If $\gamma_2 < 0$, equilibrium prices may decline, as illustrated in the numerical examples in Fig. 3. This decline often results from myopic firms over-investing in advertising during the first period, which leads them to lower prices in the second period to offset the negative consequences of their earlier promotional intensity.

Furthermore, while myopic firms consistently increase their advertising efforts in response to a higher substitution rate, far-sighted firms do so only when γ_2 is clearly positive. Their caution reflects concerns about the potential long-term negative effects of aggressive advertising, which may lead to reduced sales in the second period. As shown in Fig. 3, increases in the substitution rate do not always result in higher first-period advertising efforts or second-period prices; these outcomes may rise or fall depending on the value of γ_2 and the firms' strategic orientation.

6. Myopic vs. Far-sighted strategies

This section compares firm A's equilibrium total profits across four scenarios (π^*_{A1}, π^*_{A2}, π^*_{A3}, and π^*_{A4}) to identify conditions under which the myopic or far-sighted strategy yields higher total profits. These comparisons help determine the strategies and conditions associated with the Nash equilibrium. Since firms A and B are homogeneous and symmetric, the results for firm A also apply to firm B.

As shown in Table 1, to identify the Nash equilibrium strategy, we first determine the best response of the row player (firm A) to each possible strategy of the column player (firm B). If firm B chooses the myopic strategy, firm A's equilibrium payoff is π^*_{A1} when it also adopts the myopic strategy (M), and π^*_{A3} when it adopts the far-sighted strategy (F). If $\pi^*_{A1} > \pi^*_{A3}$, then the optimal response to a myopic competitor is to also choose strategy M. Conversely, if $\pi^*_{A3} > \pi^*_{A1}$, strategy F yields a higher payoff. Similarly, if firm B selects the far-sighted strategy, firm A earns π^*_{A2} with strategy M and π^*_{A4} with strategy F. If $\pi^*_{A2} > \pi^*_{A4}$, the best response is strategy M; otherwise, strategy F is preferable.

Since the firms are symmetric, firm B's best response to any strategy chosen by firm A mirrors this logic. Therefore, if $\pi^*_{A1} > \pi^*_{A3}$ and $\pi^*_{A2} > \pi^*_{A4}$, the Nash equilibrium is M-M, as firm A's optimal response to any strategy of firm B is M, and similarly for firm B. Conversely, if $\pi^*_{A1} < \pi^*_{A3}$ and $\pi^*_{A2} < \pi^*_{A4}$, F-F becomes the only Nash equilibrium. Additionally, if $\pi^*_{A1} > \pi^*_{A3}$ and $\pi^*_{A2} < \pi^*_{A4}$, the equilibria are M-M and F-F, and if $\pi^*_{A1} < \pi^*_{A3}$ and $\pi^*_{A2} > \pi^*_{A4}$, the equilibria are M-F and F-M. We also examine π^*_{A1} and π^*_{A4} to explore potential Prisoner's Dilemma scenarios. The following propositions summarize our core findings.

6.1. Equilibrium strategies when $\gamma_2 > 0$

We start with $\gamma_2 > 0$ and explore the firms' equilibrium strategies when both the short-term and long-term effects of advertising are positive.

Proposition 1. *When $\gamma_2 > 0$, firms opt for a far-sighted strategy in equilibrium, culminating in an F-F equilibrium; however, when $\gamma_2 < 0$, they adopt a strategy identical to their competitor's, leading to either an M-M or an F-F configuration.*

When the long-term advertising effect (γ_2) is positive, π^*_{A3} (the payoff from adopting the far-sighted strategy against a myopic rival) and π^*_{A4} (the payoff from the far-sighted strategy against a far-sighted rival) both exceed π^*_{A1} (the payoff from the myopic strategy against a myopic rival) and π^*_{A2} (the payoff from the myopic strategy against a far-sighted rival), respectively. As a result, the far-sighted strategy becomes the optimal choice for both firms, regardless of the rival's decision, making F-F the unique Nash equilibrium.

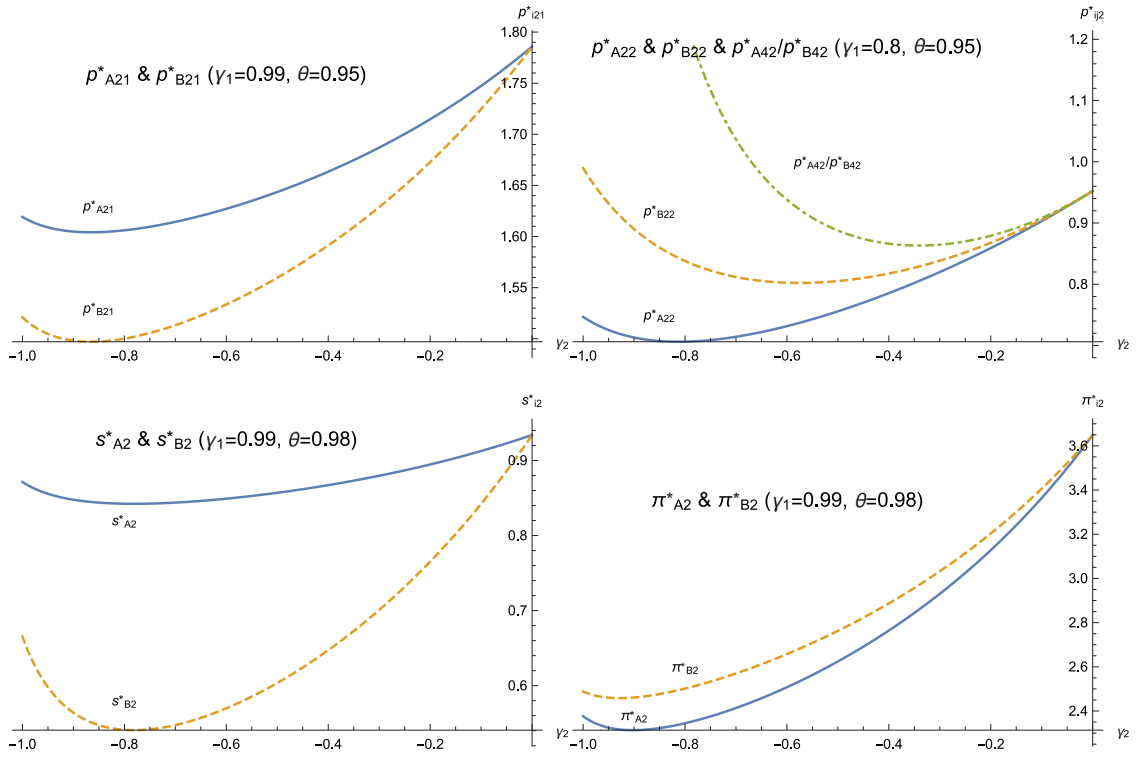

Fig. 2. Effects of γ_2 on equilibrium decisions and profits when $\gamma_2 < 0$.

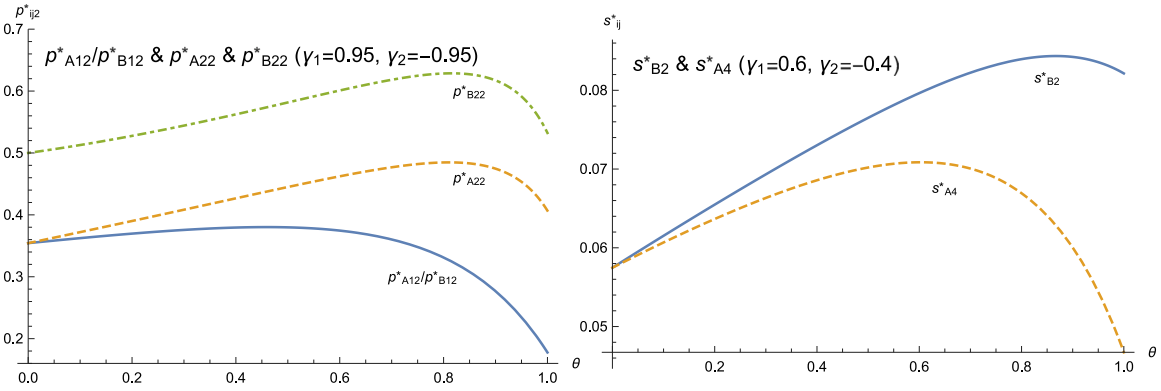

Fig. 3. Effects of θ on equilibrium decisions when $\gamma_2 < 0$.

Although the F-F strategy is always the theoretical equilibrium as long as $\gamma_2 > 0$, we find that within certain parameter ranges, businesses can experience negative profit in the first period. For example, as shown in the left diagram of Fig. 4, when $\theta = 0.7$, no matter the value of γ_1, if γ_2 exceeds approximately 0.9, businesses consistently report negative profits in the first period.

This outcome raises concerns about the practical viability of the F-F equilibrium. When firms incur losses in the first period ($\pi^*_{A41} = \pi^*_{B41} < 0$), they must have sufficient capital to endure the initial financial strain. However, many startups lack the resources or financial stability to absorb early losses. In practice, startups often seek quick profitability to demonstrate viability to shareholders and attract continued investment. As a result, generating profits in the first period becomes essential for survival. Early losses may force some firms, especially startups, to exit the market.

Our analysis shows that within certain parameter ranges, particularly when the long-term advertising effect is strong ($\gamma_2 > 0.8$) and product substitutability is high ($\theta > 0.4$), the F-F strategy, although a theoretical equilibrium, may lead to negative profits in the first period. If firms must meet short-term profit targets, they may be forced to adopt the myopic (M) strategy instead of the far-sighted (F) strategy to survive. As shown in the right panel of Fig. 4, when γ_2 and θ approach the upper-right corner, first-period profits under the F-F equilibrium become negative. In such situations, firms are likely to choose the M strategy to sustain operations, making M-M a possible real-world equilibrium.

In summary, when both the long-term benefits of advertising and product substitutability are high, the F-F equilibrium may not generate short-term profits. Firms with short-term financial goals and external commitments may have no choice but to pursue a myopic strategy to maintain operations and avoid exit. A relevant example is China's bike-sharing industry. Startups like Ofo and Mobike initially adopted aggressive promotions, offering free rides, zero deposits, or very low deposits, to rapidly gain market share. These tactics, however, resulted in substantial early losses. Ofo ultimately faced financial collapse and exited the market, while Mobike, after being acquired by Meituan,

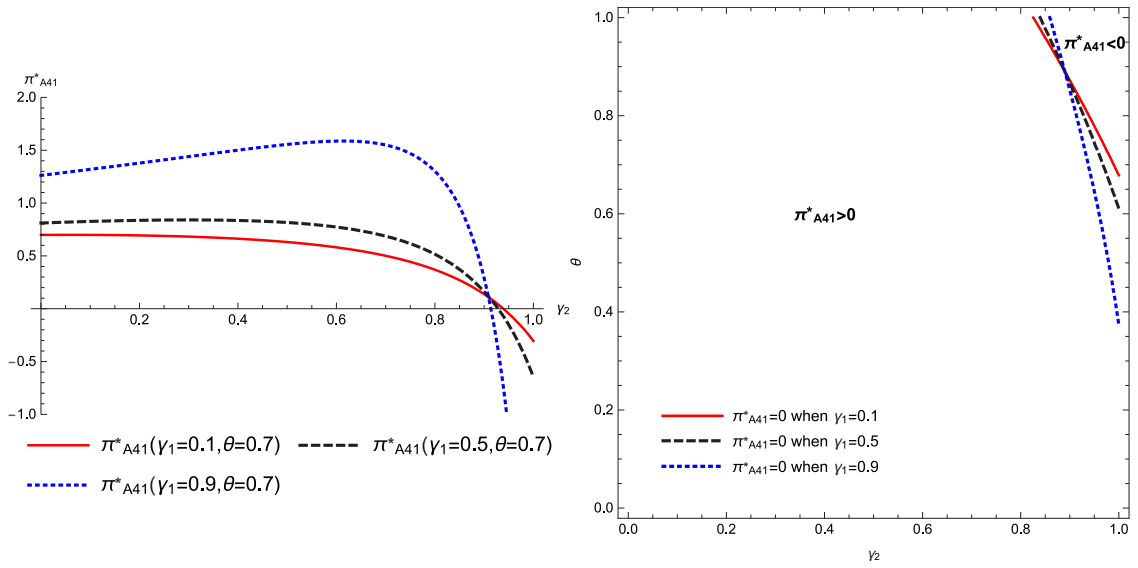

Fig. 4. The condition where $\pi^*_{A41} < 0$.

abandoned its subsidy strategy and shifted to a pricing model focused on short-term profitability and operational sustainability.

Conversely, when $\gamma_2 < 0$, π^*_{A3} does not consistently surpass π^*_{A1}, nor does π^*_{A4} consistently exceed π^*_{A2}. This variability indicates that the far-sighted strategy may not always be advantageous, thus allowing both M-M and F-F to become possible equilibria. The preference for a specific strategy depends on the intensity of the short-term effects of advertising, the adverse long-term effects of advertising, and the level of product substitution.

A far-sighted strategy is effective when long-term advertising effects significantly enhance future profits. A positive γ_2 indicates that advertising generates cumulative benefits, leading to increasing future returns. By choosing this strategy, firms take advantage of these future gains, making it a dominant strategy and resulting in an F-F equilibrium. In contrast, a negative γ_2 suggests that current advertising efforts reduce future profits. In such cases, firms may prefer a myopic strategy that focuses on immediate returns to compensate for expected future losses. The choice between myopic and far-sighted strategies depends on the specific context, particularly the trade-off between short-term and long-term effects and the level of product substitutability. This environment may lead to an M-M equilibrium, where both firms seek to maximize short-term profits by heavily advertising to achieve high initial sales at premium prices, despite the risk of long-term losses. Because the firms are homogeneous and symmetric, they tend to adopt the same strategy, resulting in either an M-M or F-F equilibrium. The following analysis and propositions examine these equilibrium outcomes and the conditions under which they arise when γ_2 is negative.

6.2. Equilibrium strategies when $\gamma_2 < 0$

When $\gamma_2 < 0$, both M-M and F-F can serve as Nash equilibria. The specific type depends on the intensity of the negative advertising effect γ_2, the strength of the short-term advertising effect γ_1, and the substitution rate θ. In Section 6.2, we first assess the joint impact of γ_2 and θ on firms' performance. To avoid potential influences from γ_1 being too strong or too weak, we fix γ_1 at 0.5 for the study. Subsequently, we explore the joint impact of γ_1 and θ on firms' profits when γ_2 is negative. Similarly, we fix γ_2, which represents the long-term negative effect of advertising, at −0.5. This approach aims to comprehensively identify patterns and general principles regarding how shifts in the three parameters, γ_1, γ_2, and θ, affect the equilibrium strategy.

Proposition 2. *When fixing γ_1 at 0.5 with $-1 < \gamma_2 < 0$, or setting γ_2 at −0.5 with $0 < \gamma_1 < 1$, the equilibrium total profits exhibit the following properties:*
(i) π^*_{A1} and π^*_{A4} have at most one intersection over θ, denoted as θ_1;
(ii) π^*_{A1} and π^*_{A3} have at most one intersection over θ, denoted as θ_2;
(iii) π^*_{A2} and π^*_{A4} have at most one intersection over θ, denoted as θ_3;
(iv) $\theta_1 < \theta_2 < \theta_3$.

We set γ_1 at a moderate level (0.5) and analyze how Firm A's equilibrium profits change across different strategic settings as γ_2 varies from −1 to 0 and θ increases from 0 to 1. As θ increases, the equilibrium profits π^*_{A1} and π^*_{A4}, π^*_{A1} and π^*_{A3}, as well as π^*_{A2} and π^*_{A4} each display at most one intersection point with respect to θ. We also fix γ_2 at a moderately negative level (−0.5) and vary the values of γ_1 and θ, which leads to the same conclusion.

Fig. 5 presents a numerical analysis example where π^*_{A1} with π^*_{A4} has an intersection point θ_1 on θ, π^*_{A1} with π^*_{A3} has an intersection point θ_2 on θ, and π^*_{A2} with π^*_{A4} has an intersection point θ_3 on θ, with θ_1, θ_2, and θ_3 occurring simultaneously, and $\theta_1 < \theta_2 < \theta_3$. When these intersection points occur, the profits relationships reverse before and after the intersection points. The occurrence of these intersection points depends on the specific values of γ_1 and γ_2.

Fig. 5 also demonstrates that when θ is small, $\pi^*_{A3} > \pi^*_{A4} > \pi^*_{A1} > \pi^*_{A2}$; this means that for Firm A, no matter what strategy its competitor chooses, its best response is to select a far-sighted strategy. When θ increases to a moderate level, $\pi^*_{A3} > \pi^*_{A1} > \pi^*_{A4} > \pi^*_{A2}$; the far-sighted strategy is still the optimal one. As θ continues to increase, $\pi^*_{A1} > \pi^*_{A3} > \pi^*_{A4} > \pi^*_{A2}$; thus, the F strategy is no longer always the optimal choice. When θ is significant, approaching 1, the myopic strategy shows absolute dominance. In environments with high substitution rates, fierce competition drives companies to secure excessive profits in the first phase through high pricing and extensive advertising. Even though they may need to sell at lower prices in the second phase, the profits from the first phase are sufficient to offset subsequent losses. Conversely, in markets with low substitution rates and high product differentiation, where competition is less intense, companies tend to adopt a long-term moderate strategy, implementing moderate pricing and advertising in both phases to steadily expand and maintain market share. After determining the magnitude of the equilibrium total payoffs in the four cases, we further investigate the equilibrium strategy under various parameter settings.

Fig. 6's left graph displays a numerical analysis example where γ_1 is fixed at 0.5, and as negative γ_2 increases from −1 to 0, while θ changes

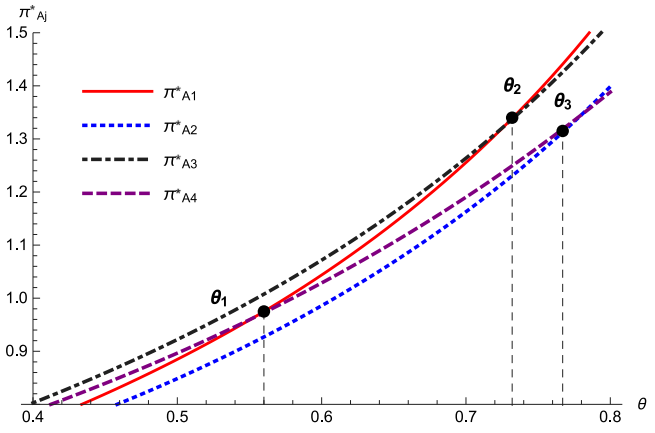

Fig. 5. Comparison of π^*_{A1}, π^*_{A2}, π^*_{A3}, and π^*_{A4} when $\gamma_2 < 0$.

from 0 to 1, the intersection points θ_1, θ_2, and θ_3 for π^*_{A1} with π^*_{A4}, π^*_{A1} with π^*_{A3}, and π^*_{A2} with π^*_{A4} appear sequentially. The solid, dashed, and dotted lines represent θ_1, θ_2, and θ_3 respectively, dividing the two-dimensional space defined by γ_2 and θ into four regions. Each line divides the two-dimensional space represented by the γ_2 horizontal axis and the θ vertical axis into two regions, and the relationship between a pair of π^*_{Aj} in the areas below and above each line is exactly opposite. The right graph of Fig. 6, with γ_2 fixed at −0.5, shows similar results as γ_1 increases and θ changes from 0 to 1, with intersection points θ_1, θ_2, and θ_3 appearing sequentially for π^*_{A1} and π^*_{A4}, π^*_{A1} and π^*_{A3}, and π^*_{A2} and π^*_{A4}. In both graphs of Fig. 6, the solid line for θ_1 is always below the dashed line for θ_2, which in turn is below the dotted line for θ_3. This indicates that as θ increases from 0 to 1, π^*_{A1} and π^*_{A4} always intersect first, followed by π^*_{A1} and π^*_{A3}, and finally π^*_{A2} and π^*_{A4}.

Proposition 3. *In the successive appearance of θ_1, θ_2, and θ_3, we draw the following conclusions:*
(i) when only θ_1 exists, each firm opts for a far-sighted strategy in equilibrium, resulting in an F-F equilibrium;
(ii) when only θ_1 and θ_2 exist, firms adopt an F-F equilibrium strategy for $\theta \le \theta_2$, align with the Prisoners' Dilemma within $\theta_1 \le \theta \le \theta_2$, and can opt for either M-M or F-F for $\theta_2 \le \theta \le 1$;
(iii) when θ_1, θ_2, and θ_3 exist, firms adopt an F-F equilibrium strategy for $\theta \le \theta_2$, face a Prisoners' Dilemma within $\theta_1 \le \theta \le \theta_2$, can choose between M-M or F-F for $\theta_2 \le \theta \le \theta_3$, and switch to an M-M equilibrium for $\theta_3 \le \theta \le 1$;
(iv) when θ_1, θ_2, and θ_3 are absent, each firm adopts a far-sighted strategy in equilibrium, leading to an F-F equilibrium.

In Proposition 2, we prove that for θ, there is at most one intersection point for each of the following pairs: π^*_{A1} and π^*_{A4}, π^*_{A1} and π^*_{A3}, and π^*_{A2} and π^*_{A4}. Moreover, the intersection point θ_1 for π^*_{A1} and π^*_{A4} occurs before the intersection point θ_2 for π^*_{A1} and π^*_{A3}, and θ_2 appears before the intersection point θ_3 for π^*_{A2} and π^*_{A4}. We examine the equilibrium strategies under various combinations of parameter values.

When $\gamma_1 = 0.5$, γ_2 ranges from −1 to 0, and θ takes any value between 0 and 1, we find that if γ_2 is strongly negative, meaning advertising has a strong adverse effect, then $\pi^*_{A4} > \pi^*_{A1}$, $\pi^*_{A3} > \pi^*_{A1}$, and $\pi^*_{A4} > \pi^*_{A2}$ hold for all values of θ. Therefore, the optimal strategy for both firms is to adopt the far-sighted approach, making F-F the equilibrium. This result suggests that when advertising has a strong negative effect, a moderately restrained and sustainable far-sighted pricing and advertising strategy maximizes profits.

As shown in the left panel of Fig. 6, a numerical example, when γ_1 is 0.5 and the negative effect of advertising gradually weakens from −1 to 0, the intersection point θ_1 begins to appear once the effect weakens beyond approximately −0.5. The solid line in the figure marks the intersection point θ_1 between π^*_{A1} and π^*_{A4}, indicating that as the long-term negative effect of advertising (γ_2) weakens, these two profit functions begin to intersect. We show that before the intersection, $\pi^*_{A4} > \pi^*_{A1}$, and after the intersection, $\pi^*_{A1} > \pi^*_{A4}$. At the same time, π^*_{A3} remains greater than π^*_{A1}, and π^*_{A4} remains greater than π^*_{A2}. Therefore, the optimal strategy for both firms continues to be far-sighted, and F-F remains the equilibrium. However, since $\pi^*_{A1} > \pi^*_{A4}$, both firms choosing strategy F leads to a lower payoff than if they had chosen strategy M. This outcome illustrates a Prisoner's Dilemma, where mutual cooperation (F-F) is stable but suboptimal.

As the substitution rate θ approaches 1, the intersection points θ_2 between π^*_{A1} and π^*_{A3} and θ_3 between π^*_{A2} and π^*_{A4} appear successively, as shown by the dashed and dotted lines in the left panel of Fig. 6. When θ lies between θ_2 and θ_3, the inequalities $\pi^*_{A1} > \pi^*_{A4}$, $\pi^*_{A1} > \pi^*_{A3}$, and $\pi^*_{A4} > \pi^*_{A2}$ hold. In this range, either M-M or F-F can serve as equilibrium strategies, with both firms tending to adopt the same strategy as their competitor to maximize profits. When $\pi^*_{A1} > \pi^*_{A4}$, $\pi^*_{A1} > \pi^*_{A3}$, and $\pi^*_{A2} > \pi^*_{A4}$ hold simultaneously, meaning that regardless of the competitor's choice, the best response is to adopt the myopic (M) strategy. In this case, M-M becomes the unique equilibrium.

This result suggests that when the long-term negative effect of advertising is relatively mild and product substitutability is high, a myopic strategy that emphasizes aggressive pricing and heavy advertising can generate higher profits. For instance, in the high-end smartphone market, startups such as OnePlus and Smartisan adopt premium pricing and intensive marketing to quickly gain market share. These firms position themselves as high-quality brands and justify their prices through enhanced user experiences and strong promotional campaigns.

As can be seen in Fig. 6, when $\gamma_1 = 0.5$, and γ_2 is about −0.4 or higher, θ_1, θ_2, and θ_3 appear successively. When γ_2 is weaker than −0.4, only θ_1 occurs; when γ_2 weakens further, both θ_1 and θ_2 appear; and when γ_2 gradually approaches 0, θ_1, θ_2, and θ_3 all appear, with the weaker the negative effect of γ_2, the lower the θ_s. Similarly, when $\gamma_2 = -0.5$, after γ_1 exceeds about 0.5, θ_1, θ_2, and θ_3 appear successively; when γ_1 is moderate, only θ_1 appears; when γ_1 is significantly positive, both θ_1 and θ_2 coexist; and when γ_1 is highly effective, θ_1, θ_2, and θ_3 all exist, and the larger γ_1 is, the smaller the θ_s are. This suggests that θ_1, θ_2, and θ_3 can be expected to occur successively when negative γ_2 is moderate and γ_1 is significant. This indicates that when the long-term negative effect of advertising is at a moderate or weak level and the short-term positive effect of advertising is relatively strong, the product substitution rate significantly impacts the firm's equilibrium strategy, which varies at different levels of product substitution. When the negative effect of γ_2 is very weak and close to 0, even if the substitution rate is very low, firms gain more from adopting the myopic (M) strategy than from the far-sighted (F) strategy, thus making M-M an equilibrium. When the value of γ_2 is close to −0.3, the M strategy shows an advantage only when the substitution rate is very high. Similarly, when γ_1 is very large and close to 1, the M strategy shows an advantage if the substitution rate is approximately greater than 0.6, while when γ_1 is close to about 0.7, M outperforms the F strategy due to its effectiveness only if the substitution rate is very high.

In summary, when $\gamma_2 > 0$ or when the negative value of γ_2 is relatively strong, the far-sighted strategy consistently yields better results. However, when the negative effect of γ_2 is weak, the substitution rate and the level of product competition influence the firm's equilibrium strategy. When the substitution rate θ is low, indicating limited competition, firms should maintain a long-term perspective. In contrast, when competition is intense, firms tend to adopt a myopic strategy that combines high pricing and heavy advertising to achieve rapid profits. Therefore, when the substitution rate is relatively high, the myopic strategy may be more effective. When θ is high but not extreme, both the myopic (M) and far-sighted (F) strategies can offer higher payoffs, depending on the competitor's choice. Given the symmetry between the

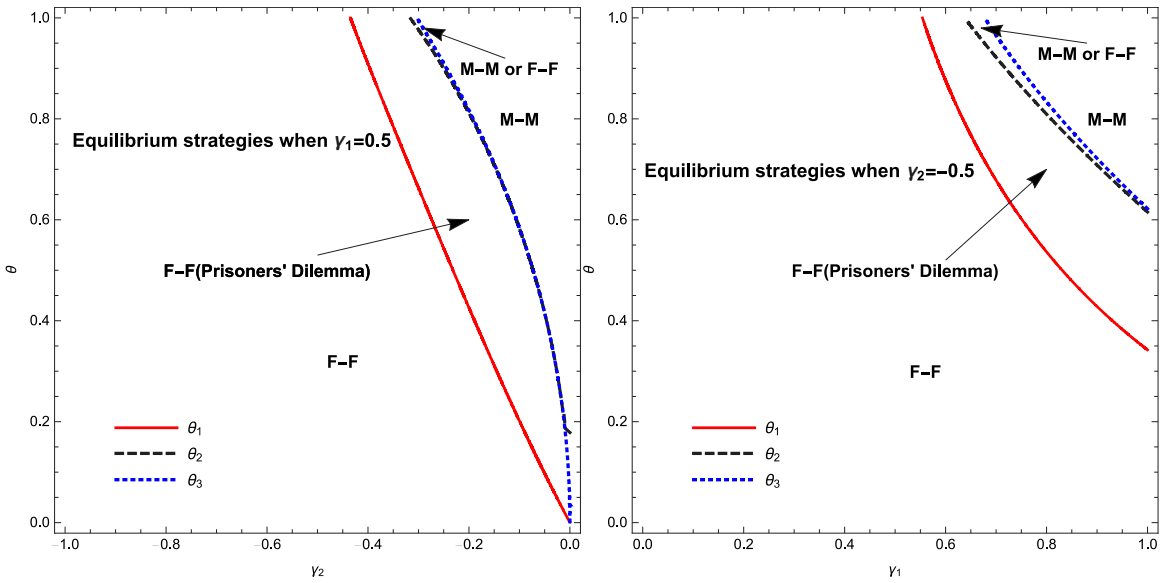

Fig. 6. Equilibrium strategies when $\gamma_2 < 0$.

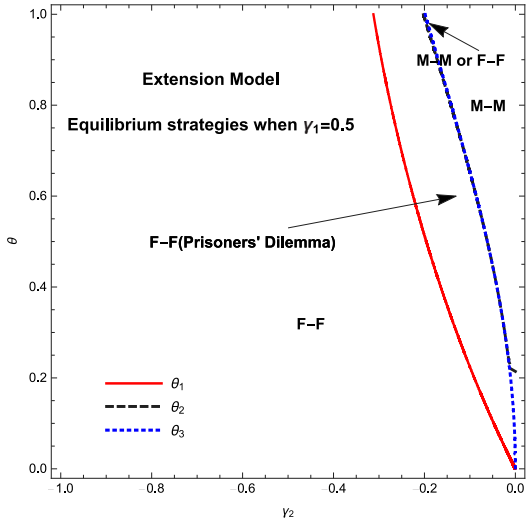

Fig. 7. Equilibrium strategies with second-period advertising.

two firms, aligning with the competitor's strategy becomes optimal. In such cases, when the substitution rate is high but not excessive, both firms are likely to adopt the same strategy, resulting in either an M-M or F-F equilibrium. Figs. 5 and 6 illustrate these dynamics. When θ is below θ_1, F-F is the equilibrium. When θ falls between θ_1 and θ_2, F-F remains the equilibrium, although a Prisoner's Dilemma emerges. When θ lies between θ_2 and θ_3, either M-M or F-F becomes the equilibrium. When θ approaches 1, M-M becomes the unique equilibrium. These findings suggest that in highly competitive markets with low product differentiation, a myopic strategy, characterized by high pricing and aggressive advertising to quickly capture market share, outperforms a more conservative and far-sighted approach.

7. Extension: Equilibrium strategies with second-period advertising

In the original main models, to emphasize the long-term impact of advertising on decision-making and profits, we include advertising decisions only in the first period and omit advertising inputs in the second period. This setup allows a clear observation of how first-period advertising independently affects a firm's profits and strategic choices in the second period. In practice, however, firms often continue to invest in advertising across multiple periods. Such repeated advertising may generate short-term effects that either offset or amplify the long-term impact of initial advertising, depending on whether that impact is negative or positive.

To examine the effect of continuous advertising on firms' profits and strategic decisions, we develop an extended game model in which firms make advertising decisions in both the first and second periods. We introduce a new decision variable, s_{ij2}, where $i = A, B$ and $j = 1, 2, 3, 4$. The profit functions in this extended model are defined as follows:

$$\pi_{ij1} = p_{ij1}(1 - p_{ij1} + \theta p_{hj1} + \gamma_1 s_{ij1}) - s_{ij1}^2,$$
$$\pi_{ij2} = p_{ij2}(1 - p_{ij2} + \theta p_{hj2} + \gamma_1 s_{ij2} + \gamma_2 s_{ij1}) - s_{ij2}^2,$$

where $i, h = A, B; h \neq i; j = 1, 2, 3, 4$. Further, we define $\pi_{ij} = \pi_{ij1} + \pi_{ij2}$, which represents firm i's total profits across both periods.

Analysis of the extended game model shows that after incorporating advertising decisions in the second period, we continue to obtain results consistent with Propositions 1, 2, and 3. Compared to the original model (left panel of Fig. 6), in the extended model (Fig. 7), the curves of θ_1, θ_2, and θ_3 shift slightly to the right. This shift indicates that when advertising continues in the second period, the F-F strategy remains the predominant equilibrium. The M-M strategy emerges as an equilibrium only when the long-term negative effect of advertising, γ_2, is relatively weak. When long-term negative effects are strong, the far-sighted strategy remains optimal.

One possible explanation is that second-period advertising can enhance short-term profits or offset losses. As a result, even with substantial negative effects, firms do not need to rely on aggressive short-term tactics to capture market share. The losses caused by negative effects in the second period can be mitigated by new advertising inputs, making it more effective to include second-period decisions in long-term planning. However, when long-term negative effects are weaker, optimal strategies depend on the competitor's behavior. Under such conditions, the myopic strategy becomes more attractive. It allows firms to earn higher short-term profits while avoiding significant losses, making it a potentially better option than the far-sighted strategy.

In the extended model, we also find that when the long-term effect of advertising is moderately negative, approximately greater than −0.5,

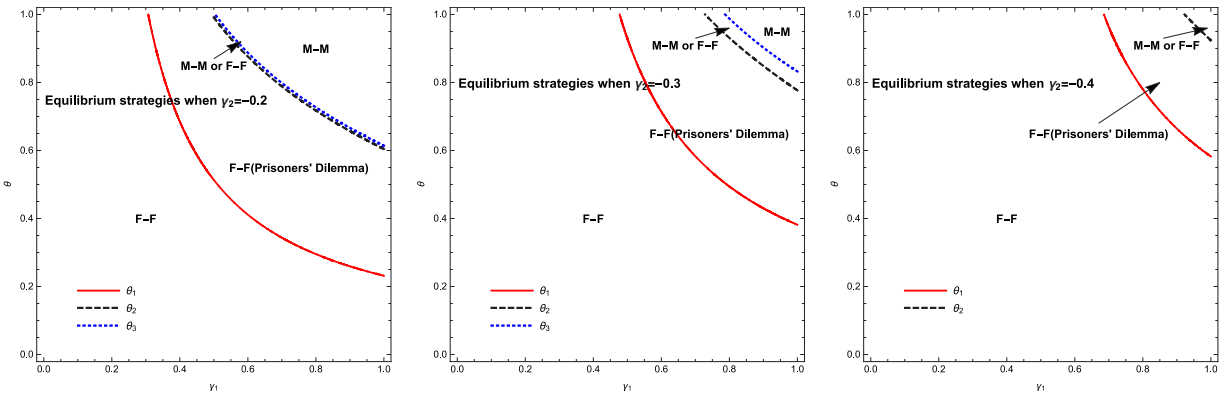

Fig. 8. Equilibrium strategies when $s_{ij2} \neq 0$ and $\gamma_2 < 0$.

companies tend to choose the same strategy as their competitors, leading to either M-M or F-F becoming equilibrium. However, when the long-term effect of advertising is highly negative, approximately less than −0.5, F-F again becomes the sole equilibrium, slightly differing from conclusions drawn from the original main model. Fig. 8 shows how the size of the long-term negative effect of advertising impacts equilibrium strategies in the extended new model. When γ_2 is fixed at a moderately negative value, π^*_{A1} and π^*_{A4}, π^*_{A1} and π^*_{A3}, π^*_{A2} and π^*_{A4} intersect successively at θ_1, θ_2, and θ_3. When these three intersections occur successively, the equilibrium of F-F can be disrupted, and M-M becomes the new equilibrium strategy when both the substitution rate θ and the short-term positive effect of advertising γ_1 are significant. Moreover, as the long-term negative effect becomes stronger, the region corresponding to M-M equilibrium gradually shrinks and eventually disappears, as shown in the right panel of Fig. 8. This occurs because π^*_{A2} and π^*_{A4} no longer intersect within the valid parameter range. This means that when the long-term negative effect of advertising is substantial, the F strategy remains the best choice. A possible explanation is that the outcome resembles a snowball effect. When the long-term negative effect of advertising is significant, adopting a myopic and aggressive strategy in each period with substantial advertising input can lead to increasingly severe long-term consequences. In such cases, continued short-term efforts fail to compensate for the accumulated losses. Therefore, to avoid this growing snowball of negative losses, a more gradual, far-sighted investment strategy is a sustainable development approach. The region of the Prisoner's Dilemma also shrinks as the negative effect of advertising strengthens.

8. Conclusions

In this study, we examine how firms in a duopoly strategically balance short-term and long-term advertising effects when making pricing and advertising decisions. Unlike prior research that often focuses on oligopoly markets or assumes constant product substitutability and uniformly positive advertising effects, our model captures three realistic features: (i) a duopoly market structure, (ii) variable product substitutability, and (iii) potentially negative long-term advertising effects. Our primary contribution is to offer a modeling approach and practical guidance that enable firms to assess dynamic trade-offs in advertising and pricing strategies under varying market conditions.

We find that the choice between a myopic and a far-sighted strategy depends on several factors, including the level of market competition, the short-term gains from advertising, the extent to which advertising stimulates consumer response, and the magnitude of its long-term negative effects. Specifically, this study highlights the pivotal role of long-term advertising effects in shaping firms' strategic decisions on pricing and promotion. Firstly, when these effects are positive, far-sighted strategies that emphasize long-term value creation and brand building are optimal, particularly in stable market conditions. For example, firms such as Tesla continue to prioritize innovation and global expansion over short-term advertising returns, demonstrating the viability of far-sighted strategies in markets where product differentiation is strong and consumer loyalty is high. Secondly, when long-term effects are negative, the best approach depends on market competitiveness and product substitutability. Aggressive, myopic strategies may be justified in highly competitive markets. During the COVID-19 pandemic, for instance, Zoom rapidly expanded its user base by adopting aggressive pricing and promotional tactics. Competing platforms such as Microsoft Teams and Cisco Webex followed similar approaches, prioritizing immediate market capture over long-term profitability. Finally, while far-sighted approaches remain viable for firms with differentiated offerings, in more nuanced scenarios, firms risk falling into a Prisoner's Dilemma where mutual conservatism reduces overall profitability. To navigate such trade-offs, managers should align strategy with market dynamics and consider collaborative solutions that balance short-term performance with long-term sustainability.

This study offers several promising directions for future research. First, it assumes deterministic demand; extending the model to examine equilibrium strategies under stochastic demand in a dynamic environment would provide valuable insights. Second, future research could explore how firm asymmetry influences advertising and pricing strategies. Variations in firm size, market power, or business context may lead to different advertising effects and strategic responses. Modeling such heterogeneity would enhance the realism and applicability of the analytical framework. Finally, incorporating customer loyalty differences could be another valuable direction. By introducing customer segmentation, researchers can more accurately assess advertising effectiveness and overall marketing performance.

CRediT authorship contribution statement

Yuhong He: Writing – review & editing, Formal analysis. **Jianghua Wu:** Writing – review & editing, Funding acquisition, Conceptualization. **Xiao Xiao:** Writing – original draft, Formal analysis.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Appendix A. Supplementary data

Supplementary material related to this article can be found online at https://doi.org/10.1016/j.omega.2025.103360.

Data availability

Data will be made available on request.

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