

# Exploration on the Application of Game Theory in Business Competition Strategies

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## ABSTRACT

This study delves into the application of game theory in business competition strategies, constructing game models to analyze the competition and cooperation among enterprises, encompassing market entry and exit, price competition, and advertising promotion strategies. Game theory aids enterprises in gaining a deeper understanding of their competitors' strategies and formulating rational strategies. In the context of e-commerce price wars, an analysis of the "618" competition between Tmall and JD.com through a duopoly game model reveals that while price wars stimulate demand in the short term, they ultimately undermine profits in the long run. Consequently, enterprises must explore win-win mechanisms, incorporating differentiated competition, technological innovation, and cost control to maintain their leading market position.

## KEYWORDS

Game Theory; Business Competition Strategies; E-commerce Price Wars

## 1. INTRODUCTION

The business sector is currently facing an increasingly complex and ever-changing market environment. Competition among enterprises is not only confined to the domestic market but has also expanded to a global scale. Against this backdrop, game theory, as a theory that explores the interactions and equilibrium states among decision-making entities, is becoming increasingly prominent in importance. It has become a key tool for analyzing business competition strategies [1]. Taking the e-commerce industry as an example, the game between Alibaba and JD.com in terms of pricing strategies and market promotion can be precisely analyzed through game theory models, thereby predicting opponents' actions and formulating reasonable strategies. Game theory also has significant value in guiding enterprises to optimize market behavior and avoid irrational competition, helping enterprises to develop steadily in complex environments. From a theoretical perspective, game theory provides a rigorous mathematical framework for business strategy analysis, which helps to deepen the understanding of the essence of market competition, such as the pricing strategy and market entry and exit decision analysis of the bike-sharing industry. This article aims to deeply analyze the formulation and execution of business competition strategies from the perspective of game theory, provide scientific decision-making basis for enterprises, enhance enterprise competitiveness under the current economic situation, achieve sustainable development, and provide useful insights and inspiration to the industry.

## 2. THEORETICAL BASIS OF GAME THEORY

Game theory, as a theory that explores the strategic choices of decision-making entities in competition, cooperation, or conflict, constructs an analytical framework centered on participants, strategies, payoffs, and information (see Table 1) [1]. Based on the assumptions of reasonable persons and common knowledge, it showcases its complexity and diversity through dimensions such as cooperation and non-cooperation, static and dynamic games, and complete versus incomplete information. The core content includes Nash equilibrium under mixed strategies, the Prisoner's Dilemma, complete information dynamic games, and the Bertrand model. These theoretical cornerstones provide enterprises with a scientific basis for deeply analyzing opponents' behavioral patterns and optimizing market behavior in the formulation of business competition strategies.

**Table 1.** Classification of Game Theory [2]

Types of Games	Main Characteristics	Description
Cooperative games	Participants cooperate to reach binding agreements.	Participants negotiate and jointly pursue the maximization of overall benefits, such as alliances and joint ventures.
Non-cooperative games	Participants individually pursue their own maximum benefit.	Participants cannot reach binding agreements and make independent decisions, such as in business competition and price wars.
Static games	Strategy choices are made simultaneously or the later actor does not know the earlier actor's strategy.	Participants make decisions at the same time or almost simultaneously, or the later actor cannot observe the earlier actor's decision.
Dynamic games	Strategy choices have a sequential order, and the later actor can observe the earlier actor's choice.	It involves decision-making sequence, where the later actor can adjust their strategy based on the earlier actor's choice.
Complete information games	All participants have accurate knowledge of all strategies and payoff functions.	Information is transparent, and all participants are aware of other participants' strategies and potential earnings.
Incomplete information games	Information asymmetry exists, and participants do not fully understand other strategies or payoff functions.	Information is incomplete, and participants can only make decisions based on limited information, leading to uncertainty.

### 2.1. Nash Equilibrium Under Mixed Strategies

Nash equilibrium refers to a situation in which the strategies of all participants constitute an optimal strategy combination, and within this combination, no party can obtain a better outcome by changing their own strategy while keeping the other participants' strategy choices unchanged. Taking the strategy combination (R3, C3) as an example, when C chooses C3, R's optimal choice is R3; conversely, if R chooses R3, then C's optimal choice is C3. Since both parties' strategy choices are consistent and mutually optimal, they form a Nash equilibrium [3].

### 2.2. The Prisoner's Dilemma Phenomenon

In the process of gaming, all participants ultimately pursue the maximization of their own interests. The Prisoner's Dilemma phenomenon specifically refers to a situation in a prisoner's game where the outcome of both parties' choices is influenced not only by individual decisions but also depends on

the other party's decision. Moreover, even if an individual choice reaches optimality, the individual result often does not align with the optimal outcome for both parties combined. To achieve the goal of maximizing benefits, cooperation becomes a necessary approach. Only through cooperation can both parties achieve a more favorable outcome than if they had made independent choices [4].

### **2.3. Complete Information Dynamic Games**

In complete information dynamic games, all participants continuously transmit information related to themselves. The later actor can observe the behavior of the earlier actor to judge or verify prior information and choose the optimal action accordingly. The earlier actor realizes that their action information will be utilized by the later actor, and therefore tends to transmit information that is conducive to the maximization of their own interests, while avoiding transmitting information that may harm their own interests.

### **2.4. Bertrand Model**

The Bertrand model is based on the following assumptions: when setting product prices, firms assume that changes in their own prices will not affect the pricing of other firms' products, and the model stipulates that the products of multiple oligopolistic firms in the market are perfectly substitutable. Within this framework, if one firm's product price is  $P_1$  and another firm's product price is  $P_2$ , both have a uniform marginal cost of  $C$  [5].

## **3. THE SPECIFIC APPLICATION OF GAME THEORY IN BUSINESS COMPETITION STRATEGIES**

### **3.1. Market Entry and Exit Strategies**

In highly competitive business environments, strategic decisions regarding market entry and exit are crucial for enterprises. Game theory provides in-depth analytical tools to guide companies in considering the reactions and potential strategies of existing market participants, optimizing entry and exit plans [2]. For example, new entrants in the e-commerce sector need to assess the reactions of incumbents, simulate pricing strategies through Nash equilibrium to maximize profits, and use complete information dynamic game models to predict the actions of incumbents, minimizing entry barriers. When exiting the market, companies need to evaluate the impact of brand image, customer relationships, and the possibility of re-entry. Exiting an oligopoly market can trigger a reshuffling; using the Bertrand model to analyze price responses and changes in market share, companies can exit gracefully through strategic alliances or asset sales. At the same time, strategy formulation must also consider factors such as market structure, technological innovation, and policies and regulations to achieve comprehensive analysis and evaluation.

### **3.2. Price Competition Strategies**

The formulation of corporate price competition strategies is particularly important in highly competitive business environments. As a core analytical tool, game theory enables companies to deeply understand the dynamics and potential strategies of market participants, optimizing strategic decisions. When emerging e-commerce enterprises enter the market, they need to accurately assess the reactions of existing giants and use Nash equilibrium to simulate pricing strategies in order to maximize profits. Dynamic game models help companies predict competitors' moves, flexibly adjust strategies, reduce entry barriers, and expand market share. When exiting the market, game theory analysis is crucial for evaluating the impact on brand, customers, and future re-entry. In oligopoly markets, a company's exit may lead to market restructuring, and the Bertrand model becomes an effective tool for analyzing price responses and share changes, guiding companies to exit gracefully

through strategic alliances or asset optimization <sup>[3]</sup>. Companies need to closely follow changes in market structure, technological innovation, and policy orientation, deeply integrate game theory with market realities, and formulate and execute competitive strategies to maintain competitive advantage and sustainable development.

### **3.3. Advertising and Promotion Strategies**

Advertising and promotion strategies occupy a pivotal position in business competition, serving as crucial means to enhance brand awareness, attract consumers, and drive product sales. In formulating optimal strategies, enterprises must delve into the dynamics of market competitors, precisely grasp consumer behavior, and fully consider their own resource conditions. From the game theory perspective, companies need to flexibly adjust their social media advertising strategies based on competitor tactics, audience preferences, and budget allocations to maximize advertising effectiveness. Meanwhile, promotion strategies must also adhere to game theory principles, anticipating competitors' promotional intensity to avoid the pitfalls of price wars. By closely monitoring consumer psychology and purchasing behavior, enterprises can design targeted promotion rules that stimulate buying desires, achieving a dual leap in sales volume and profits. In the formulation and execution of advertising and promotion strategies, companies should continuously integrate the essence of game theory, dynamically optimizing strategy combinations to ensure strategic equilibrium among market participants. This approach will empower enterprises to maintain a dominant position in fiercely competitive market environments.

## **4. CASE ANALYSIS OF GAME THEORY IN SPECIFIC BUSINESS SCENARIOS**

After entering the market, enterprises face the challenge of maintaining and expanding their market share. While price competition serves as a vital tool to reduce inventory and improve efficiency in the short term, it can erode profits and product quality in the long run. In the fiercely competitive e-commerce industry, shopping festivals like "Singles' Day" and "618" have become hotbeds of price wars, with giants like Tmall and JD.com engaging in relentless price cuts to expand their market shares. This study delves into the competitive strategies behind these price wars by constructing a duopoly price competition game model, specifically analyzing the "618" price war between Tmall and JD.com. The objective is to uncover the strategic logic behind these price wars, explore the potential for win-win scenarios, and provide theoretical support for enterprises to optimize their pricing strategies and achieve sustainable growth amidst intense market competition.

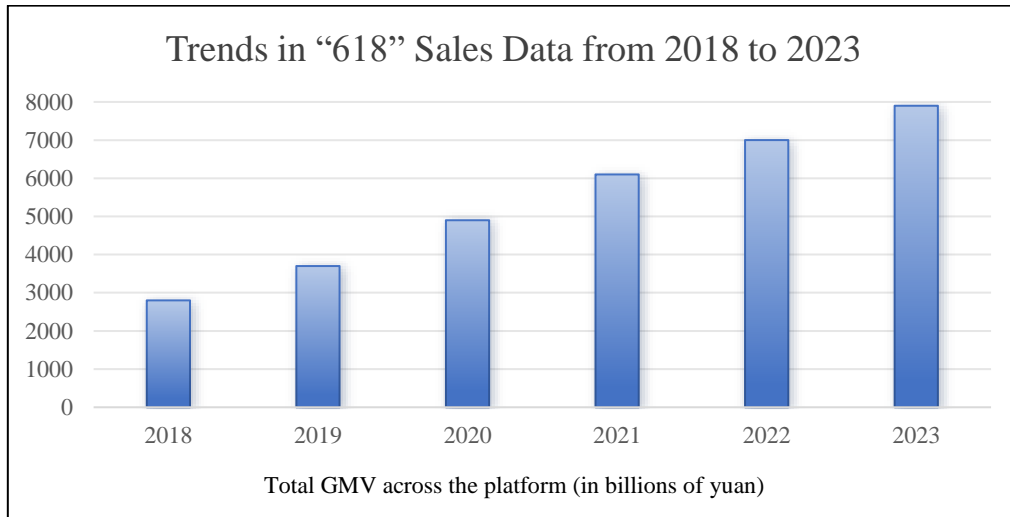
### **4.1. Game Analysis of Price Wars Implemented By E-Commerce Enterprises**

From the game theory perspective, Tmall and JD.com's "618" price war exhibits characteristics of complete information, static game, and imperfect product substitutability. Both parties employ dedicated teams to closely monitor each other's product prices, ensuring the adequacy of decision-making information and creating a highly transparent market environment. Given the swiftness of market reactions and the high cost of customer churn, both sides tend to release promotional information simultaneously, constituting a static game scenario. Although there is substitutability among products in the market, brand loyalty and platform preferences diminish the completeness of this substitution, complicating the decision-making process. Based on these insights, a Prisoner's Dilemma model (see Table 2) is constructed, where both parties, as rational and self-interested players, strive to maximize their individual interests.

**Table 2. Prisoner’s Dilemma Model**

		Player 2 (JD.com)	
		Lower price	Not lower price
Player 1 (Tmall)	Lower price	(8, 6)	(12, 4)
	Not lower price	(6, 10)	(10, 8)

By establishing a specific payoff matrix, the analysis reveals that both parties tend to adopt a pricing strategy of reduction, ultimately reaching a Nash equilibrium of (lower price, lower price). While this equilibrium does not maximize the overall or individual interests of both sides, it may contribute to an increase in social consumption. The impressive sales performance during past “618” promotions (see Figure 1) also indicates that price discounts can effectively stimulate market demand, thereby partially offsetting profit compression. The question arises whether there is a risk of collusion through informal agreements between the two parties to maintain price stability, which merits further investigation. To this end, the Bertrand oligopoly model can be introduced to provide a deeper analysis of factors such as market structure, cost conditions, and demand elasticity that influence firms’ pricing strategies and profit levels. This approach offers a fresh perspective on understanding Tmall and JD. com’s actions in the “618” price war.



**Figure 1.** Trends in Sales Data During Past “618” Shopping Festivals

(Data Source: <https://www.jiemian.com/article/9602625.html>)

#### 4.2. Construction of E-Commerce Price War Game Model

The Bertrand oligopoly model is based on three assumptions: oligopolistic firms compete on price; products are homogeneous, and there is no collusion. Tmall and JD.com, as Firm 1 and Firm 2, respectively, follow this model under the conditions of no fixed costs and equal marginal costs. That is, the two firms compete through pricing, and the demand function presents the following scenario:

$$Q_i(p_i, p_j) = \begin{cases} Q(p_i), & \text{if } p_i < p_j \\ \frac{1}{2} Q(p_i), & \text{if } p_i = p_j \\ 0, & \text{if } p_i > p_j \end{cases}$$

That is, when the prices of both parties in the game are equal, the market is evenly divided; if one party’s price is lower, that party monopolizes the market. Firm 1’s profit function is  $\pi_1 = Q(p_1)(p_1 - c)$ . When one firm sets a price higher than the cost  $c$ , Firm 2 can capture all orders by setting  $c \leq p_2 < p_1$ . Since there is always a firm that will cut prices to monopolize the market when colluding to share

benefits equally, the collusion strategy is unstable. Under continuous gaming, the prices of both parties will eventually drop to the cost  $c$ , and their profit function can be expressed as:

$$U_i = \begin{cases} \pi_m & \text{if } p_i < p_j \\ \frac{\pi_m}{2} & \text{if } p_i = p_j \\ 0 & \text{if } p_i > p_j \end{cases}$$

**Table 3.** Game Matrix When Both Parties' Prices Are Equal

		Firm 2 (JD.com)	
		Not lower price	Lower price
Firm 1 (Tmall)	Not lower price	$(\frac{\pi_m}{2}, \frac{\pi_m}{2})$	$(0, \pi_m)$
	Lower price	$(\pi_m, 0)$	$(\varepsilon, \varepsilon)$

Under the framework of game theory,  $\varepsilon$  represents an arbitrarily small number approaching zero, revealing that the Nash equilibrium of the model is (lower price, lower price), leading to nearly exhausted profits for both parties. This strategy is common in situations where there is a rapid expansion of market share, such as the price war in the bike-sharing market in 2017. For Tmall and JD.com, which have strong financial resources and a large market share, continuous price wars will deplete both parties' strength and even disrupt market order. The existence of this phenomenon suggests the need to explore whether there are other factors driving oligopolistic enterprises to seek collusion at prices above cost, beyond direct profits. Compared to brick-and-mortar retail, the e-commerce market exhibits advantages of higher efficiency, greater convenience, and lower costs. Given that the Nash equilibrium price in the Bertrand model is determined by cost, if the price war between Tmall and JD.com lowers commodity prices below those of physical retail, it will prompt orders to flow from physical stores to e-commerce platforms. As a result, e-commerce platforms will not only consolidate their existing market but also attract market share from the physical retail market. Based on this, the adjustment to the Bertrand model is:

$$U_i = \begin{cases} \frac{\pi_m^*}{2} & \text{if } p_i = p_j = p_m^* \\ \gamma\pi_m & \text{if } p_i < p_j \\ \frac{\delta\pi_m}{2} & \text{if } p_i = p_j < p_m^* \\ 0 & \text{if } p_i > p_j \end{cases}, (i = 1, 2)$$

A thorough analysis has been conducted on the pricing strategy choices and their impacts of the two enterprises under specific market conditions ( $1 < \gamma < \delta$ ). Enterprises face two main strategies: cooperation and price reduction. During cooperation, both parties set the optimal monopoly price  $P_m^*$  and equal profits  $\frac{\pi_m^*}{2}$ , but this equilibrium is easily disrupted by the motivation to lower prices. Price reduction can seize the dominance of the e-commerce market and attract customers from the physical market, resulting in profit gains  $\gamma\pi_m$ , while the that doesn't lower price loses all profits. Given that  $1 < \gamma$ , price reduction is more advantageous for the implementing party, prompting both parties to have the motivation to break cooperation. In a transparent market, both parties will eventually realize the benefits of price reduction, triggering a price war. By enhancing the promotion of online shopping platforms and customer marketing, they attract consumers. After the price reduction, the price range lies between the manufacturer's cost and the physical retail cost ( $c < P_i < C_i$ ), expanding the e-commerce market share. Both parties share the dividends of market expansion, and profits reach the maximum  $\delta\frac{\pi_m}{2}$ . In this way, both parties' profits are maximized, achieving Nash equilibrium (see Table 4). The game matrix is shown in the table below:

**Table 4.** Game Matrix for Both Parties under Specific Market Conditions

		Firm 2 (JD.com)	
		Not lower price	Lower price
Firm 1 (Tmall)	Not lower price	$(\frac{\pi_m}{2}, \frac{\pi_m}{2})$	$(0, \gamma\pi_m)$
	Lower price	$(\gamma\pi_m, 0)$	$(\delta\frac{\pi_m}{2}, \delta\frac{\pi_m}{2})$

During the mid-year major promotions, the two major online shopping oligopolistic enterprises adopted a product price reduction strategy and collaborated to set prices within the range between their respective costs and the cost of the physical market. This move effectively directed consumers who originally belonged to the physical retail industry, such as shopping malls and brick-and-mortar stores towards the e-commerce market, thereby stimulating a significant increase in demand within the e-commerce market and ultimately maximizing corporate profits.

## 5. CONCLUSION

In the fiercely competitive business environment, enterprises must adopt diversified competitive strategies to gain and maintain their competitive advantages. Among them, the differentiation strategy is a crucial component, emphasizing that enterprises should develop unique products or services by deeply understanding market demands and consumer preferences to distinguish themselves from competitors, thereby avoiding price wars and solidifying their market position. Simultaneously, the strategy of cooperation and win-win outcomes is also of paramount importance. By establishing strategic alliances with other market participants, enterprises can achieve resource sharing, risk sharing, jointly tackle market challenges, and promote mutual benefits and win-win results [4]. Additionally, technological innovation and cost control strategies play pivotal roles in enhancing corporate competitiveness. Technological innovation drives enterprises to continuously break through technological bottlenecks and lead the industry's development, while cost control requires enterprises to optimize resource allocation, reduce operating costs, and improve profitability.

In the realm of commercial competition, enterprises ought to comprehensively consider various factors such as market demand, collaboration opportunities, technological innovation, and cost control to devise strategies tailored to their unique circumstances. This approach enables them to maintain a leading position amidst fierce market competition and achieve sustainable development.

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