

Analysis of E-commerce Platforms' Price War: Based on Game Theory Model

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Abstract. Based on the fact that T-mall and JD.com, two major e-commerce platforms, reduce prices significantly every year in the shopping festival, but still can obtain high profits, this paper explains the causes and profit mechanism from the perspective of game theory. Meanwhile, this article builds a Bertrand model to analyze the profit mechanism of the two firms. The Nash equilibrium is (Discount, Discount) until they drop their prices to 0, which is obviously against the reality that both companies can gain high profits during the shopping festival, and consumers can also buy goods at lower prices. Therefore, there is a possibility of a collusion between the two firms. Finally, this paper introduces trigger strategy, the conclusion is that the two companies can make profits in the long run as long as they cooperate with each other. In addition, from the perspective of consumers, e-commerce platforms and the government, this paper also gives a reasonable decision-making strategy in the shopping festival. This research not only provides promotion programs for e-commerce platforms, but also helps consumers understand the profit mechanism of e-commerce platforms. At the same time, the government can also get inspiration from it, such as setting a minimum price to avoid the disruption of market order by vicious competition.

Keywords: Price war; Prisoner's dilemma; Bertrand Model; Trigger strategy.

1. Introduction

1.1 Research Background and Motivation

Price war generally refers to a kind of commercial competition behavior between enterprises by competing to reduce the market price of commodities, in order to suppress competitors, seize market share and digest inventory. In the short term, such behavior can reduce inventory and promote enterprise efficiency, but in the long term, it will reduce enterprise profits, increase enterprise costs, and reduce product quality. With the rapid development of the Internet, the e-commerce industry is flourishing, and the competition in the e-commerce industry is becoming more and more fierce. As early as in 2012, Liu Qiangdong, CEO of JD.com, posted a post on Weibo. The comments became the fuse of the price war of e-commerce, then other e-commerce executives responded to Liu Qiangdong, claiming that the product price will be lower than JD.com, thus starting a price war among e-commerce platforms [1]. Then, every year, shopping festivals such as Singles' Day, '618' and Annual Celebration will inevitably be contested by the two e-commerce giants T-mall and JD.com. However, the vicious competition in the shopping festival has brought huge profits to the two platforms, which is clearly worth discussing.

Exploring the causes of the price war and the profit ways of the two platforms can not only help people understand the cooperation model in game theory, but also provide reference suggestions for other e-commerce platforms. In addition, the government can also effectively regulate prices based on this perspective to avoid malicious competition disrupting market order.

1.2 Literature Review

Liu Lulu and others have analyzed the current situation of price war in Chinese e-commerce industry, analyzed the influence of price war, and further put forward policy suggestions to promote the development of e-commerce industry [2]. Jiang Xinyan et al. analyzed the causes and influences of the price war of e-commerce enterprises, and put forward countermeasures to regulate the price war [3]. Yuan Xinyi analyzed the influence brought by the price war of e-commerce enterprises, and

put forward some suggestions for e-commerce enterprises to avoid the price war [4]. Zhang Wenhui established the oligarch model to analyze the business strategies of the two e-commerce platforms [5]. Yue Hu and Manzhen Tang from the perspective of WTO gave the anti-monopoly law and other policy suggestions [6].

The above research analyzes the causes of the price war of e-commerce enterprises and the influence of the price war of e-commerce enterprises from a theoretical perspective, and puts forward countermeasures and suggestions to regulate the price war. On the basis of previous studies, this paper constructs a duopoly price competition model for analysis, and proposes a method to avoid vicious price competition through the establishment of the model.

1.3 Research Framework

The structure of this paper is as follows: the first part is the introduction of the theory; the second part is the case analysis, taking T-mall and JD.com as examples, to explore the causes of their price war and the possibility of reaching cooperation from the point of view of game theory; the third part is the discussion and suggestion based on the results of the case analysis and the reasons behind, and the last part is the conclusion.

2. Case Description

2.1 The Price War Between T-mall and JD.com

With the rapid development of big data and the Internet of Things, e-commerce has begun to exert its power in the social economy. Domestic e-commerce enterprises have created online promotion days by drawing lessons from shopping festivals on e-commerce platforms such as Amazon and eBay, and successively created large-scale shopping festivals such as "Single's Day" and "618". These holiday markdowns are a powerful boost to online spending. However, the shopping festival promotion strategy also brings new sales troubles to e-commerce platforms and online retailers. Holiday discounts can further exacerbate consumer delay, with e-commerce platforms often "sacrificing months of profits in exchange for sales on the day of the discount sale". Therefore, the traditional price reduction promotion strategy dominated by e-commerce platforms has been questioned. Many online retailers realize the above problems and begin to actively seek solutions. For example, independently design and organize various promotions in shopping festivals. The promotions, led by online retailers, extend from mobile phones and clothing to furniture and electrical appliances [7].

T-mall and JD.com are the two largest e-commerce platforms in China and the two oligarchs in the e-commerce industry. Since the Singles' Day on T-mall in 2009, Double 11 has gradually become one of the most influential festivals in the e-commerce festival. The two leading e-commerce platforms, T-mall and JD.com, are also engaged in a protracted "war" around Double 11. The comparison of transaction shares of the two platforms in the online retail market is shown in the figure 1, and the data is selected from Wind:

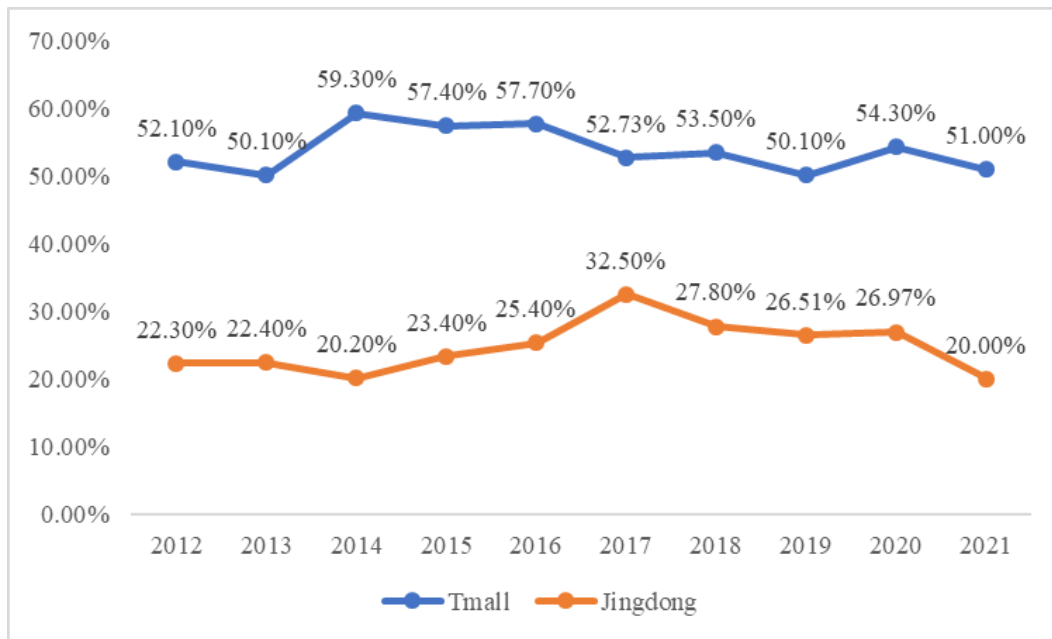


Figure 1. Comparison of Transaction Shares of T-mall and JD.com
 (Source: Wind)

2.2 Different Business Modes of Two Platforms

As a competitive relationship, the promotion models of the two e-commerce platforms are also significantly different:

2.2.1 The Mode of T-mall

Since Singles' Day in 2009, T-mall has been using the model of pre-sale plus one-day sales. During the 20 days from October 21 to November 10, all the commodities participating in the "Double 11 Global Carnival" will be pre-sold. During this period, consumers can make a deposit in advance, which also makes consumption concentrated and gives consumers more discounts. However, it will affect the sales situation of merchants from late October to early November, which is prone to overstock and other situations.

2.2.2 The Mode of JD.com

Starting from Oct. 21, there will be a 10-day warm-up period during which consumers can see which brands and products will be involved this year. But starting from November 1st, there will be ten consecutive days of special shopping festivals. In the end, there will also be "JD Global Good Thing Festival" on November 11th to participate in the "Double 11" global shopping. Compared with T-mall's model of pre-install and single day sales, this model is more like an extended front, which takes 11 days for sales and eases everyone's time [8]. Therefore, it is of great significance for both consumers and e-commerce platforms to explore the price strategies adopted by the two major oligarchs in the shopping festival and understand their core competitive advantages.

3. Results

3.1 Basic Assumptions

From the perspective of game theory, we denote T-mall and JD.com as Firm 1 and Firm 2, respectively. The price game between the two firms has the following characteristics. First, information completeness: both platforms have specialized personnel to follow up the quotation of the other platform, so both platforms can understand the price and information of the other platform. Second, although the products of the two e-commerce platforms are homogeneous, the dominant

products of different platforms are significantly different, so the products of the two platforms cannot be regarded as complete substitutes [9].

3.2 Prisoner’s Dilemma

The Prisoner's dilemma is a typical example of a non-zero-sum game in game theory, where an individual's best choice is not the group's best choice. Or in a group, individual rational choices often lead to collective irrationality.

This research suppose Firm 1 is the leader, which has a larger scale of operation, and Firm 2 is the follower, which has a smaller scale of operation, if the both sale at normal price, the utility is (6,4), the game tree can be seen in figure 2:

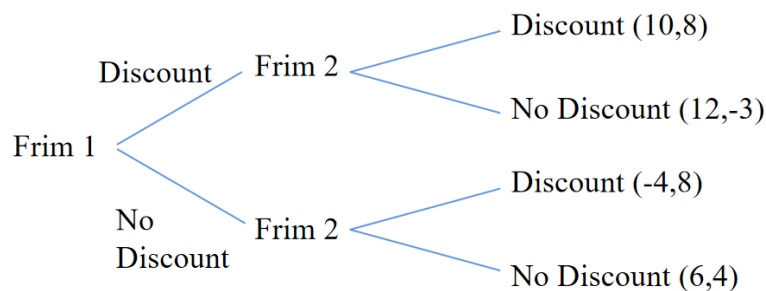


Figure 2. The Game Tree of Price War in Firm 1 and Firm 2

The interpretation of the game tree is as follows: in the case that Firm 1 chooses to reduce the price for promotion, if Firm 2 also chooses to reduce the price in return, their utility is (10,8); if company 2 does not reduce the price, their utility is (12, -3); If company 1 does not take any action, if company 2 cuts prices to promote sales, their utility is (-4,8), and if company 2 does not take any action, their utility is (6,4).

It is easy to see from the results that when one firm chooses to reduce the price for promotion, if the other firm does not fight back, it is likely to be divided into large profits or even losses. If both firms cut prices, it is likely to lead to higher profits for both companies due to a large increase in sales.

Using the backward induction, because 8 is larger than 4, 8 is larger than -3, the follower will always choose to take a discount price, and for the leader, ten is larger than -4, the leader will also choose cut the prices. Therefore, the Nash Equilibrium is leader choose discount in the first stage, and the follower choose discount in the second stage, they will gain a utility of (10,8), which is not only the best strategy for each firm itself but maximizes the social welfare.

3.3 Bertrand Model

The Bertrand Oligopoly Model has three assumptions. First, the oligopolistic firms compete by choosing prices. Second, the products produced by each oligopolistic firm are homogeneous. Third, there is no formal or informal collusive behavior among the oligopolistic firms [10]. From the above analysis of the characteristics of the game process, the game process of Firm 1 and Firm 2 conforms to the assumptions of the Bertrand model.

First of all, it is assumed that there is no fixed cost in the production process of Firm 1 and Firm 2, and the marginal cost is $c_1=c_2=c$. They compete by choosing prices, and their demand function is as follows:

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

That is, when the prices of both sides of the game are equal, the market will be divided equally; When one of the parties has a lower price than the other party, the low party will monopolize the market and the other party loses all orders.

The gains of the two players are their respective profits, so the profits of Firm i is:

$$\pi_i = Q(p_i)(p_i - c) \tag{2}$$

If the price of one manufacturer is $p_i > c$, then the other manufacturer will get all the orders by adjusting the price into $c \leq p_i < p_j$. The game goes on until both players cut their price to the marginal cost c . The utility function is as follows:

$$\pi_i = \begin{cases} \pi_m, & \text{if } p_i < p_j \\ \frac{\pi_m}{2}, & \text{if } p_i = p_j \\ 0, & \text{if } p_i > p_j \end{cases} \tag{3}$$

The payoff matrix of this game can be shown in table 1:

Table 1. The Payoff Matrix of Price War

		Firm 2	
		No Discount	Discount
Firm 1	No Discount	$(\frac{\pi_m}{2}, \frac{\pi_m}{2})$	$(0, \pi_m)$
	Discount	$(\pi_m, 0)$	$(\varepsilon, \varepsilon)$

In the payoff matrix, ε is a number approaching 0. From the game, the Nash Equilibrium is (Discount, Discount), that is, the profit of both players in the game is almost 0. The result of this game is generally to gain market share quickly. However, if these two companies want to play this game, it is impossible, they both have a certain financial base, and both have a large market share, according to the development of this game process, both parties can only be greatly damaged, or even disrupt the market. If this kind of promotion seems to have no benefit, why does it exist at all? So here we need to consider whether there are other factors that affect the game of the two oligopolistic firms so that they reach the risk of collusion at a price above cost.

3.4 Trigger Strategy

Based on the above analysis, we introduce trigger strategy: The two firms conspired and both sold the good at the same price p above the cost c , but when one player cut the price, the other player immediately cut the price in the next stage of the game. At the same time, this paper introduces the depreciation factor δ . In this case, the earnings of the two companies can be expressed as:

$$U_1 = U_2 = \frac{\pi_m}{2} + \frac{\pi_m}{2} \delta + \frac{\pi_m}{2} \delta^2 + \dots = \frac{\pi_m}{2} \cdot \frac{1}{1 - \delta} \tag{4}$$

We assume that Firm 1 defers the collusion first. Since both firms will make rational decisions, the existence of depreciation factor will make Firm 1 reduce the price slightly as early as possible to obtain all the market share. Therefore, the total profits of the two companies can be expressed as:

$$\begin{aligned} U_1 &= \pi_m + \varepsilon \cdot \delta + \varepsilon \cdot \delta^2 + \dots = \pi_m \\ U_2 &= \varepsilon + \varepsilon \cdot \delta + \varepsilon \cdot \delta^2 + \dots = 0 \end{aligned} \quad (5)$$

That is to say, when $\delta > \frac{1}{2}$, both firms can achieve greater gains by colluding. From the basic knowledge of game theory, we know that the discount factor δ can be understood as the probability that the game still exists in the next period, so the above conditions can be met, and the two companies can obtain greater benefits through collusion.

4. Suggestion

Based on the above analysis, this paper gives the following suggestions:

From the perspective of the government, relevant systems should be perfected, anti-monopoly and anti-unfair competition law enforcement should be further promoted, supervision and punishment should be strengthened on enterprises' behaviors such as malicious competition and dumping at low prices to seize market shares, and strategic alliance should be promoted among e-commerce platforms to complement each other's advantages and maintain a healthy and fair market environment.

From the perspective of platform, a more effective pricing strategy should be established. JD.com is mainly engaged in e-commerce, so it often offers large price reductions for products with a high unit price, while T-mall has similar strategies such as "50 yuan off the price of 300 yuan", which is equivalent to providing a relatively free bundling. This strategy limits the price within a controllable range and has little impact on the products that do not participate in the promotion. These two strategies are common and efficient methods of promotion on e-commerce platforms. In addition, e-commerce platforms should clearly grasp the marketing opportunities under the e-commerce environment, increase interaction and entertainment in the marketing process, so as to enhance consumers' participation in promotional activities. At the same time, no matter in the promotion of e-commerce platforms or online retailers, it is suggested that online retailers and e-commerce platforms jointly create differentiated brand promotion activities. E-commerce platforms can design beautiful display pages, online retailers use graphics to tell good brand stories and offer discounts, to consolidate and continue consumer enthusiasm.

From the perspective of enterprises, they should reduce costs and increase R&D expenses, so as to improve the core competitiveness of products. Technological innovation is the key to reduce costs, reducing unnecessary costs can increase corporate profits, increase investment in product innovation and service innovation, and provide differentiated products and services can effectively avoid homogeneous competition. Most consumers will understand the details of the product and check the buyer's evaluation before buying the product. High-quality sales services will encourage consumers to buy the product.

5. Conclusion

Based on the fact that T-mall and JD.com, two major e-commerce platforms, reduce prices significantly every year in the shopping festival, but still can obtain high profits, this paper explains the causes and profit mechanism from the perspective of game theory.

Firstly, we analyze the profits of both companies from the perspective of Prisoner's dilemma, using backward induction, and draw a conclusion that both companies must choose to reduce prices at the same time so as not to be divided into profits and lead to losses. At the same time, due to the increase in sales and the advance notice of the event, both firms can gain higher profits and expand social welfare during the shopping festival. Next, we build a Bertrand model to analyze the profit mechanism of the two firms. Assuming that the firm with the lower price will not be able to sell anything, that is, make a profit, then the Nash equilibrium will be that both firms drop to zero, again making no profit and disrupting the market. This is obviously against the reality that both companies

can gain high profits during the shopping festival, and consumers can also buy goods at lower prices. Therefore, there is a possibility of a collusion between the two firms. Finally, this research introduces trigger strategy, the conclusion is that the two companies can make profits in the long run as long as they cooperate with each other. In addition, from the perspective of consumers, e-commerce platforms and the government, this paper also gives a reasonable decision-making strategy in the shopping festival.

This research not only provides promotion programs for e-commerce platforms, but also helps consumers understand the profit mechanism of e-commerce platforms. At the same time, the government can also get inspiration from it, such as setting a minimum price to avoid the disruption of market order by vicious competition.

This study still has some shortcomings: compared with trigger strategy, the game that introduces risk factor is more realistic. At the same time, this paper can incorporate government regulation and consumer decision-making to analyze the three-way game. In the future, this paper can prove the rationality of hypothesis more scientifically and effectively through empirical analysis.

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