

Research on the Competitive Strategy of Takeaway Platform Based on Nash Equilibrium

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Abstract. As an important part of China's tertiary industry, takeaway platforms bring consumers a lot of convenience, but also face serious challenges. From the perspective of game theory, the competitive relationship of takeaway industry in China is studied. The results show that the benefits of cooperation between two takeaway platforms, namely Meituan and ELEME, are always greater than the benefits of vicious competition. New entrants in the takeaway industry will increase the complexity of the game between the platforms; the ideal game between the oligarchs in the takeaway market in the future is a competitive game that involves both competition and cooperation.

Keywords: Coopetition; Cournot game; Stackelberg game; Nash Equilibrium.

1. Introduction

With the rapid development of the Internet, the takeaway market has become China's one of the most focused markets in the catering industry, and the core of this market is the takeaway platform. Unlike the traditional transaction of goods or services, takeaway platform enterprises utilize the "platform" to achieve the purpose of attracting buyers and sellers and urging them to complete the transaction [1]. The main source of profit for this new type of enterprise is to collect a certain percentage of commission from the takeaway merchants, and the pricing of the products of the takeaway merchants affects [2]. According to the "China Mobile Internet Industry Development Analysis Report for the First Half of 2018" released by Trustdata, a third-party Internet big data monitoring organization, Meituan accounted for 59% of the market share of the takeout industry, while ELEME, Baidu and other platforms accounted for 36%, 3% and 2%, respectively. Currently, takeout market turnover has been divided by the head enterprises, and the takeout industry has established a relatively stable market share.

The confrontation between Meituan and ELEME has brought China's takeout industry closer to a duopoly. Both sides have adopted low price promotion strategies, and even if they have not yet realized profits, they still want to do everything they can to squeeze the other out of the market in order to form a "dominant" pattern. From the industry's perspective, this kind of vicious competition does not add value, but reduces the value of the takeaway market. The study of competition and cooperation strategies of takeaway platforms is of great significance to the development of themselves and the whole industry.

A large number of studies on takeaway platforms are highly informative, but at the same time there are shortcomings. Firstly, most of them are mainly qualitative studies, and quantitative studies are not sufficient. Secondly, as the takeaway industry is a new thing, scholars prefer to study the takeaway O2O model from different perspectives, while the research on the takeaway industry from the perspective of competition and cooperation is negligible. Therefore, based on the competition theory, this paper extends the study of competition among enterprises to China's takeaway platform. By establishing Cournot game model and Stackelberg game model, this paper further analyzes the competition game between Meituan and ELEME on the basis of the competition theory, and the reasons for the recurrence of price wars between takeout platforms are further explored.

2. Theoretical Foundation

In an oligopolistic market, decision-making among oligopolistic firms does not exist independently, but rather a kind of mutual influence and interdependence. The results of an enterprise's decision-making, including profit and future development, are not only affected by its own decision-making, but also constrained by the decision-making of other enterprises in the market. Therefore, when making decisions in an oligopolistic market, firms should not only consider their own factors, but also consider the behavioral strategies of their competitors. In the theory of industrial organization, Cournot model and Stackelberg model are both important models to analyze oligopolistic competition, and they are widely used in the study of oligopolistic decision-making behavior [3,4].

The Cournot model assumes that there are only two homogeneous firms producing the same product in the market, there is no collusion between the firms, and there are no production costs. The market demand curve is linear, and the two parties are in a state of complete information, fully aware of each other's state of demand, so one of the parties can be determined by the other party's production decisions [5].

The basic assumptions of Stackelberg model are the same as those of the Cournot model mentioned above. However, in Stackelberg's model, there is a difference in the positions of the two players, so the decision-making behavior will be sequential. The player with the larger market share makes the decision first, and then the party with smaller market share chooses its own production according to the production decision of the party with larger market share. In other words, according to the size of the market share, the two sides of the game are divided into dominant and subordinate positions, and the decision-making choices between the two will eventually form a dynamic game [6].

Due to the complex relationship between oligopolies that interact in the marketplace, the decisions made by any oligopoly firm will affect other oligopolies, using game theory to study the mutual constraints of strategy making among oligopolies will help enterprises better analyze oligopoly behavior and formulate appropriate strategies. The combination of game theory and competition theory not only shows the operability of enterprise strategy making, but also provides new business tools and methods for strategy management.

3. Oligopolistic Model of Competition

At present, China's takeaway platform market has become an oligopoly market, and the game process between platforms is actually a competitive decision-making process. In order to make the representation of the game model more intuitive, this paper uses output to represent the number of users of takeaway platforms. Assume that the outputs of the two platforms are q_1 and q_2 respectively, the total output of the takeaway market is $Q = (q_1 + q_2)$, then the market demand function of the model is $p = p(Q) = m - nQ = m - n(q_1 + q_2)$, m and n are all positive constants, and the revenue function is $W_i(q_1, q_2) = q_i(m - n(q_1 + q_2))$. However, due to the operating costs of the two takeout platforms, the operation cost and upfront investment cannot be ignored, the model needs to be revised. It is assumed that platforms have fixed costs of c_0 and marginal costs of c , the cost of the i -th takeaway platform is $c(q_i) = c_0 + cq_i$, and c_0 and c are normal numbers. After the correction, the market demand function of the two models remains unchanged, while the revenue function is adjusted as:

$$W_i(q_1, q_2) = q_i(m - n(q_1 + q_2)) - c_0 - cq_i \quad (1)$$

4. Competitive Relationship Analysis Under the Cournot Model

4.1. Analysis of Cournot Game in a Competitive State

Due to the similarity of the business and product types of the two takeaway platforms, Meituan and ELEME have long been in an intensely competitive environment. In terms of the finite rationality model, it is impossible for the two takeout platforms to grasp all the information about their competitors, nor can they recognize the detailed rules for decision; therefore, in the competitive state, both Meituan and ELEME will make decisions from the perspective of maximizing their respective interests.

At this time, their benefit functions are:

$$\begin{cases} W_1(q_1, q_2) = q_1(m - n(q_1 + q_2)) - c_0 - cq_1 \\ W_2(q_1, q_2) = q_2(m - n(q_1 + q_2)) - c_0 - cq_2 \end{cases} \quad (2)$$

Both Meituan and ELEME aim at profit maximization, and it is assumed that when one party makes the production decision, the other party's production is both fixed. Therefore, the first-order partial derivatives can be used to calculate the optimal output and maximum revenue of each of the two game players. Assume that the Nash equilibrium production is q_1^* and q_2^* , and the revenues under the equilibrium yields is W_1^* and W_2^* . By combining the above two equations together to obtain the first order partial derivative and make it equal to 0, we get:

$$\begin{cases} m - 2nq_1^* - nq_2^* - c = 0 \\ m - 2nq_2^* - nq_1^* - c = 0 \end{cases} \quad (3)$$

Solving this system of equations leads to a unique solution: $q_1^* = q_2^* = \frac{m-c}{3n}$. The unique Nash equilibrium solution of the game is the strategy portfolio $(\frac{m-c}{3n}, \frac{m-c}{3n})$. The optimal revenue of the two takeout platforms is $W_1^* = W_2^* = \frac{(m-c)^2}{9n} - c_0$. The total output is $Q^* = \frac{2(m-c)}{3n}$, and the total market revenue is $W^* = \frac{2(m-c)^2}{9n} - 2c_0$.

4.2. Analysis of the Cournot Game in a Cooperative State

If Meituan and ELEME cooperate with each other and stop the endless price war and maximize the overall interests of the takeaway market instead of maximizing their own interests, then the takeaway market's total revenue function is

$$W' = Q'p(Q') - c(Q') = Q'(m - nQ') - 2c_0 - cQ' \quad (4)$$

Assuming that Q' is the total market output in the cooperative state of the two parties of the game. Let $\frac{dW'}{dQ'} = 0$, then the optimal output $Q' = \frac{m-c}{2n}$, and the total market revenue is $W' = \frac{(m-c)^2}{4n} - 2c_0$. Comparing the equilibrium total output of the takeaway market under competition with the equilibrium total output of the takeaway market under cooperation, i.e., comparing Q^* with Q' , we can see that $Q^* > Q'$. Similarly, comparing the equilibrium total revenue of the takeaway market under competition with the equilibrium total revenue of the takeaway market under cooperation, i.e., comparing W^* with W' , it can be seen that $W^* < W'$.

Therefore, if the two takeaway platforms can cooperate on the basis of competition and make output decisions from the perspective of maximizing the overall interests of the takeaway market rather than maximizing their own interests, the output decisions will be more effective. The end result is a lower total output and higher total revenue in the takeaway market. In addition, if the two takeaway platforms share the equilibrium total market output equally, i.e., each party receives $\frac{m-c}{4n}$ of output, their respective revenues are $\frac{(m-c)^2}{8n} - c_0$. Compared with the output and revenue of each party in the competitive state, it can be seen that $\frac{m-c}{4n} < \frac{m-c}{3n}$, $\frac{(m-c)^2}{8n} - c_0 > \frac{(m-c)^2}{9n} - c_0$. Therefore,

if the two takeout platforms cooperate by limiting their production, they will not only reduce their production but also increase their revenues.

The analytical results in the Stackelberg model are consistent with the results of the in the Cournot model, i.e., when Meituan and ELEME can each limit their output appropriately, they will obtain more market revenue than the optimal revenue under competition. Therefore, as long as the two parties cooperate on the basis of competition, they can make their respective market revenues increase and realize a win-win situation for both parties.

5. Analysis of the Future Market in the Multi-party Game

5.1. Future Takeaway Market Cournot Game Analysis

From Michael Porter's five forces analysis model, it is clear that potential entrants can also pose a threat to existing firms. When the time is not ripe, the potential entrants do not pose a direct threat to existing takeaway platforms, but when the time is ripe, the potential entrant may become its direct competitor. In reality, many enterprises tend to ignore potential entrants in their actual market operations. Instead, they focus most of their attention on the competitors they are currently facing. The entry of potential entrants may disrupt the existing equilibrium in the market, reshuffle the market, and compete with existing firms in the market up and down the value chain, resulting in a decline in the performance of existing firms, and in serious cases, the survival of the incumbent firms will be jeopardized.

When a new entrant appears in the market, i.e., when $i = 3$, we have:

$$W_i(q_1, q_2, q_3) = q_i(m - n(q_1 + q_2 + q_3)) - c_0 - cq_i \quad (5)$$

Assume that the Nash equilibrium output of the game is q_1^{***} , q_2^{***} and q_3^{***} , and the payoffs under the Nash equilibrium yields are W_1^{***} , W_2^{***} and W_3^{***} . using the returns to output to find the partial derivation and make it equal to 0, we can get:

$$q_1^{***} = q_2^{***} = q_3^{***} = \frac{m-c}{4n} \quad (6)$$

Therefore, the unique Nash equilibrium solution to this game is the strategy portfolio $(\frac{m-c}{4n}, \frac{m-c}{4n}, \frac{m-c}{4n})$, the optimal revenue of the three takeaway platforms is $W_1^{***} = W_2^{***} = W_3^{***} = \frac{(m-c)^2}{16n} - c_0$. At this point, the total market output is $Q^{***} = \frac{3(m-c)}{4n}$. The total market yield is $W^{***} = \frac{3(m-c)^2}{16n} - 3c_0$.

Continuing the generalization of the Cournot game, if the takeaway market has i oligopolistic takeaway firms in the takeaway market, the equilibrium output and the revenue under equilibrium output are:

$$q_1^{i*} = q_2^{i*} = q_3^{i*} = \dots = q_i^{i*} = \frac{m-c}{(i+1)n} \quad (7)$$

$$W_1^{i*} = W_2^{i*} = W_3^{i*} = \dots = W_i^{i*} = \frac{(m-c)^2}{(i+1)^2n} - c_0 \quad (8)$$

By analyzing the Cournot and Stackelberg models of the takeaway market, it can be analyzed that when there is a new entrant in the market, market share will be gained by a new entrant, thus reducing the market share of the two takeaway companies, Meituan and ELEME will have less room to benefit from the market.

However, at present, the price competition between Meituan and ELEME are still caught in a prisoner's dilemma. One of the basic practices of Meituan to expand its business and increase its market share is low price promotions, and to some extent, low price promotions has become synonymous with the takeaway platform. For example, on Meituan, the original price of a takeaway is 15 RMB, the customer may only need to pay 6 yuan or even less to get the takeaway. Although this practice has boosted the number of consumers and caused ELEME to lose users and lose revenue

and in the short term, Meituan has achieved the goal of grabbing market share by competing with low prices, but this practice is clearly a bad practice between takeaway platforms.

This practice is obviously a reflection of vicious competition between takeout platforms, which not only meets the price war retaliation of the other side of the game, leading to the dispersion of its own energy, increasing operating costs, and reduces the value of the takeaway industry, and also causes the excessive consumption of market resources and waste of resources. In addition, the integration of the takeaway industry with the Internet has brought new entrants into the industry. The impact of new entrants may also affect the market revenue of Meituan.

6. Summary

Takeaway platforms have become the current development trend of the takeaway industry. Takeaway platforms should strive to grasp the new development opportunities and strive for more growth space. Due to the lack of coordination mechanisms, incidents such as "no sharing" and "price wars" and other incidents occurred frequently. The establishment of a cooperative relationship between takeaway platforms is the most effective way to solve these problems. In this paper, we adopt the Cournot model and the Stackelberg model to solve these problems. This paper analyzes the two oligopoly games in the takeaway industry and finds the following results.

First, when Meituan and ELEME cooperate on the basis of competition, their respective gains are always greater than those in the case of unhealthy competition. Second, the relationship between competition and cooperation between takeaway platforms is a unity of opposites. In the actual operation of the platforms, competition and cooperation are complementary and indispensable. The necessity of competition among takeaway platforms is that it can help promote the development of the takeaway industry, improve the efficiency of resource allocation and enhance consumer welfare. Finally, with the continuous progress of social information technology and the deepening of market competition, competition, but also among new entrants. The involvement of new entrants will increase the complexity of the game between platforms.

To address the above issues, this paper makes the following recommendations. First, as the two takeaway platforms have similar business products, they need to withdraw from the current "price war" and formulate a differentiation strategy like indirectly compete with competitors through service differentiation. Second, platforms can establish an alliance by means of joint construction and sharing to alleviate the competitive pressure on each other and maintain the overall interests. However, the sharing will involve the interests of many parties, and the details of its operation are very complicated. Therefore, the realization of common sharing is a long process, which requires each platform to continuously improve the system and process, and to maintain the overall interests. It is necessary for each platform to continuously improve the system process and working mechanism, so as to steadily and orderly carry out the work of building and sharing. Third, while competing, take-away platforms should consider the impact of the integration of the take-away industry with the Internet. The fusion of the takeaway industry with the Internet has led to the impact of new entrants, prompting the existing takeaway platforms to compete with each other. The existing takeaway platforms should be prompted to review the importance of mutual cooperation, so as to induce them to adopt a cooperative game to obtain more market revenues. On the basis of mutual agreement, both parties can open up consumer resources and launch customized joint marketing campaigns for different consumers, so as to achieve the purpose of increasing consumer stickiness. If we have common interests, we will be able to cooperate better and face new challenges together. The ideal game between the oligarchs in the future takeaway market is both competition and cooperation. The ultimate goal is to realize a win-win situation for takeaway platforms and the healthy development of the takeaway industry.

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