

# Study on Market Competition Behaviors of Mobile Communication Industry in China Based on the Game Theory

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**Abstract.** 4G is the fourth generation of mobile communication technology for short. 4G is a new generation of wireless high-speed broadband network. This paper analyzes on the structures of market competition of Chinese mobile communication industry in the 4G era, discusses on the competition behaviors by using the game theory. According to the theoretical analysis of cooperative game, we argue that China Unicom and China Telecom should share the 4G base station construction achievement together and carry out extensive cooperation and avoid the Bertrand paradox by producing differential product to gain more market profits.

## Introduction

4G is the fourth generation of mobile communication technology for short; it is a new generation of wireless high-speed broadband network. Customers surf the Internet through the LTE network with the theoretical downlink peak rate of up to 100Mbps and uplink peak rate of up to 50Mbps. On December 4, 2013, the Ministry of Industry and Information Technology formally released 4G licenses to, China Mobile, China Telecom and China Unicom, the three biggest operators, which have both received TD-LTE license. However, due to its serious conservative 4G strategy in the early days, China Unicom still cling to the 3G user market in the 4G era, while China Mobile seizing the opportunities for the development of 4G network in the beginning. Three operator's relatively balanced situation in the 3G market was break down by 4G competition. The situation returns to a thriving situation in the 2G era when China Mobile is the biggest operator when nobody can threaten it. It is sad that China Unicom, which is exceeded by China Telecom, has become the most disadvantaged operators in 4G market. So how can China Unicom and China Telecom break the current competitive situation in the 4G network market in order to share the market profits? So in this paper, we attempt to use of game theory tools to explore the competitive strategy of the three giants of China's telecommunications industry in the 4G era.

## Literature Review

Game theory is a good tool in analyzing complex market competition. Nash game is a non-cooperative game involved two or more players competing at the same level with their own profit maximization objectives. This game model have been successfully applied in various competition analyses in many disciplines including economics[1], supply chain management[2], urban transportation analysis[3], airline service management[4], and maritime competition analysis[5].

The prisoner's dilemma game is one of 5 well-known social dilemma games. Tucker defined the "prisoner's dilemma" In 1950, it is not only triggered a large number of relevant researches and explains the numerous economic phenomenon, but also a significant development of game theory.[6-8]The prisoner's dilemma game is widely considered for investigating the collective behaviors among selfish individuals in repeated game[9-11].

There also lots of research discussing the duopoly market using game theory. Haan and Marks studied Stackelberg model and pointed out that Stackelberg competition does not necessarily

improve welfare when there are barriers to market.[12] Matsumura studied the role of stock in the multi-stage game and the condition to become a Stackelberg leader by analyzing on finite period Cournot duopoly game model.[13] Huck study the influence of External conditions on the game results of Berg Starr model From the perspective of experimental economics.[14]

**Prisoner's Dilemma Analysis**

**Model Formulation.** “Prisoner's dilemma” is a classic case of game theory, which reflects the contradiction between individual rationality and collective rationality. “Prisoner’s dilemma” model is hereinafter used to analyze the price competition of mobile communication industry in China.

In the game on the China Mobile communication market, there are two players, respectively, China Mobile and China Uni-Telecom. China Mobile has two kinds of strategies, price reduction or non-price reduction that can be chosen. It is the same with China Uni-Telecom. Assuming that  $S_1$  stands for China Mobile's strategy,  $S_2$  stands for China Uni-Telecom's strategy.  $S_{1j}$  stands for China Mobile's No.j strategy,  $S_{11}$  on behalf of China Mobile does not reduce prices,  $S_{12}$  on behalf of China Mobile reduce prices.  $S_{2j}$  stands for China Uni-Telecom's No.j strategy,  $S_{21}$  on behalf of China Uni-Telecom does not reduce prices,  $S_{22}$  on behalf of China Uni-Telecom reduce prices.  $U_1$  stands for China Mobile's gaming revenue,  $U_2$  stands for China Uni-Telecom's gaming revenue. The game of the two players is  $G=\{S_1, S_2, U_1, U_2\}$ , as shown in Fig. 1.

		China Uni-Telecom			
		Not reduce prices		Reduce prices	
China Mobile	Not reduce prices	$R_1$	$R_2$	$R_1-M_1$	$R_2+N_1$
	Reduce prices	$R_1+M_2$	$R_2-N_2$	$R_1-M_3$	$R_2-N_3$

Figure 1. Changes of revenue of  $U_t$  and  $U_u$  due to price reduction

Assuming that when China Mobile and China Uni-Telecom do not reduce prices, China Mobile revenue  $u_1=R_1$ , China Uni-Telecom revenue  $u_2=R_2$ . When China Mobile does not reduce the price and China Uni-Telecom reduce the price, apparently China Mobile’s market share will reduce, the income will reduce  $M_1(u_1=R_1-M_1)$ .China Uni-Telecom's revenue increased  $N_1(u_2=R_2+N_1)$ ; when China Uni-Telecom does not reduce the price, and China Mobile reduce the price, the income of China Mobile will increase  $M_2(u_1=R_1+M_2)$ , while China Uni-Telecom revenue has a reduction of  $N_2(u_2=R_2-N_2)$ ; when China Mobile and China Uni-Telecom both reduce the price, their share of the market will keep the same, but the price are lower, which lead to the reduction( $M_3, N_2$ ) of their earnings( $u_1=R_1-M_3, u_2=R_2-N_3$  ,apparently  $m_3 < M_1$  and  $N_3 < N_2$ ).

**Best Response Functions.** It can be learned that (Reduce prices, Reduce prices) the Nash equilibrium of this game is at the lower right corner of the matrix. That is to say, for China Mobile and China Uni-Telecom, no matter what strategy the other side of game chooses, reducing the price is the best choice. However, the game is a non-cooperative game. The games will make chooses in accordance with the individual rational behavior decision-making principle. So although the price equilibrium strategy are not ideal results for the two players, since the player could not trust each other, they must guard against each other in case of the other seeking benefits in use of his trust. So the (Not reduce prices, Not reduce prices) strategy is unable to realize in fact. Even if the two players are fully aware of the better choose of the game, it also can’t change the result. China Mobile and China Uni-Telecom, just like two prisoners who can’t collude with each other, both know that they can carve up the market and obtain the maximum economic benefit by reaching pricing agreement in the duopoly market situation. However, this agreement is doomed to be fragile. Even if the agreement can be reached, once there is one or several company who break the agreement in decision making in order to maximizing their own interests, which will stimulate a chain reaction, the agreement will be broken entirely. Another price competition will begin to fight

fiercely.

**Resolution.** Since communications products tend to homogeneity and have a fairly high substitutability, price reduction is an effective means to improve market share. That's why China Mobile and China Uni-Telecom are much likely to starting the price war to compete in market. The Bertrand paradox will happen when China Mobile and China Uni-Telecom provide completely homogeneous products. That means, China Mobile and China Uni-Telecom will keep reducing the price until the enterprise product price is equal to the cost. However, the products provided by the two companies have a fairly low substitutability if the service provided by the two companies is different and variable. Consumers will take some other variable factors (except price) into consideration when making purchasing decision. Price is no longer the only concern of purchasing behavior. Therefore, to get rid of the prisoner's dilemma, mobile communications operators should transform from the price competition to the differentiation strategy. Differentiation strategy means that the enterprise strengthen product (service) features and increase consumer value by providing unique output characteristics and technology, brand image, additional characteristic and characteristic service ,which make consumers willing to pay much higher price for their products.

We attempt to use mathematical method to simulate the conclusion: There are two stores (A and B) at the ends of the street. Customers are evenly distributed in the street, and everyone wants to buy the product, store A sells the product for price  $P_1$ .and store B sells the product for price  $P_2$ . Product costs are  $c$ , We use  $t$  to stand for a unit of travel costs. The distance between customer and store is  $x$ , the length of the whole street is 1.Then, the distance between the customer and the store B is  $1-x$ . Therefore, the travel costs for customers to buy the product from store A is  $tx$ . The travel costs for customers to buy the product from store B is  $t(1-x)$ . For a specific customer, the total cost of buying the product from store A is  $P_1+tx_0$ . The total cost of buying the product from store B is  $P_2+ t(1-x_0)$ . The customer will buy the product in store A if  $P_1+tx_0 < P_2+ t(1-x_0)$ . The customer will buy the product in store B if  $P_1+tx_0 > P_2+ t(1-x_0)$ . Let  $P_1+tx_0 = P_2+ t(1-x_0)$ ,we can have the value of  $x_0$  .  $x_0$  is the market share of store A ( $D_A(P_1, P_2)$ ),  $1-x_0$  is the market share of store B ( $D_B(P_1, P_2)$ ).We have expression as following:

$$D_A(P_1, P_2) = x_0 = \frac{P_2 - P_1 + t}{2t}$$

$$D_B(P_1, P_2) = 1 - x_0 = \frac{P_1 - P_2 + t}{2t}$$

$$\text{The profit of store A: } \pi_A(P_1, P_2) = (P_1 - c) \frac{P_2 - P_1 + t}{2t}$$

$$\text{The profit of store B: } \pi_B(P_1, P_2) = (P_2 - c) \frac{P_1 - P_2 + t}{2t}$$

Let  $\frac{\partial \pi_A}{\partial P_1} = 0, \frac{\partial \pi_B}{\partial P_2} = 0$ , we have  $P_1^* = P_2^* = c + t$ , which is the only Nash equilibrium.

Therefore, the equilibrium price is the sum of average production cost and the difference of the product. This means when the average production costs keep the same under certain circumstances, the greater the difference between the products provided by the enterprise, the higher the equilibrium price, the greater the profit. The reason is that the substitutability of products decreases and monopoly ability enhanced with the increase of the difference. The equilibrium price will be closer to monopoly pricing and companies realize the profit maximization. The price competition is similar to the "zero-sum game" in the game theory (it's may even be "Negative-Sum Game" sometimes). However, differentiation strategy is "positive-sum game". It can create new values and new interests by implement differentiated and better meet consumer needs.

## Conclusions

(1) There is no winner in the price war. The final result is often loss at both sides. It may even hurt the entire industry. Disorderly price war not only will cause the decline of the operator's profit and the slow-down of the development, but also bring a deformity of the market development and distorted competitive mentality.

(2) For China mobile communication operators, it is much wiser to tectonic differential mode of operation. Pay attention to the brand and brand competition, and you can get advantage in brand

competition.

(3) In the oligopoly market competition, cooperation has both the necessity and possibility. In rational ways, cooperation should be the optimal decision of both parties.

(4) For China Unicom and China Telecom who have already lagged behind, rather than compete with China Mobile in developing the market, it is wiser that watching China Mobile's action first. Follow China Mobile to take action, or wait for the China Mobile successfully develop the products, then imitate the competitive strategy of China Mobile and launched a similar brand to seize and strive for the customers.

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