The analysis on the pricing strategy in Chinese mobile telecommunications market

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Abstract: Using the attractive low tariff, China Telecom and China Netcom put PHS into service and broke the original duopoly in Chinese mobile telecommunications market. The existing operators, CMCC and China Unicom counterattacked with the price strategy and a new price war started. In this paper, we applied the circular city model, established a 2 stage game model, and analyzed PHS’s entering Chinese mobile communication market, the pricing competitive behaviors of the operators and their consequence in the current stage. In the end, we put forward the current operator competition and development strategy that the operator innovate in the product and the service, increase the value-added of the product, create product differentiation and decrease the sensitivity of the customers to achieve the maximized equilibrium profit.

Keywords: PHS, Mobile telecommunications, game, price, differentiation

1. INTRODUCTION

Personal Handy Phone System (PHS) realized the mobile telecommunications function of the traditional fixed telephone in the coverage area, accessing the fixed telephone network in a wireless way, utilizing the telephone number resource and the switch of the fixed telephone network [1]. PHS is not clearly classified in the classificatory catalog of MII telecommunications business, and China Telecom and China Network named PHS as "wireless fixed telephone". However, from the technical characteristic, PHS is actually a mobile telecommunication for the users, just limited in the local areas. China Telecom and China Network put PHS into service in more than 300 cities and areas in the nation wide and have more than sixty millions subscribers. With the aggressive low price, PHS survived and
participated in the competition in the market of Chinese mobile telecommunications effectively.

Before the large-scale deployment of PHS, duopoly, China Mobile (CMCC) and China Unicom dominated Chinese mobile telecommunications market with their massive networks. Among all the business applications, the voice is the most basic consumption demand. It plays an important role and takes around 90% total income. Since the voice services became homogenous, the competition is also fiercest. After PHS of China Telecom and China Network intruded the mobile telecommunications market, it developed dramatically, shunted a large amount of the local mobile telecommunications traffic, and hindered the subscriber increase of CMCC and China Unicom greatly. Consequently, these two traditional mobile telecommunications operators retort PHS with a stick of low price.

According to the MII statistical data in 2003, the market shares in Chinese mobile telecommunications market are illustrated in Fig.1. CMCC has 176,500,000 subscribers, and its market share is 58%; China Unicom has 92,200,000 subscribers, and the market share 30%; PHS, the new entrant, has 35,000,000 subscribers, and the market share 12%.

![The Market Shares in Chinese Mobile Telecommunications Market in 2003](image)

Figure 1. The market shares in Chinese mobile telecommunications market in 2003

Aiming to the actuality that PHS entered Chinese mobile telecommunications market, we applied the circular city model (Salop, 1979) to research the issue on the entrance to the mobile telecommunications market, and constructed a 2 stage game model based on Hotelling model to analyze the competitive behaviors in the current mobile telecommunications market in our country.

2. **THE BUILD OF THE MODEL**
Considering the fact that PHS is a mode of mobile telecommunications, in the field of mobile telecommunications function, the voice services provided by PHS of CMCC and China Unicom are regarded as the homogeneity products. The classical Hotelling model indicates that the equilibrium price is not equal to the marginal cost, if the positions of this product are different. When the enterprises compete in this kind of different products, they will not only select the position of the product, but also choose the price of the product. The consumer demand function is deduced below [2].

Assumed that there are two enterprises, the positions of the product are located at $a_1$ and $a_2$ in the area of $[0,1]$, and $a_2 > a_1$. The product preference of the consumers complies the proportional distributing in the area of $[0,1]$. If the consumers select consumable $a_1$, they need pay the departure cost $t(h - a_1)^2$. If they select consumable $a_2$, they need pay departure cost $t(a_2 - h)^2$, departure cost is used to describe the loss that the product that human beings consumed is different to their prefer product $h$. The parameter $t$ is named as the rate of departure cost.

Assumed that the consumers have a unit demand for this product. The payment of the demand includes two parts of the cost, the cost of price and the cost of departure. If $p_1$, and $p_2$ are the prices of the products with two different positions, assumed that the consumer preference, $h = h^*$. The consumptions of two products with two positions is the same, namely $h^*$ satisfies

$$ p_1 + t(h^* - a_1)^2 = p_2 + t(a_2 - h^*)^2 $$

Accordingly,

$$ h^* = \frac{a_1 + a_2}{2} + \frac{p_2 - p_1}{2t(a_2 - a_1)}. \quad (1) $$

And, $\bar{a} = \frac{a_1 + a_2}{2}$, $\Delta a = a_2 - a_1$. Assumed that there is only one consumer in the market. For the product of position $a_i$, the product demand is

$$ p\{h \leq h^*\} = F(h^*) = \bar{a} + \frac{p_2 - p_1}{2t\Delta a}. \quad (2) $$
Using the circular city model (Salop, 1979), we reviewed the issue on the entrance to market. The space that the enterprise is located in is expressed in a circle, whose perimeter is 1. Assumed that there are \( n \) enterprises in the market, the distance between the position nodes is \( \frac{1}{n} \). If the consumer preference is distributing between \( a_i \) and \( a_{i+1} \), the consumer select the product, \( i \) or \( i+1 \). Illustrated in Figure 2.

![Salop ring](image)

**Figure 2. Salop ring**

Salop ring can be divided into \( n \) lines with a distance of \( \frac{1}{n} \), The ends of each line are positions of two enterprises. The deference of positions is denoted as \( \Delta a = a_{i+1} - a_i \), \( i = 1, 2, \cdots, n \).

Considering the consumer demand function. For the arc \((a_i, a_{i+1})\), with Hotelling model, for the product with a position of \( a_i \), we can deduce that the product demand \( i \) is

\[
\frac{1}{2n} + \frac{p_{i+1} - p_i}{2t} = \frac{1}{2n} + \frac{n(p_{i+1} - p_i)}{2t}.
\]

For the arc \((a_i, a_{i+1})\), we know that the product demand \( i \) is \( \frac{1}{2n} + \frac{n(p_{i+1} - p_i)}{2t} \), sequentially, for the product with a position of \( a_i \), the product demand \( i \) is

\[
x_i = \frac{1}{n} + \frac{n(p_{i+1} + p_{i+2} - 2p_i)}{2t}, \quad i = 1, 2, \cdots, n-1. \tag{3}
\]

The game sequence is described below. In game stage 1, \( k(1 \leq k \leq n) \) enterprises decide
whether they will enter the market. In game stage 2, \( n \) enterprises participate in Bertrand competition. According to the regular method to the game resolution, we first get subgame equilibrium in stage 2, then solve the game equilibrium in stage 1 with backward induction.

Assumed that the fixed cost on the entrance to market of the enterprise is \( F \), and the unit marginal cost is \( c \), accordingly, the profit of the enterprise is

\[
\pi_i(p_i, p_{i-1}, p_{i+1}) = (p_i - c)x_i - F = (p_i - c) \left( \frac{1}{n} + \frac{n}{2t} (p_{i-1} + p_{i+1} - 2p_i) \right) - F
\]

\[
= (p_i - c) \left( \frac{1}{n} + \frac{n}{2t} (p_{i-1} + p_{i+1}) \right) + \frac{nc}{t} p_i - \frac{n}{t} p_i^2 - F
\]

(4)

In game stage 2, for the fixed \( p_{i-1}, p_{i+1} \), if the enterprise \( i \) select \( p_i \), the premise in the stage 1 of maximized \( \pi_i \) is

\[
\frac{\partial \pi_i}{\partial p_i} = \frac{1}{n} \left( \frac{1}{n} + \frac{n}{2t} (p_{i-1} - p_i) \right) + \frac{nc}{t} - \frac{2n}{t} p_i = 0
\]

Then, we solve the price reaction function of the enterprise \( i \)

\[
p_i^a(p_{i-1}, p_{i+1}) = \frac{1}{4} (p_{i-1} + p_{i+1}) + \frac{c}{2} + \frac{t}{2n^2}, \quad i = 1, 2, \cdots, n-1.
\]

(5)

Shown in the above equation, for the assured \( n, t, c \), when \( p_{i-1} \) or \( p_{i+1} \) go up, the price of the enterprise \( i \) increase accordingly.

To reach the equilibrium, with the symmetry of the enterprise, we suppose that there exist the equilibrium price of \( n \) enterprises, \( p_1 = p_2 = \cdots = p_n = p^b \). These parameters are put into the reaction function, then \( p^b = \frac{1}{2} p^b + \frac{c}{2} + \frac{t}{2n^2} \), Consequently,

\[
p^b = c + \frac{t}{n^2}
\]

(6)

Under equilibrium price \( p^b \), the demand is \( x_i^b = \frac{1}{n} \),

(7)

The profit is \( \pi_i^b = \frac{t}{n^3} - F \).

(8)

3. THE ANALYSIS AND CONCLUSION OF THE MODEL

First, in the game stage 1, for each enterprise, if the enterprise has the positive profit, namely, \( \pi_i^b \geq 0 \), the enterprise will decide to enter the market. Assumed that \( \pi_i^b = \frac{t}{n^3} - F = 0 \), it is learned that the maximum number of the enterprises is \( n_{\text{max}} = \sqrt[3]{\frac{t}{F}} \). As
is known, it is an inevitable trend that entrants appear, when only CMCC and China Unicom dominate Chinese mobile telecommunications market. For the mobile telecommunications operators, the ratio of their cost to the cost of the fixed telephone is 2.1:1.1, while the ratio of the price is 6.2:1.3, so the profits of both two operators go beyond those of the fixed telephone operators [3]. As a result, when the licenses of 3G will not be released in a short time, China Telecom and China Netcom want to promote PHS and attract the subscribers with the low price to increase their incomes.

Second, the equilibrium price (6) of \( n \) enterprise can be solved from the model. the product difference is explained to the position difference of the consumers. Furthermore, this difference will also be interpreted as departure cost. Higher departure cost, more different the products. The equilibrium profit of the product goes higher consequently. We can find the reason. When the departure cost of the product increases, the alternative of the product of the different enterprises decreases, the domination of each enterprise becomes stronger, the competition among the enterprise goes weaker, the customers’ sensitivity decline, and the optimized price of each enterprise approach the domination price. On the other hand, when departure cost is zero, the products of the different enterprise can substitute each other, and no enterprise can release a higher quotation than the cost. So, we get the Bertrand equilibrium [4].

\[ p_1 = p_2 = \cdots = p_n = c, \quad \pi_1 = \pi_2 = \cdots = \pi_n = 0. \] (9)

From the above, we can find that differentiation in products frees the enterprise from the price competition.

At the last, in the game stage 2, considering the actuality that China Telecom and China Netcom deployed PHS in the northern and southern fixed network regions severally, we regard them as one enterprise, which exploit Chinese mobile telecommunications market with PHS. Thus, three enterprises exist in Chinese mobile telecommunications market. Assumed that CMCC is the enterprise 1, China Unicom enterprise 2, and China Telecom and China Netcom are enterprise 3, with the price reaction function of enterprise \( i \) in the game stage 2 (5), we can deduce the price reaction function of the enterprise 2,

\[ p_2^*(p_1, p_3) = \frac{1}{4} (p_1 + p_3) + \frac{c}{2} + \frac{t}{18}. \] (10)

From the price reaction function (10), it is indicated that, for the assured parameters \( t, c \), the price that helps any enterprise achieve the maximized profit is positive correlative to the prices of other two enterprises. The correlativeity shows that, under the formed market structure, the price fluctuation of any enterprise will result in the price action of the whole market. It is the reason that the voice business plunged into an endless price war. Further, the new subscribers, who are attracted by the low tariff, are the middle and lower level users, and they can’t do a great help in increasing the income of the enterprise. [5] Occupiers compete the price with the new entrants to retain the subscribers. It does not increase the profit of the potential transfer, but reduce the prices of non-transfer, and will undoubtedly decrease the
maximized profit. The price war will depress the maximized profits of the participants and affect the margin and healthy development greatly. Thus, the price war is not an advisable way to making a big cake and two win. Only keeping the price stable relatively can guarantee the maximized profits of the enterprises in the market and the gross profit of the industry.

Based on the analysis above, we give the following advice to Chinese mobile telecommunications operators. (i) As the occupiers in Chinese mobile telecommunications market, CMCC and China Unicom should face the reality. In another word, it is a necessary trend that entrant enters the relatively high revenue mobile telecommunications market. The new situation on market requires of these two occupiers to change the strategy in duopoly. They should demonstrate their advantage in 2G and 2.5G mobile telecommunications network, research the way to increase ARPU of the subscribers, rely on the R&D of data product and creativity, cultivate value-added service market, lead and foster middle and high level users to use data service, increase the mobile telecommunications subscribers, educate the loyalty of the users and realize the differentiation competition to avoid the price war; (ii) CMCC and China Unicom should reinforce the management on the equipment suppliers, terminals vendors, channel agents, SP and so on in the industry value chain, promote the heath circle, found their domination positions in the industry value chain in order to counterattack the stronger entrant in future; (iii) The operator with PHS should optimize their network, focus the service quality of the network users, develop and promote short message service (SMS), location base service (LBS) and other PHS value added services, and guarantee the continuous increase; attract the potential mobile telecommunications service subscribers. In conclusion, the operators should position themselves in the market, according to the development of their network and technology. They should also aim at adding the value of subscribers, keep patient in contesting the mobile voice subscribers, not appealing to the stick of price in a hurry.

4. SUMMARY

Through the attractive low price, the PHS entered the mobile telecommunications market and broke the duopoly. The original occupiers, CMCC and China Unicom, beat back these new entrants by the price strategy. In this paper, using the model analysis, we explained the necessity that new entrants appear in Chinese mobile telecommunications market, and indicated that the competition relying on the price will lead to the endless war, the profit that the operator obtain will go down, consequently, the total profit of the industry will deteriorate. None but operators keep innovating, maintain the current price in the mobile voice, aggrandize the value of the subscribers, create the competitive differentiation, the operators will retain the subscribers and attain the maximum profit.

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