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Advertising Competition in Mixed Oligopoly: From the Perspective of Shareholding Reform of China's State-Owned Enterprises

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Abstract

The model of considering state-owned enterprises with shareholding reform in the mixed oligopoly market is considered to compete with private enterprises in advertising, and the impact of the proportion of state shares on advertising competition is explored. We found that within a certain range, with the increase in the proportion of state-owned shares, the advertising level of state-owned enterprises and private enterprises is declining, and the advertising level of the entire industry is declining. The impact of state-owned shares on output and profits was also explored. Finally, the changes in the market advertising level before and after the shareholding reform were compared, and it was found that the advertising level of the market after the reform was higher than that before the reform.

Keywords

Shareholding Reform, Social Welfare, Advertising Competition, State-Owned Enterprises

1. Introduction

In this article, we examine persuasive advertising competition in mixed oligopolies from the perspective of China's state-owned enterprise shareholding reform. We introduce the benefit-maximizing shareholding reform state-owned enterprises into the hybrid oligopoly advertising competition model proposed by Matsumura & Sunada (2013). The relationship between advertising level and the proportion of national shares, as well as the relationship between the overall advertising level before and after the reform, was explored.

The concept of advertising competition in the field of economics adopts the perspective of elasticity, and the change of one variable must cause the change of other related variables, so from the perspective of economics, the change of brand A's advertising leads to a change in the sales volume of brand B, then it can be said that brand A and brand B have advertising competition behavior. Chen & Riordan (2008) argue that consumers will have different preferences for different products. Zhou et al. (2018) found that advertising is the main marketing method for companies to convey their own product-related information to consumers, and at the same time, consumers can understand the company's products. In the market, many state-owned enterprises also compete with private enterprises. Many scholars have studied the mixed oligopoly of state-owned enterprises and private enterprises. Zhou et al. (2020) explored the online advertising decision-making of oligopolistic competitors. Jin et al. (2018) explored the impact of advertising competition between two strong brands in the same category on weak brands, and used duplication and length of advertisements as specific means to control the intensity of advertising competition. Wang & Mukherjee (2012) proved that in the presence of state-owned enterprises, the entry of profit-maximizing enterprises will make the situation of consumers worse. The entry of profit-maximizing firms increases the profits of nationalized firms, industry profits, and social welfare, but reduces the consumer surplus. Hausman & Leibtag (2007) believe that the more competition there is, the better it is for consumers. Astorne-Figari et al. (2019), in terms of consumer choice, the study concluded that moderately cost advertising encourages companies to raise prices and can improve profits by reducing the proportion of price-sensitive consumers and dividing the market according to whether consumers consider companies with lower prices. Hattori & Higashida (2012) studied the impact of misinformation on market competition, corporate behavior, and social welfare. They found that the extent of advertising externalities and the size of advertising costs are critical to welfare effectiveness. Zhang & Zhong (2016) established a two-stage duopoly advertising and price competition model in the information dissemination environment, and explored the impact of information dissemination and advertising costs on firm decision-making and profits.

Huang (2019) believes that state-owned enterprises play an important role in the market. In addition to promoting the improvement of enterprise productivity, Chen & Yan (2021) held the view that the productivity of state-owned enterprises can also improve allocation efficiency through the exit of low-productivity enterprises, the entry of high-productivity enterprises, and the consequent change in market share. In order to improve the production efficiency of state-owned enterprises, Chen & Chen (2018) based on Marx's theory of the shareholding system and relying on the actual self-help experience of state-owned enterprises, it is advocated transforming state-owned enterprises with the shareholding system. Wang (2018) advocated that China's choice of shareholding as the path of state-owned enterprise reform is not to gather social capital, but to try to improve the efficiency of state-owned enterprises with the help of the go-

vernance mechanism of joint-stock enterprises. Sarah & Huang (2012) elaborated that China's state-owned enterprise reform was officially launched in the late 1970s. At that time, state-owned enterprises were not only inefficient and low-profitability, but also shouldered the burden of providing basic social benefits and employment. More specifically, since 1984, the focus of the reform has shifted from management adjustment to enterprise structure adjustment. Zhang & Zhang (2019) held the view that the government has also experimented with equity reform to explore different ways to improve the governance of state-owned enterprises. Xiang (2018) considered that carrying out the shareholding reform and properly handling the relationship between the government and the market is, from a macro point of view, the key to the complete transformation of the economic system. Driven by the innovation of establishing a modern enterprise system, the status of shareholding as the main form of public ownership has been established and has become more and more stable. The reform of state-owned enterprises is not a unique phenomenon in China, and almost all countries in the world are constantly adjusting and reforming state-owned enterprises. However, looking at the world, the large-scale and long-lasting shareholding reform of state-owned enterprises like China is unique and has accumulated rich experience.

This conclusion is summarized based on the elaboration of the above literature. Most of the previous studies have focused on the impact of advertising competition on social welfare, and few have studied advertising competition in the context of China's shareholding reform. In this paper, in the mixed oligopoly, the model takes the share-reformed state-owned enterprises into consideration, which enriches the research on advertising competition. Let a joint-stock reform enterprise and a private enterprise compete in advertising, and like pure state-owned enterprises, the share-holding reformed state-owned enterprises still pursue the maximization of social welfare while pursuing profits. The effect between the share of the country's shares and the level of advertising, the effect on output, profit, as well as the relationship between the level of advertising before and after the shareholding reform.

2. The Model

Based on the model of Matsumura & Sunada (2013), a hybrid oligopoly model is constructed. Suppose there is a state-owned enterprise and a private enterprise, the two enterprises compete, the products produced are homogeneous products, company 0 represents the state-owned enterprise that maximizes social welfare, and company 1 represents the private enterprise that maximizes profits. The profits of the two companies are π_0, π_1. The game is divided into two phases, in which both companies choose their respective advertising levels z_0, z_1 and z_i can be negative. The advertising costs are $kz_0^2/2$, $kz_1^2/2$, then the advertising level of the entire industry is $Z = z_0 + z_1$. In the second stage, after observing the advertising level Z, each company chooses its own level of output q_0, q_1. The

total production is $Q = q_0 + q_1$, the anti-demand function is $P = a + Z - bQ$, where P is the price of the homogeneous product produced. Supposed the marginal cost of company 0 is c_0, the marginal cost of company 1 is c_1. We assume that $c_0 > c_1$, that is, purely state-owned enterprises are less efficient than private enterprises. To simplify the model without losing generality, we suppose that $c_1 = 0$. Before the shareholding reform, when state-owned enterprises were purely state-owned, the total social surplus was given by

$$W = \frac{1}{2}Q^2 + \sum_{i=0}^{1}\pi_i = \frac{1}{2}Q^2 + PQ - c_0 q_0 - \frac{1}{2}kz_0^2 - \frac{1}{2}kz_1^2 \tag{1}$$

where π_i represents the profit of 0 and 1 of the enterprise. The profits of state-owned enterprises and private enterprises are that

$$\begin{aligned} \pi_0 &= (a + Z - bQ)q_0 - k\frac{z_0^2}{2} \\ \pi_1 &= (a + Z - bQ)q_1 - k\frac{z_1^2}{2} \end{aligned} \tag{2}$$

When the state-owned enterprise carries out the shareholding reform, assuming that θ is the proportion of state-owned shares, $\theta \in (0,1)$, and $(1-\theta)$ is the proportion of shares of private enterprises, the total social surplus is U, as shown in the following formula:

$$U = \theta W + (1-\theta)\pi_0 \tag{3}$$

According to Glaeser & Ujhelyi (2010), they argue that advertising is a public good and specific. Advertising is also persuasive, it makes the product more attractive, but it does not create value for the consumer.

3. Equilibrium

To solve the equilibrium solution, reverse induction is used. The steps to solve an equilibrium solution are discussed below.

3.1. Competition for Production

For companies undergoing shareholding reform 0 regarding q_0 maximization of U, and for company 1 regarding q_1 maximization π_1, their first-order conditions are obtained, and the second-order conditions are also satisfied, resulting in symmetric equilibrium. We set $q_0(Z)$ as the equilibrium output level of state-owned enterprises, $q_1(Z)$ representing the equilibrium output level of private enterprises, and $Q(Z)$ representing the equilibrium output level of the entire industry. The resulting equilibrium result is as given by

$$\begin{aligned} q_0 &= -\frac{-a\theta + 2bc_0 - \theta Z}{b(2b-\theta)} \\ q_1 &= -\frac{-ab + a\theta - bc_0 - bZ + \theta Z}{b(2b-\theta)} \\ Q &= \frac{a - c_0 + Z}{2b - \theta} \end{aligned} \tag{4}$$

According to Equation (4), we can derive the following lemma.

Lemma 1. *Under the background of shareholding reform, the increase in the advertising level of state-owned enterprises can effectively improve the production efficiency of state-owned enterprises and the overall industry.*

when a is large enough and $b>1$, the demand curve will shift upwards due to the increase in Z, and the equilibrium price will also increase, and the production level of the industry as a whole will also increase. When z_0 increases, q_0, q_1 also increase. This result is different from Matsumura & Sunada (2013)'s conclusion that the productive substitution of state-owned enterprises to private enterprises will produce strategic complementarity, suggesting that under the background of shareholding reform, the improvement of the advertising level of state-owned enterprises can significantly improve the efficiency of state-owned enterprises.

3.2. Advertising Competition

Now considering the problem of the first stage, that is, the two companies choose their own advertising levels and substitute the above (4) formula into W, U and π_1, we can derive the following formula:

$$\begin{aligned}
W &= -\frac{k}{2}\left(z_0^2+z_1^2\right)+\frac{\left(a-c_0+Z\right)^2}{2\left(-2b+\theta\right)^2}+\frac{b\left(a-c_0+Z\right)\left(bc_0+\left(b-\theta\right)\left(a+Z\right)\right)}{b\left(-2b+\theta\right)^2},\\
U &= -\frac{1}{2}k\theta z_0^2-\frac{1}{2}k\theta z_1^2+\frac{b\theta\left(a-c_0+Z\right)^2+2\theta\left(bc_0+\left(b-\theta\right)\left(a+Z\right)\right)^2}{2b\left(-2b+\theta\right)^2}\\
&\quad -\frac{\left(-bc_0-\left(b-\theta\right)\left(a+Z\right)\right)\left(-2bc_0+\theta\left(a+Z\right)\right)}{b\left(-2b+\theta\right)^2},\\
\pi_0 &= -\frac{1}{2}kz_0^2+\frac{\left(a+Z\right)\left(b-\theta\right)+bc_0\left(a\left(b-\theta\right)+Z\theta+bc_0\right)}{b\left(-2b+\theta\right)^2},\\
\pi_1 &= -\frac{1}{2}kz_1^2+\frac{\left(bc_0+\left(b-\theta\right)\left(a+Z\right)\right)^2}{b\left(-2b+\theta\right)^2}.
\end{aligned} \tag{5}$$

Company 0 maximizes U with respect to z_0 and company 1 maximizes π_1 with respect to z_1. Through the first-order conditions, and also meet the second-order conditions, we can find the symmetrical equilibrium of state-owned enterprise advertising level z_0, private enterprise advertising level z_1 and the entire industry advertising level Z respectively, where the superscript "E" represents the equilibrium result, and the following formula can finally be obtained:

$$\begin{aligned}
z_0^E &= \frac{ak\theta\left(4b^3+b^2\left(6-10\theta\right)-2\left(-1+\theta\right)\theta^2+b\theta\left(-7+8\theta\right)\right)}{k\left(2b-\theta\right)\theta\left(4b^3k+2\left(1-2\theta\right)\theta-4b^2\left(1+k\theta\right)+b\left(-3+8\theta+k\theta^2\right)\right)}\\
&\quad +\frac{2b\left(b-\theta\right)\left(1+2bk\left(-1+\theta\right)-k\left(-1+\theta\right)\theta\right)c_0}{k\left(2b-\theta\right)\theta\left(4b^3k+2\left(1-2\theta\right)\theta-4b^2\left(1+k\theta\right)+b\left(-3+8\theta+k\theta^2\right)\right)},
\end{aligned}$$

$$
\begin{aligned}
z_1^E &= \frac{2(b-\theta)ak\theta\left(2b^2-3b\theta+\theta^2\right)+b\left(-1+2bk\theta-k\theta^2\right)c_0}{k(2b-\theta)\theta\left(4b^3k+2(1-2\theta)\theta-4b^2(1+k\theta)+b\left(-3+8\theta+k\theta^2\right)\right)},\\
Z^E &= \frac{a\theta\left(4b^2+b(3-8\theta)+2\theta(-1+2\theta)\right)+2b(b-\theta)(-1+2\theta)c_0}{\theta\left(4b^3k+2(1-2\theta)\theta-4b^2(1+k\theta)+b\left(-3+8\theta+k\theta^2\right)\right)},
\end{aligned}
\tag{6}
$$

Then substitute (6) into the above (4) and (5) formulas to obtain an equilibrium of yield and profit.

$$
\begin{aligned}
q_0^E &= \frac{ak(2b-\theta)\theta+\left(2-4b^2k-4\theta+2b(2+k\theta)\right)c_0}{4b^3k+2(1-2\theta)\theta-4b^2(1+k\theta)+b\left(-3+8\theta+k\theta^2\right)},\\
q_1^E &= \frac{ak\theta\left(2b^2-3b\theta+\theta^2\right)+b\left(-1+2bk\theta-k\theta^2\right)c_0}{\theta\left(4b^3k+2(1-2\theta)\theta-4b^2(1+k\theta)+b\left(-3+8\theta+k\theta^2\right)\right)},\\
Q^E &= \frac{abk(2b-\theta)\theta+\left(-2b^2k\theta+2(1-2\theta)\theta+b\left(-1+4\theta+k\theta^2\right)\right)c_0}{\theta\left(4b^3k+2(1-2\theta)\theta-4b^2(1+k\theta)+b\left(-3+8\theta+k\theta^2\right)\right)}.
\end{aligned}
\tag{7}
$$

$$
\begin{aligned}
\pi_0 = &-\frac{(ak(2b-\theta)\theta(2b^2+b(3-4\theta)+2(-1+\theta)\theta)+2b(1+k(2b-\theta)(-1+\theta))(b-\theta)c_0)^2}{2k(-2b+\theta)^2}\\
&+\frac{b(ak\theta(-2b+\theta)(-b+\theta)}{\theta(4b^3k+2(1-2\theta)\theta-4b^2(1+k\theta)+b(-3+\theta(8+k\theta)))^2}\\
&+\frac{b(-1+k(2b-\theta)\theta)c_0)(ak(2b-\theta)\theta+(2-4\theta+2b(2-2bk+k\theta))c_0))}{\theta(4b^3k+2(1-2\theta)\theta-4b^2(1+k\theta)+b(-3+\theta(8+k\theta)))^2}\\
\pi_1 = &\frac{(b^3k-\theta^2+b^2(-1-2k\theta)+2b\theta(4+k\theta))(ak\theta(2b^2-3b\theta+\theta^2)+4b(-2+4bk\theta-2k\theta^2)c_0)^2}{k(b-\theta)^2\theta^2(2b^3k+(1-2\theta)\theta+8b^2(-1-k\theta)+2b(-3+8\theta+k\theta^2))^2}
\end{aligned}
\tag{8}
$$

4. Results

4.1. Advertising Level and Shareholding Ratio

According to the above formula, the advertising level of state-owned enterprises and private enterprises in the shareholding reform affects each other, and the relationship between advertising level and the proportion of national shareholding is discussed below.

Discuss the impact of the proportion of state-owned shares on the advertising level of state-owned enterprises. Partial derivative to z_0^E, regardless of the influence of the product quantity coefficient and the advertising coefficient, let $b=1, k=1$, we can get that

$$
\frac{\partial z_0^E}{\partial\theta} = -\frac{2\left(a(-2+\theta)^3\theta^2+\left(-2+8\theta-16\theta^2+16\theta^3-7\theta^4+\theta^5\right)c_0\right)}{3(-2+\theta)^2(-1+\theta)^3\theta^2}.
\tag{9}
$$

Regardless of the influence of a and c_0 (take a and c_0 as 1), at the same time, $\theta\in(0,1)$. The resulting image of partial derivative function of z_0^E on θ is shown in Figure 1.

From Figure 1, we can draw that $\partial z_0^E/\partial\theta<0$, that is, the first-order partial

derivatives of z_0^E with respect to θ are all less than 0. The function of z_0^E with respect to θ shows a downward trend. The result shows that z_0^E and θ are inversely proportional. That is, for joint-stock state-owned enterprises, with the increase in the proportion of state-owned shares, the advertising level of state-owned enterprises is decreasing.

Considering the impact of the proportion of state-owned shares on the advertising level of private enterprises. Also, for the sake of simplifying the formula, let $b=1, k=1$, and we get that

$$\frac{\partial z_1^E}{\partial \theta} = -\frac{2\left(2-2\theta+\theta^2\right)c_0}{3\left(-2+\theta\right)^2\theta^2}. \tag{10}$$

Since $c_0 > 0, \theta \in (0,1)$ and regardless of the influence of c_0 (take c_0 as 1). The resulting image of partial derivative function of z_1^E on θ is shown in Figure 2.

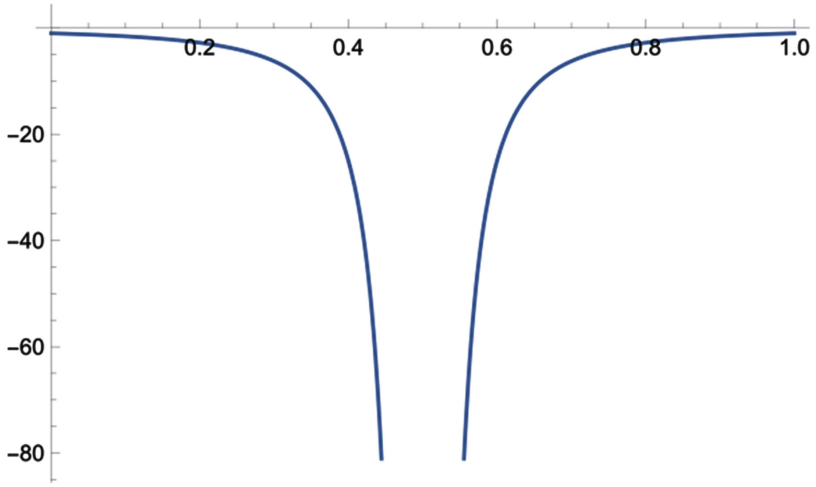

Figure 1. Image of partial derivative function of z_0^E on θ.

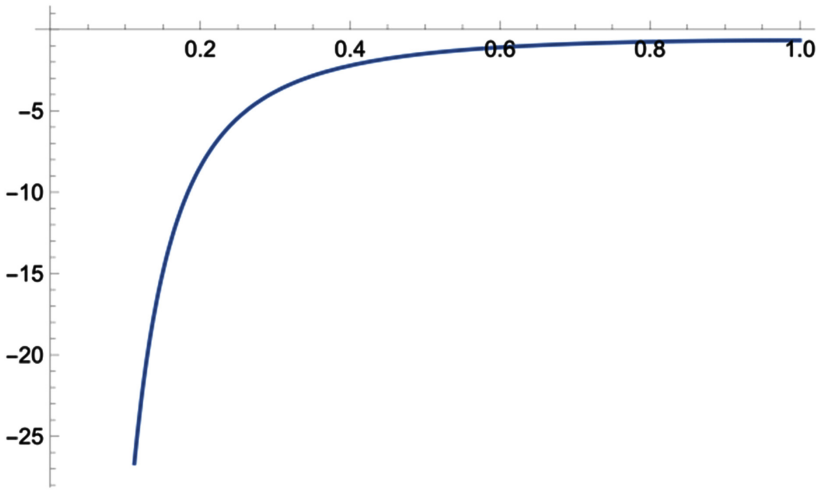

Figure 2. Image of partial derivative function of z_1^E on θ.

It can be drawn that $\partial z_1^E / \partial \theta < 0$, so z_1^E is inversely proportional to θ. That is, for private enterprises, with the increase in the proportion of state-owned shares under the shareholding reform, the advertising level of private enterprises is declining. When $\theta = 1 - i$, the advertising level of private enterprises reaches a minimum.

Next, we discuss the level of advertising across the industry. Partial derivative to Z^E, let $b = 1, k = 1$, it is clear that

$$\frac{\partial Z^E}{\partial \theta} = \frac{-2a(-2+\theta)\theta^2 + (2-6\theta+8\theta^2-4\theta^3)c_0}{3(-1+\theta)^3\theta^2}. \tag{11}$$

Since $\theta \in (0,1)$, regardless of the influence of a and c_0, the resulting image of partial derivative function of Z^E on θ is shown in Figure 3.

It can be drawn that $\partial Z^E / \partial \theta < 0$. Therefore, with the increase in the proportion of state-owned shares, the advertising level of the entire industry is declining.

Proposition 1. *If* $a > 0, c_0 > 0, \theta \in (0,1)$ *and* $\theta \neq 0.5$, *when* θ *raises,* z_0^E, z_1^E *and* Z^E *both decrease.*

Under the shareholding reform, with the increase in the proportion of state-owned shares, the advertising level of state-owned enterprises and private enterprises is declining. Therefore the level of advertising in the entire industry is also declining.

This is reasonable, because when the proportion of state-owned shares is relatively high, then state-owned enterprises are less inclined to advertise, which will lead to weaker competition in advertising, and private enterprises are not inclined to advertise, resulting in a low level of advertising in the entire industry.

4.2. Production Level and Shareholding Ratio

Then we discuss the relationship between production and the proportion of state-owned shares. Partial derivative to q_0^E, regardless of the influence of the product quantity coefficient and the advertising coefficient, let $b = 1, k = 1$. We

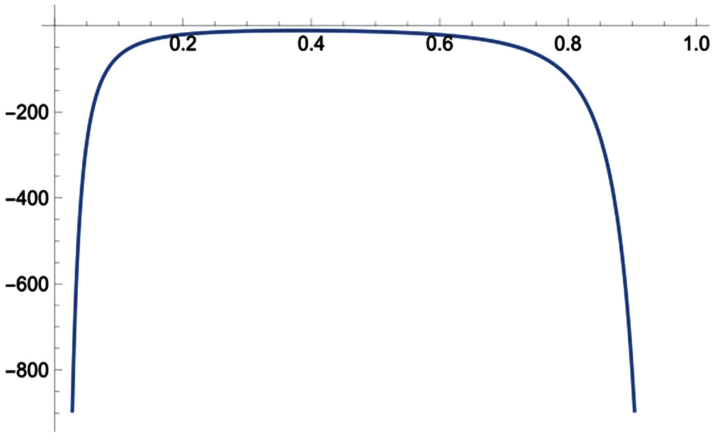

Figure 3. Image of partial derivative function of Z^E on θ.

can get that

$$\frac{\partial q_0}{\partial \theta} = \frac{2\left(a-\left(-1+\theta\right)c_0\right)}{3\left(-1+\theta\right)^3}. \tag{12}$$

Since $c_0 > 0, a > 0$ and $\theta \in (0,1)$, we can draw that $\partial q_0 / \partial \theta < 0$, so q_0 and θ are inversely proportional. That is, with the higher the proportion of state shares, the smaller the output of state-owned enterprises.

Next partial derivative to q_1 let $b = 1, k = 1$. We can get that

$$\frac{\partial q_1}{\partial \theta} = -\frac{a\theta^2 + \left(-1+\theta\right)^2 c_0}{3\left(-1+\theta\right)^2 \theta^2}, \tag{13}$$

since $c_0 > 0$ and $a > 0$, when $\theta \in (0,1)$, q_1 and θ are inversely proportional. That is, with the higher the proportion of state shares, the smaller the output of private enterprises.

Partial derivative to Q, regardless of the influence of the product quantity coefficient and the advertising coefficient, we can get that $\partial Q / \partial \theta = -c_0 / \theta^2$. Since $c_0 > 0$ and $a > 0$, when $\theta \in (0,1)$, Q and θ are inversely proportional. That is, with the increase of the proportion of national shares, the overall output will decrease, indicating that the implementation of the shareholding system reform can increase the output level of the industry to a certain extent.

Proposition 2. *If* $a > 0, c_0 > 0, \theta \in (0,1)$, *when* θ *raises,* q_0^E, q_1 *and* Q *both decrease.*

Under the shareholding reform, with the increase in the proportion of state-owned shares, the output level of both state-owned enterprises and private enterprises is declining, and the output of the entire industry will also decline. Conversely, the implementation of the shareholding system reform and the reasonable reduction of the proportion of the state in state-owned enterprises can increase the output of state-owned enterprises, private enterprises and the entire industry to a certain extent, reflecting the benefits of the shareholding system reform.

4.3. Profit and Shareholding Ratio

Then we discuss the relationship between profit and the proportion of state-owned shares. Partial derivative to π_0, let $b = 0, k = 1$, we can get that

$$\begin{aligned}\frac{\partial \pi_0}{\partial \theta} = &\frac{a^2\left(2\left(1-2\theta\right)-4\theta\right)\left(-1+\theta\right)^2}{2\left(1-2\theta\right)^3\theta} + \frac{a^2\left(-1+\theta\right)^2}{\left(1-2\theta\right)^2\theta} + \frac{a^2\left(-1+\theta\right)^2}{\left(1-2\theta\right)^2\theta} \\ &+ \frac{2a\left(-1+\theta\right)\theta\left(-4a\left(-1+\theta\right)\theta^2 - a\theta^2\left(2\left(-1+\theta\right)+2\theta\right)\right)}{4\left(1-2\theta\right)^2\theta^4}\end{aligned} \tag{14}$$

Discuss the above formula, if $c_0 > 0, a > 0, \theta \in (0, 0.5)$, π_0 and θ are inversely proportional. That is, within this range, as the proportion of state-owned shares increases, the profits of state-owned enterprises are decreasing. When $\theta \in (0.5, 1)$, π_0 and θ are directly proportional. That is, for state-owned en-

terprises, as the proportion of shares in the state increases, the profits of state-owned enterprises also increase.

Then we take a partial derivative of π_1. Regardless of the influence of the product quantity coefficient and the advertising coefficient, regardless of the influence of the product quantity coefficient and the advertising coefficient, let $b=0, k=1$, we can get that

$$\frac{\partial \pi_1}{\partial \theta} = -\frac{a\theta c_0^2}{\left(-3+8\theta+(1-2\theta)\theta+\theta^2\right)^2}. \tag{15}$$

Since $c_0 > 0$, when $a > 0$, $\theta \in (0,1)$ and $\theta \neq 4.5-0.5\sqrt{69}$, π_1 and θ are inversely proportional. That is, for private enterprises, as the proportion of state shares in the shareholding reform increases, the profits of private enterprises are decreasing.

Proposition 3. *Under the shareholding reform, if* $c_0 > 0, a > 0, \theta \in (0.5,1)$, *as* θ *is higher,* π_0 *is decreasing. If* $\theta \in (0.5,1)$, *as* θ *is higher,* π_0 *is increasing. If* $\theta \neq 4.5-0.5\sqrt{69}$, *as* θ *is higher,* π_1 *is decreasing.*

When the state-owned shareholding exceeds half, the profits of state-owned enterprises increase as the proportion of state-owned shares increases. When the proportion of shares is less than half, as the proportion increases, the profits of state-owned enterprises are decreasing. Meanwhile, for private enterprises, as the shareholding reform of the state shares is higher, the profits of private enterprises are decreasing.

4.4. Advertising Level before and after the Shareholding Reform

The social welfare before the shareholding reform is as shown in (1), for companies undergoing shareholding reform 0 regarding q_0 maximization of W and for company 1 regarding q_1 maximization π_1, reverse induction is used to solve. Finally, the level of advertising of state-owned enterprises z_0' was obtained, the level of advertising in private enterprises z_1' and the level of advertising in the industry as a whole Z' are symmetrically balanced, where the superscript "E" indicates the equilibrium result and we can obtain the result that

$$\begin{aligned}
z_0'^E &= \frac{a(1-2b)^2 b^2 k + \left(2+b\left(-4+b^2(2-4k)-k+4bk\right)\right)c_0}{b(-2+2b)k\left(-2+(5-4b)b+(1-2b)^2 bk\right)},\\
z_1'^E &= \frac{2a(1-b)^2 b(-1+2b)k + \left(-2+4b+b^3(-2-6k)+2b^2k+4b^4k\right)c_0}{bk\left(2+b^3(-8-12k)+b(-9-k)+b^2(14+6k)+8b^4k\right)},\\
Z'^E &= \frac{a\left(2+b(-5+4b)\right)+\left(1+2(-2+b)b\right)c_0}{-2+b\left(5+k+4b\left(-1+(-1+b)k\right)\right)}.
\end{aligned} \tag{16}$$

Compare the market equilibrium Z'^E before the shareholding reform in formula (16) with the market equilibrium Z^E after the shareholding reform in (6). In order to simplify the formula, the influence of the product coefficient and the advertising coefficient is not considered, if $b=1, k=2$, we can get that

$$Z'^{E} - Z^{E} = \frac{6a(-1+\theta)^{2}\theta - (2-7\theta+2\theta^{2}+2\theta^{3})c_{0}}{\theta(-1-2\theta+2\theta^{2})}. \quad (17)$$

At the same time, the impact of market size and marginal cost is not considered, if $a=5, c_0=1$, when $0.0599<\theta<1$, we can get that $Z'^{E}<Z^{E}$. That is, the overall market advertising level before the shareholding reform was lower than after the reform. When $0.171<\theta<1$, $Z'^{E}-Z^{E}$ decreases as θ increases. That is, the difference in advertising levels before and after the shareholding reform narrows with the increase in the proportion of state-owned shares.

Proposition 4. *If* $0.75-0.25\sqrt{5}<\theta<1$, *we can get that* $Z'^{E}<Z^{E}$. *If* $0.171<\theta<1$, *as* θ *increases, the value of* $Z'^{E}-Z^{E}$ *decreases.*

That is, if $0.75-0.25\sqrt{5}<\theta<1$, the overall market advertising level before the shareholding reform was lower than after the reform. It shows that before the shareholding reform, state-owned enterprises were less inclined to carry out advertising, and after the shareholding reform, state-owned enterprises increased advertising investment. And if $0.171<\theta<1$, the difference in advertising levels before and after the shareholding reform narrowed with the increase in the proportion of state-owned shares. The increase in the proportion of state-owned shares makes state-owned enterprises less inclined to advertise, and when the proportion of state-owned shares continues to increase to 1, the enterprise becomes a pure state-owned enterprise at the same level of advertising as before the reform.

5. In Conclusion

State-owned enterprises are the main organizational form of state-owned economic and social public enterprises, and their reform plays an important role in the reform of China's economic system. In this paper, in the mixed oligopoly market, the state-owned enterprises of the shareholding reform are taken into account and compete with private enterprises in advertising. The enterprise under the shareholding system reform pursues profits while still pursuing the maximization of social welfare, while private enterprise only pursues the maximization of their profits, exploring the impact of the proportion of state shares on advertising competition. The results show that within a certain range, with the increase in the proportion of state-owned shares, the advertising level of state-owned enterprises and private enterprises is declining, and the advertising level of the entire industry is declining. The proportion of state-owned shares also has an impact on output, and the increase in the proportion of shares has caused the output level of state-owned enterprises and private enterprises to decline, and the output of the entire industry will also decline, reflecting that the shareholding reform can improve the production efficiency of the industry and increase output. In addition, the relationship between the proportion of shares and profits was discussed, and it was found that different ranges of shares would produce different laws of profit changes. Finally, the changes in the market ad-

vertising level before and after the shareholding reform were compared, and it was found that the advertising level of the market after the reform was higher than that before the reform. This paper enriches the research on advertising competition of mixed oligopoly and provides a valuable reference on how the shareholding ratio of state-owned enterprises affects the level of advertising competition, product production efficiency and profit level in the market.

Considering that the shareholding reform of state-owned enterprises in real life can enhance the competitiveness and profitability of state-owned enterprises, expand the autonomy of enterprises, and create good conditions for the development of state-owned enterprises, so in this context, we pay attention to advertising competition, and in order to facilitate research, we have limited many conditions. With certain limitations, the products of two competitors are assumed to be homogeneous products, and the situation of heterogeneous products is not considered. For the convenience of calculation, we assume that the marginal cost of firm 1 is 0, ignoring the impact of the market size and the marginal cost of firm 0. So other oligopoly advertising competition in more realistic situations needs to be further studied.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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