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DEVELOPMENT OF PE'S VS. PRIVATIZATION OF SOE'S:
A MIXED OLIGOPOLY MODEL BASED ON PRICE COMPETITION*

Yang Qijing Song Pengcheng

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Abstract : The analysis of privatization of SOE's (state-owned enterprises) in this paper is based on the assumptions of product heterogeneity and price competition, trying to reveal the interdependence between the development of PE's (private enterprises) and the privatization of SOE's. On one hand, the pricing strategy of a PE is influenced by the characteristic of the industry, cost advantage and product advantage of the PE and degree of privatization of SOE's in that industry. On the other hand, the development of PE's stimulates and prepares the conditions for the privatization of SOE's. We inspect the influence of the privatization process on equilibrium prices, quantities and market structure and show that the reform policies that treat all the SOE's equally without any discrimination are not consistent with general rules, while "big bang" always causes disastrous stagflation.

Key Words : Privatization Development of PE's Mixed Oligopoly
Heterogeneity Price competition

JEL Classification : L11 L21 O17 P26 P31

DEVELOPMENT OF PEs VS. PRIVATIZATION OF SOES:

A MODEL BASED ON PRICE COMPETITION^{*}

Yang Qijing Song Pengcheng

(School of Economics, Renmin University of China)

Abstract: Former researches on privatization of SOEs (state-owned enterprises) assume that products are homogeneous and enterprises are involved in quantity competition. In this paper, we look into this issue based on the assumption of product heterogeneity and price competition, trying to reveal the relation between the development of PEs (private enterprises) and the privatization of SOEs. On the one hand, the pricing strategy and development of PEs are influenced by the feature of the industry, their cost advantage, product advantage, and degree of privatization of the SOEs in that industry. On the other hand, the development of PEs motivates and facilitates the privatization of SOEs. We analyze the influence of privatization on equilibrium prices, outputs and market structure and certify that the reform policies that treat all SOEs equally without any discrimination are against the general rule, while “big bang” that would lead to stagflation is more hazardous.

Key words: development of PE privatization of SOEs mixed oligopoly
heterogeneity quantity competition

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1. Introduction

The privatization of SOEs, for their inefficiency, is a common task for transforming countries. Scholars have been involved in the following issues for a long time: why an SOE should be privatized, how to privatize, what the best path of privatization is, whether complete privatization is necessary or not, *et al.* Economists

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also contribute their ideas from different points of view. The most influential seems to be the analysis within the framework of neo-institutional economics. Principal-agent theories are used and lead to the consensus that SOEs are lack of efficiency, which requires privatization as soon and comprehensively as possible¹. There are also economists (for instance, Gao Hongye, 1995; Lin Yifu *et al*, 1997; Liu Shaojia *et al*, 1998) holding the opinion that inefficiency of SOEs should not be attributed to the principal-agent problem related to the property of property rights, but to the difficulty in evaluating performance of the management of SOEs, due to lack of fairness and adequate competition. Some economists (Liu Shijin, 1995; Lin Yifu *et al*, 1997, 2000) attribute the inefficiency of SOEs to their special policy burden, the distorted industry structure caused by “catch up” strategy and the lack of SOEs’ capability of self-support, so they suggest that SOEs be freed from policy burden and the industry structure be re-constructed according to the principle of comparative advantage. Moreover, they believe that as long as an SOE has the same performance with non-SOEs, it is unnecessary to privatize (Lin Yifu & Liu Peilin, 2001). At the same time, some economists try to surpass the general discussion on SOEs. They point out an idea of categorized reformation according to different functions of SOEs and their capital, and contended that state-owned capital should retreat from competitive industries but stay in strategic and public sectors (Yang Ruilong, 1995; Dong Funai, 1995; Yang Canming, 2001).

Researches mentioned above try to reveal the underlying reason for privatization of SOEs and to seize the essence of the problem. However, they do leave a formal analysis of the following issues untouched: the schedule and path of the process of privatization in a specific industry, whether or not an industry should be completely privatized, *et al*. Following this thread, some economists realize that the process of privatization of SOEs is also the process of transmutation in industrial organization. Modern theory of industrial organization is employed and the privatization of SOEs is then analyzed through models called the mixed oligopoly of an SOE and a PE, among which De Fraja & Delbono (1989) was the most influential². They assume an SOE as a Stackelberg leader or a Cournot-Nash player pursuing the maximization of social

¹ A representative of this thought is Zhang Weiyang, whose papers on this topic are collected in the book *The Theory of the Firm and the Reformation of SOEs*, PKU Press, 1999.

² One paper on mixed oligopoly written by Cremer and his coauthors was published in the same edition of *Oxford Economics Papers*. The paper assumed that SOEs maximized output and were faced with a constraint of the balance of revenue and cost. They won support from economists like Bennett & Manna (2003).

welfare, or as a pure monopoly pursuing profit maximization, competing with n PEs whose aim are to maximize profit, and draw the conclusion that whether a SOE should be privatized depends on the number of PEs. Later, Fershtman (1990) tries to endogenously explain the determination of the compass of state-owned capital and constructs a model composed of a partially privatized SOE and a PE, assuming the SOE to maximize the weighted average of profit and social welfare denoted as the sum of consumer surplus and producer surplus. This approach has been widely accepted since then. For instance, Matsumura (1998) transmuted the problem of privatization of SOEs into “how much share the government should hold after a SOE is privatized”. In China, Ping Xinqiao (2000) follows the above approach and, through the analysis of cost function, tries to explain the endogenous mechanism of the determination of the proportion of state-owned capital. Although his research is meaningful, he does not consider the differences of technique and management of enterprises for different ownerships. On the contrary, Zhang Jun *et al* (2003) and Sun Qunyan *et al* (2004) emphasize the cost disadvantage of SOEs compared to PEs, and verified that the government would not privatize a SOE unless the difference in costs reached a critical value. Besides, what's worthwhile to mention is that Zhang Jun *et al* (2003) think that the feature of a SOE is not shown by its pursuit of social welfare maximization, but by the change of its status before and after privatization, namely from a Stackelberg leader to an ordinary Cournot player. They also emphasize the endogenous influence of the number of PEs on the process of privatization of SOEs.

Admittedly, work done till now has contributed a lot to the solution of the opportunity of privatization, necessary conditions for privatization--endogenous mechanism--and the best path of privatization, and has widely recognized that although complete state ownership is not optimal, unconditionally pure privatization is also not the best either. But as we have mentioned, all these researches are based on such an assumption as products are homogeneous and substitutable and enterprises are competing--either Cournot or Stackelberg competition--with respect to quantity. Although it greatly simplifies the model and mathematical analysis, it is aberrant from reality. Products of different enterprises are different in quality, performance, after-sale service and brand (credit), so in reality, product heterogeneity is far more prevalent than homogeneity³.

³ If we want to discuss the privatization of SOEs and the development of PEs in an open economy, this point of view seems to be more substantial.

What's more, those quantity competition models based on product homogeneity allude that PEs have already grown up to mature enterprises that have considerable market power against long established SOEs; they can use quantity strategy to influence the behavior of SOEs. Such underlying assumption is unable to reveal PEs' evolution from none to existence and from weak to strong. On the contrary, we suggest a more realistic condition should be that competition between enterprises, more often than not, are price competition but not quantity competition. The intuition is simple as follows. In order for a young PE to survive, it will resort to appropriate pricing strategy to enter and occupy the market, rather than quantity strategy because it is not mature enough to do so. In this process, on the one hand, PEs gradually grow up and become a counterbalance of SOEs. On the other hand, the privatization of SOEs is motivated and facilitated.

For the above reasons, this paper, under the assumption of product heterogeneity and through a thorough investigation of the price competition between SOEs and PEs, tries to reveal the underlying rule of privatization of SOEs, especially the interplay between development of PEs and the privatization of SOEs. This paper is arranged as follows. In the next section, we introduce the model and find the equilibrium of it. In section three, we do comparative static analysis, making use of our basic model. Finally we summarize our work and try to point out efforts left to be made.

2. Basic Model

2.1 Assumptions

We assume that there is a monopolistic SOE in a certain industry and then PEs enter. To simply our analysis, we leave only one PE to represent all the PEs. As reformation of the traditional economy goes on, the central government decides to partially privatize the SOE, allowing private shareholders to hold θ of the SOE's total stocks and leaving $(1-\theta)^4$ of the stocks remaining state-owned. To facilitate the extension of our analysis, we have several following assumptions.

(1) Because of the differences in performance, after-sale service, reputation and other aspects, there is heterogeneity between products of the SOE and the PE. As a

⁴ Although $\theta \in [0,1]$, the meaningful scope for θ in our model should be not too small, or private shareholders will have little impact on the SOE's management and decisions.

result, they compete with each other through price strategy, but not quantity strategy. To denote heterogeneity, we have the following conjecture: if we do not take income effect into account and the price of SOE product is p_1 , when and only when price of PE product (p_2) equals p_1 , consumers are indifferent between the two products. So, $\varepsilon > 0$ reflects the relative advantage of PE products compared to SOE products from consumers' perspective. $\varepsilon < 1$ means that PE products are disadvantageous, while $\varepsilon > 1$ means that PE products are advantageous. $\varepsilon = 1$ is a special case the same with the assumption of product homogeneity, which is prevalent in present literatures.

In a specific period, the value of ε is mainly determined by two factors: the feature of the industry and the maturity of the PE. For products that require little technology, of small value or whose quality is easily verified, such as agricultural products, low-end daily consumptions, non-essential accessories, consumers do not have special preferences towards suppliers. In such industries, PEs have a comparatively big ε ($\varepsilon \rightarrow 1$ or even > 1) at the very beginning of their development. However, as to the products those are technique intensive, of high value or whose quality is hard to observe, such as electronic and mechanical equipments and luxurious goods, there is different scenery. In such industries, evaluation of PE products mainly depends on the history and maturity of the PE, so $\varepsilon < 1$ is common when the PE is young. It's easy to understand because mature SOEs, although inefficient, have advantages in scale and technique, and is supported by the credit of the central government. Besides, consumers are accustomed to SOE products and time is required for them to adjust to PE products.

Grounded on the above cognition, we establish the demand functions for the SOE and the PE as follows:⁵

$$Q_1 = a - p_1 + \varepsilon^{-1} p_2 \quad (1)$$

$$Q_2 = a - p_2 + \varepsilon p_1 \quad (2)$$

In the demand functions, a is a constant and can be perceived as market capacity. It's magnitude is exogenously determined by feature of the industry and the development of national or local economy.

⁵ A rigorous version of the functions should be $Q_1 = a - \alpha p_1 + \beta \varepsilon^{-1} p_2$ and $Q_2 = a - \beta p_2 + \alpha \varepsilon p_1$.

But to simplify our analysis, we just show product heterogeneity in the last term of each function.

(2) As to production costs, we consider the following assumption to be the most general: average cost of the SOE (c_1) is higher than it is of the PE (c_2) because of the property rights problem inborn to the SOE. To reduce mathematical work, we assume that $c_1 = c_2 + t$ and c_1, c_2 both are constants bigger than 0. Obviously $t = t(\theta)$ with $t'(\theta) \leq 0$ ⁶ and $c'_2(Q_2) \leq 0$ are more rigorous, because privatization is the process of changing an SOE to a PE and also the process of PE's development and making use of economies of scale.

It's worthwhile to mention that although our model does not include variables such as fixed investment, c_2 denotes the property of the products and technique in the industry. An industry with higher fixed investment tends to have higher c_2 , and vice versa.

(3) The payoff for each player should now be discussed. We use $U_i (i=1,2)$ to denote the payoff functions for the SOE and the PE respectively. The same with other literature, we assume that the PE is a pure profit maximizer. What's different is that our PE uses pricing strategy but not quantity strategy to compete with the SOE. So the PE's task is to

$$\max_{p_2} U_2 = (p_2 - c_2)(a - p_2 + \varepsilon p_1) \quad (3)$$

What's difficult but critical is how to abstract a payoff function for the SOE and the central government that fits to reality closely. For a partially privatized SOE, although the main-stream “maximizing the weighted average of profit and social welfare” and “pursuit of output maximization constrained by the balance of revenue and cost” emphasized by some economists both sound reasonable to some extent, we believe that pursuit of the maximization of the weighted average of profit and revenue is more rational. The second approach mentioned above is not able to reveal the change of SOEs' behavior in the process of privatization. Moreover, social welfare, which is sum of consumer surplus and producer surplus, seems to be intangible, thus the central government does not have any means to insure that the SOE is pursuing the

⁶ Positive research in Liu Xiaoxuan (2004) finds that state-owned share has a negative influence on the efficiency of the enterprise being reformed, and more state-owned share will offset the positive role of economies of scale.

maximization of social welfare. For the government, checking the SOE's revenue is more realistic and applicable. On one hand, increase in the SOE's revenue provides more taxation to the government and calls for more labor, which helps relieve the pressure of high unemployment rate and maintain a peaceful social environment. On the other hand, managers of SOEs are inclined to increase revenue because this can help them to be more influential, both to the market and the society, and is an east-to-observe signal of how well the manager is doing from the government's perspective. Above all, we describe the SOE's behavior like this:

$$\max_{p_1} U_1 = \theta\pi_1 + (1-\theta) R_1 = (p_1 - \theta c_1)(a - p_1 + \frac{p_2}{\varepsilon}) \quad (4)$$

In the above equation, π_1 is the SOE's profit function while R_1 is its revenue function.

We treat the process of privatization as a perfect information two phase sequential game whose players are the government, the SOE and the PE. In the first phase of the game, the government, as initiator of the reformation, determines the optimal degree of privatization, namely θ^* ⁷. In the second phase, given θ^* , the two enterprises involve themselves in price competition of Bertrand style, leading to equilibrium prices p_1^* , p_2^* and outputs Q_1^* , Q_2^* .

Although the government, especially the central government, is not able to make sure that the SOE maximizes social welfare, it privatizes the SOE from the stance of the society. As representative of the society, the central government chooses the optimal degree of privatization⁸. Now the central government's choice can be depicted

as $\max_{\theta} W = \int_0^{Q_1^*} (a - Q_1 + \varepsilon^{-1} p_2^* - c_1) d(Q_1) + \int_0^{Q_2^*} (a - Q_2 + \varepsilon p_1^* - c_2) d(Q_2)$, where W is social welfare and the government's payoff function. According to demand functions we have $a + \varepsilon^{-1} p_2^* = Q_1^* + p_1^*$, $a + \varepsilon p_1^* = Q_2^* + p_2^*$, so

⁷ We do not choose the model in which the incumbent set price first and the PE later. Generally, SOEs are not allowed to use pricing strategy as a means to stop the entry of PEs in countries that are undergoing market-oriented reformation

⁸ Although some positive researches (Wang Hongling et al, 2001; Guo Kai & Yao Yang, 2004) have found that privatization of SOEs is motivated by financial or budget constraint but not the maximization of social welfare, we notice that all of these researches are investigating the behavior of local governments, but not the central government.

$$W = \int_0^{Q_1^*} (Q_1^* + p_1^* - c_1 - Q_1) d(Q_1) + \int_0^{Q_2^*} (Q_2^* + p_2^* - c_2 - Q_2) d(Q_2) \quad (5)$$

2.2 Equilibrium of The Model

Backward induction is used to solve the Nash-Equilibrium of the game. First, we determine how the SOE and the PE maximize their payoffs through price competition, given degree of privatization θ . Choices of the SOE and the PE being the best means that equations $U_1'(p_1) = 0$ and $U_2'(p_2) = 0$ hold simultaneously, so the equilibrium pricing strategies are:

$$p_1^* = \frac{2a + a\varepsilon^{-1} + 2c_1\theta + c_2\varepsilon^{-1}}{3} = \frac{2a + a\varepsilon^{-1} + 2(c_2 + t)\theta + c_2\varepsilon^{-1}}{3} \quad (6)$$

$$p_2^* = \frac{2a + a\varepsilon + c_1\theta\varepsilon - c_2}{3} = \frac{2a + a\varepsilon + (c_2 + t)\theta\varepsilon - c_2}{3} \quad (7)$$

Equilibrium outputs for the SOE and the PE are as follows.

$$Q_1^* = \frac{2a + a\varepsilon^{-1} - c_1\theta + c_2\varepsilon^{-1}}{3} = \frac{2a + a\varepsilon^{-1} - (c_2 + t)\theta + c_2\varepsilon^{-1}}{3} \quad (8)$$

$$Q_2^* = \frac{2a + a\varepsilon + c_1\theta\varepsilon - c_2}{3} = \frac{2a + a\varepsilon + (c_2 + t)\theta\varepsilon - c_2}{3} \quad (9)$$

Now, we consider the central government's optimal decision concerning the privatization. Put (6) through (9) to (5), we get

$$W'(\theta) = \frac{(c_2 + t)}{3} \left[(c_2 + t)(\varepsilon^2 - 1)\theta + c_2(1 - \varepsilon) + 2a\varepsilon + a\varepsilon^2 + t \right] \quad (10)$$

Let $W'(\theta) = 0$, then

$$\theta^* = \frac{c_2(1 - \varepsilon) + 2a\varepsilon + a\varepsilon^2 + t}{(c_2 + t)(1 - \varepsilon^2)} \quad (11)$$

When $\varepsilon < 1$, $W''(\theta) = \frac{(c_2 + t)}{3} (c_2 + t)(\varepsilon^2 - 1) < 0$, so θ^* determined by (11) is the solution for social welfare maximization. When $\varepsilon > 1$, $W''(\theta) > 0$, so θ^* leads to minimized social welfare and the maximized social welfare should be either $W(\theta = 0)$ or $W(\theta = 1)$. To avoid complexity, we have the following conjecture. If,

compared to the total output when $\theta=0$ (Q_I), total output when $\theta=1$ (Q_{II}) is bigger, then we say that larger social welfare is accomplished because not only are more consumers satisfied but also no fiscal resource is wasted. By straightforward calculation, we get $Q_I - Q_{II} = \frac{(c_2 + t)(\varepsilon - 1)}{3} > 0$. Conclusively, when $\varepsilon > 1$, $\theta^* = 1$ is the optimal degree of privatization that the government should choose. Optimal degree of privatization is influenced by the magnitude of ε , showing the rationality of “classified reformation”. In industries that are competitive, PEs can easily get an ε that is bigger than one, so complete privatization is applicable. But in strategic industries where ε is usually smaller than 1, the schedule and extent of privatization should be carefully meditated.

3 Heterogeneity, Cost, Market and Privatization

To better extend our analysis, we now introduce an introductory proposition.

Proposition 1 If and only if product disadvantage is small enough ($\varepsilon \geq \underline{\varepsilon}$) and cost advantage is big enough ($t \geq \underline{t}$), privatization of the SOE can stimulate the development of the PE ($p_2^* \geq c_2$); besides, $\underline{\varepsilon}$ and \underline{t} are complementary. $\underline{\varepsilon}$ and \underline{t} are negatively correlated with a and θ , but positively correlated with c_2 .

Proof (1) For the PE pursuing profit maximization, only when $p_2^* \geq c_2$ will it enter the market that was formerly occupied by the SOE, so $2a + a\varepsilon + (c_2 + t)\theta\varepsilon - c_2 \geq 0$, which means

$$\varepsilon \geq \underline{\varepsilon} = (c_2 - 2a)[(c_2 + t)\theta + a]^{-1}$$

$$t \geq \underline{t} = (c_2 - 2a - a\varepsilon)(\theta\varepsilon)^{-1} - c_2, (\theta > 0, \varepsilon > 0).$$

To insure that $\underline{\varepsilon} > 0$, there must be $c_2 - 2a > 0$.

(2) Further still, we have

$$\frac{\partial \underline{\varepsilon}}{\partial t} = -(c_2 - 2a)[(c_2 + t)\theta + a]^{-2} < 0 \quad \text{and} \quad \frac{\partial \underline{t}}{\partial \varepsilon} = -(c_2 - 2a)\varepsilon^{-2} < 0.$$

(3) Besides, $\underline{\varepsilon}, \underline{t}$ and a, θ, c_2 are related as below:

$$\partial \underline{\varepsilon} / \partial a < 0, \partial \underline{t} / \partial a < 0 ; \partial \underline{\varepsilon} / \partial \theta < 0, \partial \underline{t} / \partial \theta < 0 ; \partial \underline{\varepsilon} / \partial c_2 > 0, \partial \underline{t} / \partial c_2 > 0.$$

The implication is simple. Given the degree of privatization of the SOE fixed at θ , when and only when product disadvantage is small enough and cost advantage is big enough would the PE be capable of using low--price strategy, enter the market occupied by the SOE and earn some profit to sustain its development. This alludes that the path of the development of the PE is determined by the PE's maturity, the feature of the industry and the degree of privatization of the SOE. We will leave the more detailed and concrete analysis to the following subsections.

3.1 Product heterogeneity and market structure

Proposition 2 At equilibrium, as the disadvantage of the PE's products gets smaller ($\varepsilon \uparrow$), p_2^* and Q_2^* increase while p_1^* and Q_1^* decrease. Besides, small c_2 , large t and θ , can help the PE dominate the market ($Q_2^* > Q_1^*$) with a small ε .

Proof (1) According to (6) through (9), for the SOE, we have

$$\partial p_1^* / \partial \varepsilon = \partial Q_1^* / \partial \varepsilon = \frac{-(a + c_2)\varepsilon^{-2}}{3} < 0 ;$$

for the PE, we have $\partial p_2^* / \partial \varepsilon = \partial Q_2^* / \partial \varepsilon = \frac{a + (c_2 + t)\theta}{3} > 0$.

(2) $Q_2^* > Q_1^*$ means $(c_2 + t)\theta\varepsilon > c_2 \Rightarrow \varepsilon > \frac{c_2}{(c_2 + t)\theta}$. According to

Proposition 1, we get $\varepsilon > \hat{\varepsilon} = \frac{c_2}{(c_2 + t)\theta} > \underline{\varepsilon} = \frac{c_2 - 2a}{(c_2 + t)\theta + a}$. That means

when $\varepsilon > \hat{\varepsilon} = \frac{c_2}{(c_2 + t)\theta}$, $Q_2^* > Q_1^*$

Besides, we can easily see that

$$\partial \hat{\varepsilon} / \partial c_2 > 0, \partial \hat{\varepsilon} / \partial t < 0, \partial \hat{\varepsilon} / \partial \theta < 0.$$

As the quality and credit of the PE's product are improved, its demand will be larger and market power higher, guaranteeing that the can set its price the same as or even higher than the SOE's. The SOE's market share will be taken over by the PE. What's more, the SOE has to lower the price of its product. The SOE is supported by the government and has social functions--for instance, to guarantee a high employment rate, so it tends to resist a lower price and a lower output. However, as

the development of the PE takes place, such anti--market power can no longer stop the PE from eventually dominating the market. If the government can follow this trend, privatize the SOE in time and deaden the anti--market power, the dominance of the PE can come earlier. Moreover, if the PE is greatly advantageous with respect to cost, it can dominate the market sooner, because they are more capable to use low--price strategy (see Proposition 3) to offset its product disadvantage.

3.2 Cost Difference and Market Structure

Proposition 3 At equilibrium, if the cost advantage of the PE is larger, the relative price difference will be higher, Q_1^* will be lower, but Q_2^* will be higher. Besides, if ε and θ are relatively large, a small t can lead to $Q_2^* > Q_1^*$.

Proof (1) First let's see the influence of the PE's cost advantage on equilibrium prices. According to (6) and (7), we have

$$\partial p_1^* / \partial t = \frac{2\theta}{3} \geq 0; \partial p_2^* / \partial t = \frac{\theta\varepsilon}{3} \geq 0.$$

What's more important is that $\partial[(p_1^* - p_2^*) / p_1^*] / \partial t = \frac{\theta(a + c_2)}{3(p_1^*)^2} > 0$.

(2) According to (8) and (9), we have

$$\partial Q_1^* / \partial t = -\frac{\theta}{3} \leq 0 \quad \text{and} \quad \partial Q_2^* / \partial t = \frac{\theta\varepsilon}{3} \geq 0.$$

Further still, $Q_2^* > Q_1^* \Rightarrow (c_2 + t)\theta\varepsilon > c_2 \Rightarrow t > \hat{t} = \frac{c_2}{\theta\varepsilon} - c_2$.

It can be easily testified that $\partial \hat{t} / \partial \theta < 0$ and $\partial \hat{t} / \partial \varepsilon < 0$.

This proposition tells us that if the disadvantage of the SOE's cost is bigger, the SOE product will be priced higher and leads to a lower demand. In that case, the PE product can be priced higher and this does not stop the PE from using aggressive low price strategy to get a larger market share and a higher profit. As long as the PE's cost advantage is big enough, its low price strategy will result in the PE's domination of the market. Certainly, if the PE's product disadvantage is relatively small, or if the central government does not support the SOE to a great extent, the PE does not have to price very low to dominate the market and the cost advantage that is required when

using the low price strategy will be smaller.

3.3 Market Capacity and Market Structure

Proposition 4 As market capacity a is enlarged, equilibrium prices and outputs $p_1^*, p_2^*, Q_1^*, Q_2^*$ tend to increase; besides, if the PE product is advantageous to the SOE product, the PE's price and output have a bigger momentum to increase than the SOE's.

Proof According to (6) through (9), we have

$$\partial p_1^* / \partial a = \partial Q_1^* / \partial a = 1/\varepsilon + 2 > 0 \quad \text{and}$$

$$\partial p_2^* / \partial a = \partial Q_2^* / \partial a = 2 + \varepsilon > 0.$$

Furthermore, when $\varepsilon > 1$, $\partial p_2^* / \partial a = \partial Q_2^* / \partial a > \partial p_1^* / \partial a = \partial Q_1^* / \partial a$.

This conclusion is quite straightforward. When market demand increases, any enterprise is motivated to raise price and supply to get more profit. The PE that is a pure profit maximizer is more apt to do so than the SOE because the SOE also bears some policy burden. However, when the evaluation of the PE's product is lower than the SOE's, the PE must curb such motivation to make sure that its market share is extended effectively. It also means that if the market demand is high while PEs have not entered or are not mature, the SOE can still have good performance.

3.4 Extension of Proposition 1--4

As a summarization of Proposition 1 through 4, we see that factors, including large enough market capacity (a) and cost advantage (t), low demand for advanced technique and investment (small c_2), and small product disadvantage (big ε) are necessary conditions for the development of a PE, because they make the PE capable of using low--price strategy to enter the market and accumulating sufficient capital in a short time.

According to Proposition 1 to 4, we can also get the following important inferences.

1 An important reason for the fast development of Chinese PEs is that Chinese

economy is endowed with a large potential domestic market because of its large population, a condition that other transforming countries do not have. It's true that only when the potential market becomes real market because of the raise in income per capita can PEs get real and fast development. That's why PEs are active and mature in areas that have a concentrated population and a high-level economy before the reformation.

2 At the beginning of their development, PEs had better not choose industries that are capital and technique intensive, because in such industries ε and t are small while c_2 is large. As a result, it's natural that initially PEs are clustering in industries that are of low investment scale and low demand for credit (such as daily services and consumption). In such industries, PEs can become dominant in a short time.

3 At the beginning of development, producing “fake products” seems to be a rational choice for PEs because such strategy increases ε and t but leads to a lower c_2 . However, when a PE gets more mature, such strategy will be dropped because it can never increase the consumers' evaluation of the PE product or make ε bigger than 1.

4 Generally speaking, the development of PEs is featured by acceleration. At the beginning, although a PE has a cost advantage, it is not fully accepted by the market and is forced to stay in low-end industries, relying on low-price strategy for survival. What's more, initially the national economy as a whole is of low level, so a PE grows up slowly in its youth. As the PE accumulates more capital and more advanced technique, its brand and credit are enhanced and even surpass those of the SOE's, it will develop at a much higher speed than before and dominate more markets. Now it's easy for us to explain such phenomenon as that although PEs in China appeared in the beginning of the 1980s, they didn't have great achievements until mid 1990s. But we should also pay attention to the increase of the SOE's efficiency in the reformation, which implies that it's not that easy for PEs to dominate a market.

3.5 Privatization and market structure

Proposition 5 As degree of privatization goes up, p_1^*, p_2^* increase; although Q_2^* increases, total output ($Q_1^* + Q_2^*$) will decrease unless $\varepsilon > 1$.

Proof (1) First let's see the influence of θ on prices. According to (6) and (7), we have $\partial p_1^* / \partial \theta = \frac{2(c_2 + t)}{3} > 0$, $\partial p_2^* / \partial \theta = \frac{(c_2 + t)\varepsilon}{3} > 0$.

(2) The influence of θ on the SOE's output is $\partial Q_1^* / \partial \theta = -\frac{(c_2 + t)}{3} < 0$; for the PE, we have $\partial Q_2^* / \partial \theta = \frac{(c_2 + t)\varepsilon}{3} > 0$. Total equilibrium output follows

$$\partial(Q_1^* + Q_2^*) / \partial \theta = -\frac{(c_2 + t)(1 - \varepsilon)}{3} \begin{cases} < 0, \text{当 } \varepsilon < 1 \\ > 0, \text{当 } \varepsilon > 1 \end{cases}$$

The reason for this proposition is as follows. In traditional economy, the SOE bears policy burden--insure a high urban employment rate, and increase social welfare--which leads to a low price and a high output that are not consistent with production cost, a problem called overproduction because $MC > MR$. As the degree of privatization increases and pursuit of profit is more emphasized, social welfare is attached less importance, so it's natural that the SOE will produce less and price higher. Under such condition, the PE is allowed to raise price and the necessity of a low-price strategy to resist the SOE's anti--market power is weakened. Besides, this new pricing strategy will lead to higher output and profit for the PE. When the PE is not mature and its product is not advantageous enough, the decrease of the SOE's output may not be offset by the increase of the PE's output, so the total output may decrease at first.

As we see, it's natural that certain “stagflation” appears in the process of privatization of SOEs. If we reform gradually, the stagflation will be moderate and is good to the development of PEs and the whole economy, and ultimately will lead to a lower price. Because $\theta \uparrow \rightarrow (p_1^* - c_2) \uparrow$, more PEs will be attracted to the industry. Besides, taking the more realistic condition of $t'(\theta) < 0$ into account, we can see that a higher θ leads to a lower t , which will make all enterprises bring down their prices (see proposition 3).

This proposition not only shows the rationality of “the system of dual price tracks” and the necessity to privatize SOEs at a proper time, but also implies how dangerous a “big bang” reformation--to make θ from 0 to 1 in a very short time--is. Initially PEs only exist in low-end industries and are of low scale. “Big bang” reformation results in SOEs that are pure profit maximizers and monopolists,

whose rational choice is to reduce output and raise price to a considerably high level. Such completely privatized SOEs are inclined to take actions to stop PEs from entering, making use of their technology advantage and first--move advantage, being a *market* power hazardous to the development of PEs and the whole economy.

3.5 Optimal Path for Privatization

We have shown that when $\varepsilon < \underline{\varepsilon}$ and $t < \underline{t}$, social welfare will not be improved immediately after privatization, because no PE will enter (see Proposition 1). Moreover, a “big bang” reformation is more hazardous (see Proposition 5). Whereas, the central government should treat the process of privatization very cautiously and choose a proper opportunity or, so called path.

In subsection 3.1, we have shown that if $\varepsilon < 1$, $\theta^* = \frac{c_2(1-\varepsilon) + 2a\varepsilon + a\varepsilon^2 + t}{(c_2+t)(1-\varepsilon^2)}$ is

the optimal degree of privatization, but θ^* should be 1 if $\varepsilon > 1$. Now we further investigate the determination of optimal degree of privatization.

Proposition 6 If $\varepsilon < 1$, optimal degree of privatization θ^* is negatively related to c_2 , but positively related to market capacity a .

Proof (1) If $\varepsilon < 1$, $\frac{d\theta^*}{dc_2} = \frac{-2a\varepsilon - a\varepsilon^2 - t}{(c_2+t)^2(1-\varepsilon^2)} < 0$.

(2) If $\varepsilon < 1$, $\frac{d\theta^*}{da} = \frac{\varepsilon + \varepsilon^2}{(c_2+t)(1-\varepsilon^2)} > 0$.

Higher c_2 leads to higher p_1^* and p_2^* , because of

$$\frac{dp_1^*}{dc_2} = \frac{2\theta + \varepsilon^{-1}}{3} > 0, \quad \frac{dp_2^*}{dc_2} = \frac{\theta\varepsilon + 2}{3} > 0.$$

To escape the negative influence of higher prices on consumer surplus, the government should slow down the privatization. On the contrary, if market capacity a is enlarged, the process of privatization should be speed up to make sure that potential market capacity is exploited and potential consumers are saturated.

The fact that we can not definitely determine the influence of ε and c_2 on optimal degree of privatization makes us fully realize the complexity of privatization and the necessity of different privatization policies for different industries. Gradual reformation is supported because of the inefficiency of reformation policies that threat all industries equally without any discrimination. There are so many factors influencing the determination of optimal degree of privatization that the government can only find the best scheme for privatization by continuously making mistakes and adjustments.

Proposition 7 When $t > \underline{t}$, there is a minimum $\bar{\varepsilon} (< 1)$ to make $\theta^* = 1$; When $\underline{\varepsilon} < \varepsilon < 1$, there is a minimum \bar{t} that leads to $\theta^* = 1$.

Proof (1) According to (11), we have

$$\theta^* = \frac{c_2(1-\varepsilon) + 2a\varepsilon + a\varepsilon^2 + t}{(c_2+t)(1-\varepsilon^2)} \leq 1.$$

If $\varepsilon < 1$, it can be written as $\Gamma = c_2(1-\varepsilon) + 2a\varepsilon + a\varepsilon^2 + t - (c_2+t)(1-\varepsilon^2) \leq 0$ (when and only when $\Gamma = 0$, $\theta^* = 1$). Because $\theta^* = 1$ and $\Gamma(\varepsilon = 1) > 0$, there is a minimum $\bar{\varepsilon} (< 1)$ making $\theta^* = 1$.

By the same logic, we can prove the contention concerning \bar{t} .

The economic implications of Proposition 7 are also very straightforward. As the PE becomes more cost advantageous and product advantageous, it would hinder the improvement of social welfare if we maintain the SOE's former ownership and operation style. Under such condition, complete privatization will not do any harm to consumer surplus, and what's more, will relieve the government's fiscal burden to compensate the SOE's net loss.

Industries are different in their attributes. In different industries, PEs' cost advantage and product advantage are not the same. Proposition 5, 6 and 7 warn us again that privatization of SOEs is a process that should be finished gradually. A reformation policy that treats all SOEs equally indeed is not a rational approach.

4 Conclusions

Chinese economy is fast developing, drawing attention from economists all over the world. The reformation of SOEs has become a feature of transforming China. In this paper, our investigation of the privatization of SOEs is based on the assumption of product heterogeneity and price competition. We analyze the impact on domestic market and economy of the price competition between a partially privatized SOE and a PE and reveal a basic principle: there is a positive mutual relationship between the

privatization of SOEs and the development of PEs. On one hand, the development of PEs facilitates the privatization of SOEs. The development of PEs not only motivates the privatization of SOEs, but also eases the torment in the process of privatization by providing enough products and creating jobs for the society. On the other hand, the privatization of the SOE helps to construct an economic environment that is market oriented, which is a catalyst to the development of PEs.

Another contribution of this paper is that we have verified that the degree of privatization should be determined according to how much PEs have developed. Different privatization strategies should be applied to different SOEs because they are in different industries and local economies and are faced with competition from different PEs. On the contrary, a reformation policy that treats all SOEs equally is against the general principle. What's worse is the “big bang” reformation, because it inevitably results in serious stagflation.

In a word, this paper not only gets the main achievements that were obtained by researches assuming quantity competition, but also reaches some new meaningful conclusions. This does not mean that we have completely cracked all the flaws existing in literatures. Although our assumption of product heterogeneity and price competition is more realistic compared to other models, it still has some deficiencies. In reality, especially at the beginning of privatization, SOEs do not have the discretion to price their own products, neither can they determine how many to produce. Secondly, although we accept the widely used duopoly model, this may exaggerate the PE's role, especially at the beginning of its development. Lastly, although we believe that our model can be extended to the open economy case, we only discuss the privatization of SOEs and the development of PEs in a closed economy. Besides, cost functions and payoff functions for the SOE and the PE should be reconsidered to be more accurate and realistic.

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