

Foreign Ownership, Privatization and Strategic Industrial Policy in a Free-Entry Cournot Oligopoly

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Abstract

In this paper, we show that under mixed oligopoly and free market entry, the government's output subsidies are positive and will not be affected by foreign holdings; however, under complete privatization and free market entry, the government needs to collect a production tax due to excessive market entry. We further demonstrate that the social welfare with privatization will be lower than that without privatization regardless of the shareholding of foreign owners in the free entry equilibrium. This result implies that when the market is completely free and open, it is necessary for state-owned enterprises to enter the market to ease excessive market competition.

Keywords

Mixed Oligopoly, Subsidization, Privatization, Free Entry, State-Owned Enterprises (SOEs)

1. Introduction

Since China carried out economic reforms in 1978, the reform of state-owned enterprises (SOEs) has been one of the most important issues. The reform path of SOEs can be divided into the big-bang reforms adopted by the Soviet Union and Eastern Europe, and the gradual reforms adopted by China. The big-bang reform advocated complete price liberalization at one time, and the literature pointed out that this would lead to the emergence of monopolies in the state-owned sector, causing output to fall sharply due to the monopoly of SOEs. (Koford et al., 1993; Ross, 1994; Zhou, 1994)

Zhou (1997) believed that under China's gradual reform, the government re-

serves the right to decide on planned quotas and planned prices while allowing state-owned enterprises to sell excess production in the market, which will make gradual reforms better than big-bang reforms. [Naughton \(1994\)](#) pointed out that the formation of emerging economies and the rapid entry of non-state-owned enterprises are examples of successful economic transitions in socialist countries, while [Huang and Lee \(2000\)](#) indicated that the increase of non-state-owned enterprises eventually led to the successful transformation of the dual-track economy into a market economy.

Since 2002, China has established a state-owned asset management system, and the central and local governments have successively established state-owned asset management agencies to supervise state-owned enterprises on behalf of the state as investors. In 2007, China Investment Co., Ltd. was established to conduct supervision work on behalf of the country through the controlling shareholder of financial institutions and to operate the corporate governance model of the company's board of directors, thereby attempting to improve the dilemma of the poor operating efficiency of SOEs and develop the economy towards a modern corporate system.

As China joined the WTO at the end of 2001, the domestic market had to be greatly opened to foreign participation, so foreign holdings of Chinese corporate equity and large numbers of private companies entering the market were therefore bound to have an impact on the government's industrial policies. On February 25, 2005, the State Council of China issued "Several Opinions on Encouraging, Supporting and Guiding the Development of Individual and Private Enterprises and Other Non-public Ownership Economy", which significantly eased market entry for private sectors of the economy ([The State Council of PRC, 2005](#)). In the theory of privatization, with the entry of private firms, the degree of privatization of state-owned enterprises will gradually increase, while at the same time, government subsidies to the market will gradually decline. Eventually, state-owned enterprises are completely privatized or withdrawn from the market, which is called "the private sector advances, the state sector retreats" in the literature. Most privatized or partly privatized state-owned enterprises have improved efficiency to a certain extent, increased profits, and created higher corporate value ([Megginson & Netter, 2001](#)).

However, more than 150 A-share listed companies in China changed ownership in 2019, and at least a quarter of them was nationalized, such as GREE ELECTRIC APPLIANCES, INC. Compared with the 99 companies in 2018, the number of companies that changed ownership increased by more than 50%. These private enterprises that were forced to sell to "state-owned assets" have a total market value of nearly 220 billion yuan ([UDN News, 2020](#)). "The state sector advances, the private sector retreats" has become a focus of recent policy research.

Based on the above background, this study explores the influence of foreign ownership on privatization and industrial policies (output subsidies or output taxes) under restricted and free-market entry respectively.

The rest of this paper is organized as follows. The literature review is provided in Section 2. The basic frameworks are outlined in Section 3; Section 4 provides the analysis of output subsidy policies and welfare comparison under entry restriction. Section 5 provides the analysis under free entry, while Section 6 concludes the paper.

2. Literature Review

The literature touching upon the theoretical analysis of privatization has proliferated from De Fraja and Delbono (1989), Bös (1991), Brandão and Castro (2007), Matsumura (1998), Matsumura and Kanda (2005), to Wang and Chen (2010), because of the wave of privatization emerging in various countries since the 1980s. De Fraja and Delbono (1989) pointed out that the social welfare might be increased by privatizing the welfare-maximizing public firms. Matsumura (1998) explicitly demonstrated that a partial privatization policy may be the best for the social welfare and Huang et al. (2006) showed that the optimal degree of privatization depends on the relative productive efficiency and the number of private firms. Matsumura and Kanda (2005) emphasized that the viewpoint of welfare in partial privatization as recommended might be another option to regulate the free entry of the market and avoid the problems of excess entry. The optimal policy is that the public firm holds the nationalization in the long-term equilibrium.

Wang and Chen (2010) indicated that due to a cost-efficiency gap between public and private firms in a mixed oligopoly, it is better to use privatization in foreign competition. Wang and Chen (2011a) suggested that without considering optimal subsidy (tax) policy and deregulated entry of private firms, it is better for the government to increase the degree of privatization in the multinational firms thereby leading to an increase in the profit and social welfare for all domestic private firms in the short-run. Likewise, Cato and Matsumura (2012) investigated the influence of privatization policy on foreign ownership towards domestic market and proved that the level of privatization is rising in the shareholding of foreign owners in the long-term equilibrium. The perspectives of the above two papers mentioned that open-capital market and privatization policy are complementary, no matter whether entry barriers exist or not, in entering or exiting the market. Even the welfare may decrease temporally, and the open capital market is still better off to have more privatized firms. This author has determined that the above papers did not consider the influence of the government's industrial policy with free entry on the privatization of the public firm.

Concerning the literature on subsidization in mixed oligopoly, White (1996) demonstrated that under both mixed and private oligopoly, the equal subsidy rate yields the first-best outcome in his quantitative competition setting. Numerous papers show that regardless of privatization in a mixed oligopoly, the government can use subsidies to ensure the best results (Fjell & Heywood, 2004; Tomaru, 2006; Kato & Tomaru, 2007; Hashimzade et al., 2007; Tomaru & Saito, 2010; Wang & Chen, 2011b; Tomaru & Matsumura, 2013, 2015). Lee and Wang

(2018) examined how the excess burden of taxation and foreign competition in a mixed oligopoly will affect optimal policy on privatization in the presence of strategic subsidy (tax); the government may switch to using output tax coupled with partial privatization and tariff to improve the social welfare, if the taxation burden is relatively large. Tomaru and Wang (2018) pointed out that privatization plays a supplementary role in enhancing social welfare by further improving the technology of the privatized firm and adjusting the production allocation. Chen et al. (2019) determined that the effect of foreign ownership on the degree of privatization and subsidy rate are dependent upon the number of firms as well as policy mix. Recently, Sun et al. (2022) explain the difference between indirect tax and production tax in mixed market.

The above literature has provided important implications on how government should execute subsidization and privatization policy in a closed-economy mixed market; however, in some markets such as airline, oil, internet telecom and banking industries, public firms compete against foreign firms as well as domestic private firms. Beside the open-door policy in product markets, we have observed many mixed industries and found that capital liberalization is a global trend in recent years. It increases the willingness for domestic investors and foreign investors to own domestic private firms. Foreigner investors play an important role in mixed markets. Matsumura and Tomaru (2012) showed that the government is better off to privatize the public firm under two situations: 1) the entry of private firms is regulated, and 2) when the shareholding of the foreign owners is not mature under the optimal subsidy (tax) policy. Wang and Lee (2013) proved how the firm's move orders impact on the social efficiency in the presence of free entry and foreign ownership under a mixed oligopoly market. In particular, they found that the private followers' entry will lead to a higher social welfare and lower consumer surplus when the shareholding of the foreign owner is small; on the other hand, when there is no entry in the market, the profit of the incumbent nationalized firm is higher. Furthermore, they found that excessive entry exists under public leadership no matter what the degree of foreign ownership is. The author believes that this finding has important implications on making policies on industrial and market-opening¹.

The welfare meanings of public policies in non-entry markets versus free-entry markets² are dramatically different. This paper extends the previous analysis using a four-stage game to probe into how the government determines output subsidy and how it will affect the privatization and market opening policy aiming

¹In an influential work, Mankiw and Whinston (1986) showed that in an oligopolistic market with homogeneous products and scale economies, entry of firms may decrease the social welfare, thus providing the rationale for anti-competitive entry regulation in certain markets. The reason for "excessive entry" in their work is the business-stealing effect of entry. For more works on the so-called "excess entry theorem", see for example, Okuno-Fujiwara and Suzumura (1993), Ghosh and Morita (2007), Mukherjee and Mukherjee (2008), Mukherjee (2012), and Wang et al. (2014).

²See Lahiri and Ono (1995), Etro (2006, 2007, 2008, 2011, 2014), Davidson and Mukherjee (2007), Ghosh and Morita (2007), Wang and Chen (2010), Ino and Matsumura (2010, 2012), Wang and Lee (2013), Wang et al. (2014), Matsumura and Okumura (2014).

for the social welfare maximization of the host country³. In stage one, the privatization policy is based on social welfare maximization; in stage two, the optimal output subsidy is determined under the premise of social welfare maximization; in stage three, firms are in Cournot competition to determine the output given unit output subsidy. We assume that under entry restriction, the number of private firms is fixed, while in free entry, private firms stop to enter the market with zero profits in the free entry equilibrium. We show that the optimal output subsidy under nationalization will be higher than that under privatization when the shareholding of foreign owners is relatively large between zero and one, but when the shareholding of foreign owners is zero or one, the government's privatization policy will not affect its optimal output subsidy (privatization neutrality theorem holds). We further demonstrate that free entry will make market competition intensive, even over-crowded on the premise that the shareholding of foreign owners is low. Privatization will instead reduce the social welfare. However, the foreign investors can share some fixed cost caused by free entry if the shareholding of foreign owners is relatively higher. The social welfare will be increased after privatization.

3. The Model

One public firm and n private firms is the typical situation in a domestic product market as in [Matsumura and Tomaru \(2012\)](#), [Cato and Matsumura \(2012\)](#), and [Wang and Lee \(2013\)](#). The shareholding of foreign owners for each private firm is denoted by α . Products produced by all the firms are homogeneous and all engage in Cournot competition. It is assumed that the (inverse) demand function is $P = a - Q$, where a denotes market scale and P represents the market price. The aggregate output is expressed as $Q = q_0 + \sum_{i=1}^n q_i$, where q_0 and q_i respectively stands for the production of the public and the private firms. As in [Wang and Chen \(2010, 2011a, 2011b\)](#), and [Matsumura and Tomaru \(2012\)](#), the cost of production for the public firm and the private ones, both increasing marginal cost functions⁴, are quadratic forms $C(q_0) = q_0^2/2 + f$ and $C(q_i) = q_i^2/2 + f$ respectively, where f denotes the fixed cost for market entry, assuming that the government subsidizes the public firm and private ones, each production unit with subsidy rate s .

The profit function of public and private firms is expressed as the following:

$$\pi_0 = (a - q_0 - nq_i + s)q_0 - q_0^2/2 - f \quad (1)$$

$$\pi_i = (a - q_0 - nq_i + s)q_i - q_i^2/2 - f, \quad i = 1, 2, \dots, n \quad (2)$$

³Instead of only looking at the implications of tariff under free entry, [Matsumura and Okumura \(2014\)](#) revisited the classic discussion of the comparison between tax and quota in a free-entry Cournot oligopoly without foreign penetration. They found that tariff-quota equivalence does not hold and tariffs dominate quotas in the free entry market because quotas can increase the number of entering firms and increase the loss caused by excessive entries.

⁴In [De Fraja and Delbono \(1989\)](#) and many other papers, increasing marginal cost functions are assumed for both public and private firms.

The domestic social welfare is expressed as follows:

$$W = CS + \pi_0 + (1 - \alpha) \sum_{i=1}^n \pi_i - sQ \quad (3)$$

where $CS = Q^2/2$ denotes consumer surplus, and α ($0 \leq \alpha \leq 1$) indicates the fraction of foreign ownership of private firms. If $\alpha = 0$, we consider the private firm is thoroughly owned by domestic investors; on the other hand, if $\alpha = 1$, this private firm could be regarded as a foreign firm because no private firm's profit is accumulated as domestic social welfare. As described in Matsumura and Tomaru (2012), if $0 \leq \alpha \leq 1$, 100α percent of firm i 's profit is taken away by foreign investors; $100(1 - \alpha)$ percent of firm i 's profit is attributed to domestic residents.

This paper uses a four-stage game to probe into how the government determines subsidization and privatization policies. A backward induction method is used to solve the equilibrium outcomes.

4. Privatization and Industrial Policy with Entry Restriction

In a market with one public firm and n domestic private firms, we will first examine the government's output subsidy policies and privatization under entry restriction.

4.1. Mixed Oligopoly with Entry Restriction

The number of private firms is fixed under entry restriction. In the third stage, the outputs for the public and the private firms are obtained by partially differentiating Equations (2) and (3) with respect to q_i and q_0 , and the first-order conditions are:

$$q_0 = \frac{a(2 + n\alpha) - ns(1 - \alpha)}{4 + n + n\alpha} \quad (4)$$

$$q_i = \frac{a + 2s}{4 + n + n\alpha}. \quad (5)$$

Lemma 1: *When the shareholding of foreign owners is increasing, the output of the private firms is decreasing, but the output of the public firm and total output are increasing.*

Proof:

$$\frac{dq_0}{d\alpha} = \frac{n(2 + n)(a + 2s)}{(4 + n + n\alpha)^2} > 0, \quad \frac{dq_i}{d\alpha} = -\frac{n(a + 2s)}{(4 + n + n\alpha)^2} < 0, \text{ and}$$

$$\frac{d(q_0 + nq_i)}{d\alpha} = \frac{2n(a + 2s)}{(4 + n + n\alpha)^2} > 0.$$

The output decision of public firm and private firms is strategic substitution. While the shareholding of foreign owners is increasing, due to the profit of the private firms flowing out more, the public firm will produce more to enhance the social welfare.

Substituting Equations (4) and (5) into Equation (3) and then differentiating

with respect to s , the government's optimal subsidy is obtained:

$$s^{MR} = \frac{a(2 - \alpha(6 - n + n\alpha))}{2(2 + n + 6\alpha + n\alpha^2)} \quad (6)$$

where MR denotes mixed oligopoly with fixed number of private firms.

According to Matsumura and Tomaru (2012), because $s^{MR}(\alpha = 0) > 0$ and $s^{MR}(\alpha = 1) < 0$, the government's optimum output subsidy may be negative if the private firms are fully owned by foreign investors; that is, output tax is levied under entry restriction.

$$\text{From Equation (6), we get } s^{MR} \geq 0 \text{ iff } \alpha \leq \alpha^{MR} \equiv \frac{\sqrt{36 + (n-4)n} - 6 + n}{2n}.$$

When the shareholding of foreign owners goes beyond a critical value, the government will levy output tax. Otherwise, the government will provide output subsidy.

Profit shifting arises when foreign owners hold the equity shares of any domestic private firms. On one hand, when the shareholding of foreign owners is sufficiently high, positive output subsidies may reduce domestic social welfare, so the officials should levy output taxes. On the other hand, when the shareholding of foreign owners is not high, the officials will provide positive subsidies to firms in order to correct the production insufficiency in mixed oligopoly market.

Substituting Equation (6) into Equations (1) and (3), we have the following equilibrium outcomes:

$$\begin{aligned} q_0^{MR} &= \frac{a(2 + \alpha(6 + n + n\alpha))}{2(2 + n + 6\alpha + n\alpha^2)}, \quad q_i^{MR} = \frac{a}{2 + n + 6\alpha + n\alpha^2}, \\ Q^{MR} &= \frac{a(2 + 6\alpha + n(2 + \alpha + \alpha^2))}{2(2 + n + 6\alpha + n\alpha^2)}, \quad P^{MR} = \frac{a(2 + (6 - n(1 - \alpha))\alpha)}{2(2 + n + 6\alpha + n\alpha^2)}, \\ \pi_0^{MR} &= \frac{a^2(6 - \alpha(6 + n + n\alpha))(2 + \alpha(6 + n + n\alpha))}{8(2 + n + 6\alpha + n\alpha^2)^2} - f, \\ \pi_i^{MR} &= \frac{3a^2}{2(2 + n + 6\alpha + n\alpha^2)^2} - f, \\ CS^{MR} &= \frac{a^2(2 + 6\alpha + n(2 + \alpha + \alpha^2))^2}{8(2 + n + 6\alpha + n\alpha^2)^2}, \\ W^{MR} &= \frac{1}{4}a^2 \left(1 + \frac{n}{2 + n + 6\alpha + n\alpha^2} \right) - [n(1 - \alpha) + 1]f. \end{aligned}$$

4.2. Pure Oligopoly with Entry Restriction

Assuming the public firm is completely privatized under entry restriction, and the number of private firms is fixed. Thus, $n + 1$ private firms exist in the mar-

ket. First, differentiate Equation (2) with q_i and make it zero. The output of each firm is obtained:

$$q_i = \frac{a+s}{3+n} \quad (7)$$

Substituting Equation (7) into Equation (3) and differentiating it with s , we get the optimal output subsidy:

$$s^{PR} = \frac{a(1+n-3n\alpha)}{2+n(3+n+3\alpha)} \geq 0 \quad (8)$$

where PR denotes pure oligopoly with fixed number of private firms.

Likely, the sign of s^{PR} is either positive or negative. We infer that the government's optimal output subsidy may be negative under entry restriction; that is, output taxation.

This result indicates that whether the government subsidizes or levies taxation after privatization depends on how many equity shares of n private firms is held by foreign investors. The economic explanation is similar to Lemma 1, but, the critical value of equity shares held by foreign investors goes up or down based on intensity of market competition. When the public firm is privatized, its production quantity will shrink. If the number of existing private firms is not enough, then market competition is insufficient. The critical value for the government to subsidize will increase. Given other things being equal, the government tends to take subsidy policy to replenish production insufficiency resulting from insufficient market competition.

Substituting Equation (8) into Equations (2) and (3), we have the following equilibrium outcomes:

$$q_0^{PR} = q_i^{PR} = \frac{a(1+n)}{2+n(3+n+3\alpha)}, \quad Q^{PR} = \frac{a(1+n)^2}{2+n(3+n+3\alpha)},$$

$$P^{PR} = \frac{a(1+n+3n\alpha)}{2+n(3+n+3\alpha)},$$

$$\pi_0^{PR} = \pi_i^{PR} = \frac{3a^2(1+n)^2}{2(2+n(3+n+3\alpha))^2} - f, \quad CS^{PR} = \frac{a^2(1+n)^4}{2(2+n(3+n+3\alpha))^2},$$

$$W^{PR} = \frac{a^2(1+n)^2}{2(2+n(3+n+3\alpha))} - f[1+n(1-\alpha)].$$

We compare the optimal subsidy in mixed oligopoly and that in pure oligopoly under entry restriction:

$$s^{MR} - s^{PR} = \frac{a\alpha(n(3+n-(2+n)\alpha+3\alpha^2)+n(2(7\alpha-5))-24)}{2(2+n+6\alpha+n\alpha^2)(2+n(3+n+3\alpha))}$$

As shown in [Matsumura and Tomaru \(2012\)](#), s^{PR} could be either positive or negative under entry restriction. Not only in mixed oligopolies, but in pure ones also, the output level of each firm is too low; thus, the officials need to raise sub-

sidy rates so as to stimulate the output level of private firms. In other words, a higher α increases the outflow of surplus to foreign investors, which declines domestic social welfare. The latter effect becomes more significant when α is getting larger; thus, s^{PR} is decreasing in α . There is an additional distortion effect appearing in mixed oligopoly where the public firm increases the output when α is larger, which results in a further reduction of the output in private firms. In order to lighten the welfare loss caused by output-reduction of private firms, the officials need to raise s . Since the total output in mixed oligopoly is larger than the total output in pure oligopoly, we have that $s^{PR} > s^{MR}$.

4.3. The Decision on Whether to Privatize with Restriction

It remains for us to find whether the government should privatize the domestic public firm or not.

We compare the welfare levels before and after the privatization:

$$W^{MR} - W^{PR} = \frac{a^2 n \alpha^2 (18 - n - n^2 + 3n\alpha)}{4(2 + n + 6\alpha + n\alpha^2)(2 + n(3 + n + 3\alpha))}. \quad (9)$$

Lemma 2 (Matsumura & Tomaru, 2012):

(i) *In the absence of foreign ownership, whether the government should adopt privatization policy depends on no effect on welfare levels (privatization neutrality theorem);* (ii) *Under entry restriction, whether the government should adopt privatization policy depends on the equity shares held by foreign investors.*

Proof:

(i) $\alpha = 0$, $W^{MR} = W^{PR}$.

(ii) $W^{MR} - W^{PR} \geq 0$ iff $\alpha \geq \bar{\alpha} \equiv \frac{n^2 + n - 18}{3n}$.

Lemma 2 (i) confirms the validity of the so-called privatization neutrality theorem without foreign ownership. **Lemma 2** (ii) is the same as the finding in [Matsumura and Tomaru \(2012\)](#) without allowing free entry of private firms. Given a fixed number of private firms in the market, the higher the shareholding of foreign owners, the lower the production after privatization. Though private firms' profits thus increase after privatization, the profit-shifting effect is also enhanced resulting from a higher foreign investors' equity share. This increased profit cannot make up the loss of both profit shifting and consumer surplus due to the decreases in total production. Therefore, privatization is harmful to social welfare enhancement.

5. Privatization and Industrial Policy with Free Entry

In a market with one public firm and n domestic private firms, we will first examine the government's output subsidy policies and privatization under free entry.

5.1. Mixed Oligopoly with Free Entry

We next turn to the case in the presence of private firms free entry. For this

purpose, we consider the following stage game: in the first stage, the government sets the subsidy rate, private firms decide whether they enter or not in the second stage, and firms in the market choose their outputs in the third stage. In this game, private firms with free entry meet the condition of zero profit in the equilibrium. Substituting Equations (4) and (5) into Equation (2), the equilibrium number of private firms in the long run is:

$$n^{MF} = \frac{\sqrt{6}(a+2s) - 8\sqrt{f}}{2\sqrt{f}(1+\alpha)} \quad (10)$$

where MF denotes mixed oligopoly with free entry of private firms. It would be natural to presume that private firms enter the market even if the government provides no subsidies to them, so we assume that $8\sqrt{f} < \sqrt{6}a$, provided that market scale is large enough. This assumption implies that $n^{MF} > 0$ if the government does not impose a large amount of taxes.

Note that the number of domestic private firms increases with s and decreases with α when the government does not impose taxes. Indeed,

$$\frac{\partial n^{MF}}{\partial s} = \frac{\sqrt{6}}{(1+\alpha)\sqrt{f}} > 0, \quad \frac{\partial n^{MF}}{\partial \alpha} = \frac{8\sqrt{f} - \sqrt{6}a - 2\sqrt{6}s}{2\sqrt{f}(1+\alpha)^2} < 0. \quad (11)$$

The former can be easily explained by reductions in effective marginal costs of private firms. On the other hand, the latter is a special feature in our model. As observed from Equations (4) and (5), the public firm becomes more aggressive as the fraction of foreign ownership α increases. Accordingly, the price is decreased, so that it falls short of each private firm's average cost if the number of private firms remains unchanged. Therefore, some of the private firms exit the market.

Substituting Equation (10) into Equation (3) and differentiating it with s , the optimal output subsidy under free entry is obtained:

$$s^{MF} = \frac{\alpha(1-\alpha)(3a - 4\sqrt{6}\sqrt{f})}{6(1+\alpha^2)} \geq 0, \quad (12)$$

where the second-order condition is satisfied and $s^{MF} < \bar{s}$.

$$\frac{ds}{d\alpha} = \frac{(3a - 4\sqrt{6}\sqrt{f})(1-\alpha(2+\alpha))}{6(1+\alpha^2)^2} < 0, \text{ if } \alpha > \sqrt{2} - 1.$$

Notice that from Equation (12), s^{MF} is zero if $\alpha = 1$, the private firm could be regarded as a foreign firm because no private firm's profit is accumulated as domestic social welfare. If $\alpha = 0$, and also $s^{MF} = 0$, the private firm is owned by domestic investors and subsidy is not needed because entry is excessive. However, when α is increasing from zero, the output subsidy is increasing to attract entry of the firm, while when α exceeds $\sqrt{2} - 1$, the output subsidy is decreasing.

We conclude with the following proposition immediately.

Proposition 1: *With free entry of domestic firms and foreign ownership in mixed oligopoly, the government's best policy is output subsidy if the fraction of foreign ownership of private firms is less than one.*

When free entry occurs in the market, private firms earn zero profits. The equity return held by foreign owners is accordingly zero; namely, there is no profit shifting. Therefore, the government should provide output subsidy in order to improve the production efficiency and lower the output of the public firm in oligopoly when the fraction of foreign ownership of private firms is *less than one*.

We then have the following equilibrium outcomes:

$$n^{MF} = \frac{\sqrt{6}a - 8\sqrt{f}}{\sqrt{f}(2 + 2\alpha^2)} > 0,$$

$$q_0^{MF} = \frac{\sqrt{6}a\alpha(1 + \alpha) + 8\sqrt{f}(1 - \alpha)}{2\sqrt{6}(1 + \alpha^2)} > 0, \quad q_i^{MF} = \sqrt{2/3}\sqrt{f},$$

$$Q^{MF} = \frac{\sqrt{6}a(2 + \alpha + \alpha^2) - 8\sqrt{f}(1 + \alpha)}{2\sqrt{6}(1 + \alpha^2)}, \quad P^{MF} = \frac{4\sqrt{6}\sqrt{f}(1 + \alpha) - 3a(1 - \alpha)\alpha}{6(1 + \alpha^2)} > 0,$$

$$\pi_0^{MF} = \frac{8\sqrt{6}a\sqrt{f}(\alpha + \alpha^2)^2 + 8f(1 - \alpha^2(2 + \alpha(8 + 3\alpha))) - 3a^2(\alpha + \alpha^2)^2}{24(1 + \alpha^2)^2},$$

$$\pi_i^{MF} = 0,$$

$$CS^{MF} = \frac{(\sqrt{6}a(2 + \alpha + \alpha^2) - 8\sqrt{f}(1 + \alpha))^2}{48(1 + \alpha^2)^2},$$

$$W^{MF} = \frac{4f(5 - 3\alpha^2) + 3a^2(2 + \alpha^2) - 8\sqrt{6}a\sqrt{f}}{12(1 + \alpha^2)}.$$

We here compare the optimal unit production subsidies under entry restriction and under free entry.

$$(s^{MF} - s^{MR}) \Big|_{n=n^{MF}} = \frac{2\sqrt{f}(1 - 3\alpha)\Delta}{3(1 + \alpha^2)(\sqrt{6}a - 4\sqrt{f}(1 - 3\alpha))}$$

where $\Delta \equiv 4\sqrt{6}\sqrt{f}(1 - \alpha)\alpha - 3a(1 + \alpha)$. Due to that

$$a > 4\sqrt{2/3}\sqrt{f} > \frac{4\sqrt{2/3}\sqrt{f}(1 - \alpha)\alpha}{1 + \alpha}, \text{ we have } \Delta < 0. \text{ We obtain } s^{MF} - s^{MR} < 0,$$

if and the only if $\alpha < \frac{1}{3}$.

We infer the following proposition immediately.

Proposition 2: *When the shareholding of foreign owners is relatively lower (higher), the optimal output subsidy under entry restriction is higher (lower) than that in the free entry equilibrium.*

This finding is consistent with economic intuition. When the shareholding of

foreign owners exceeds critical value, $\frac{1}{3}$, the profit shifting through private firms is too much under entry restriction, so the government will levy output tax. However, when the shareholding of foreign owners is relatively small, the officials should provide subsidy to improve production insufficiency. In free-entry equilibrium, the product market competition is intensive with private firms free entry, and the officials will reduce its optimal subsidy. We demonstrated that when the shareholding of foreign owners is lower than a critical value, the optimal output subsidy under entry restriction will be higher than that in the free entry equilibrium.

5.2. Pure Oligopoly with Free Entry

In the presence of free entry, private firms can enter or exit the market and meet the condition of zero profit in equilibrium. The equilibrium number of private firms can be obtained by Equations (10) and (2), we have:

$$n^{PF} = \sqrt{\frac{3}{2f}}(a+s) - 3 \quad (13)$$

which is positive under the assumption that $8\sqrt{f} < \sqrt{6}a$ and $s \geq 0$.

Substituting Equation (7) into Equation (3), and differentiating it with s , we obtain

$$\frac{\partial W}{\partial s} = -s < 0.$$

The smaller the optimum output subsidy, the larger the welfare. The government's optimal output subsidy will be negative under free entry; that is, output taxation is employed.

The upper bound of the output taxation will be solved when $n^{PF} = 0$, we get the

$$s^{PF} = -a + \sqrt{6}\sqrt{f} < 0. \quad (14)$$

Proposition 3: *After privatization, the optimal output subsidy is negative with private firms free entry.*

After privatization and due to excess entry, the government should tax output instead of providing output subsidy. Cato and Matsumura (2012) showed that the optimal degree of privatization is increasing in foreign ownership in the long-run. We echo their result and show that when there is free entry of private firms in the market, all private firms earn zero profit; concurrently, the equity returns held by foreign owners are zero, implying that there is no profit-shifting. Accordingly, the government should not provide output subsidy but levy output tax to deter the entry of the private firm in mixed oligopoly with full privatization.

From Equations (14) and (13), we then have the following equilibrium outcomes:

$$n^{PF} = 0, \quad q_0^{PF} = \sqrt{2/3}\sqrt{f}, \quad Q^{PF} = \sqrt{2/3}\sqrt{f}, \quad P^{PF} = a - \sqrt{2/3}\sqrt{f}, \quad \pi_i^{PF} = 0,$$

$$CS^{PF} = \frac{f}{3}, \quad W^{PF} = \frac{1}{3}(\sqrt{6a}\sqrt{f} - 5f).$$

We compare the optimal output subsidy under entry restriction and free entry equilibrium, after privatization

$$(s^{PF} - s^{PR})|_{n=n^{PF}} = -\frac{3a}{2} + \sqrt{6}\sqrt{f} < 0.$$

We have the following proposition immediately.

Proposition 4: *After privatization, the output subsidy under entry restriction is higher than that in the free entry equilibrium.*

The intuition can be explained as Mankiw and Whinston (1986), they showed that free entry is not socially desirable in an oligopolistic market. The equilibrium output of each firm is declined by a business-stealing effect as the number of firms increases. The intuition of “excessive entry” is that the decision of the entrant depends on its profit, while the social planner takes both the profit of the enterprise and consumer surplus into account. Because the marginal entrant’s contribution to social surplus is equal to its profit less the social value of the output lost caused by the output reduction of the other firms, the business-stealing effect makes entry more attractive than the society guarantees. Due to entry not being socially desirable, the output tax is used in the free entry equilibrium after the government adopts the privatization policy.

We next compare the optimal subsidy rate before and after the privatization in the presence of free entry,

$$s^{MF} - s^{PF} = \frac{3a(2 + \alpha + \alpha^2) - 2\sqrt{6}\sqrt{f}(3 + \alpha(2 + \alpha))}{6(1 + \alpha^2)} > 0.$$

We immediately infer the following proposition immediately.

Proposition 5: *With private firm free entry, the optimal output subsidy under full nationalization will be higher than that purely under privatization, and the equity shares held by foreign investors do not matter.*

For not only mixed oligopolies but the pure ones with free entry also, the output level of each private firm is too low. But due to the output of the public firm being more aggressive than the private firm, the number of the private firms at free entry in mixed oligopoly is higher (excessive entry) than pure oligopoly, and the total output in pure oligopoly is larger than the total output in mixed oligopoly (output substitution effect), then we can infer that $s^{MF} > s^{PF}$, which is different from the result obtained in the regulated entry scenario.

5.3. The Decision on Whether to Privatize with Free Entry

Next, we compare the welfare in the free entry equilibrium before and after the privatization,

$$W^{MF} - W^{PF} = \frac{3a^2(2 + \alpha^2) - 4\sqrt{6a}\sqrt{f}(3 + \alpha^2) + 8f(5 + \alpha^2)}{12(1 + \alpha^2)} > 0.$$

We can infer the following proposition immediately.

Proposition 6: *In a free entry equilibrium, the social welfare with privatization will be lower than that without privatization regardless of the shareholding of foreign owners.*

The decision on privatization policy in the presence of free entry is different from that of oligopoly with entry restriction. In the free entry scenario after privatization, it will lead to excess competition, and the number of private firms in this free entry market may be higher than that for social welfare maximization (excess entry theorem). Privatization instead lowers the social welfare. However, in the free entry scenario before privatization, the public firm can help to balance the social welfare loss due to over-crowdedness of firms in the domestic product market; hence, we conclude that the social welfare will decrease after privatization in the free entry. This finding is the same as that in [Matsumura and Kanda \(2005\)](#) who argued that the government, in free entry equilibrium without allowing foreign ownership, should keep the public firm state-owned. Besides, the privatization policy under entry restriction is contrary to that in [Matsumura and Tomaru \(2012\)](#) and [Wang and Chen \(2011a\)](#) in which the equity shares held by foreign owners are low, so the government should privatize the public firm.

The country with more product market openness should privatize firms more, even though this will temporarily reduce welfare. Our Proposition 5 generalizes the previous result in a way that the subsidy rate is used to expand the output of private firms associated with more foreign penetration, and further nationalization of the public firm is required.

6. Concluding Remark

From the exploration of this paper, we show that in mixed oligopoly with foreign ownership and free entry of domestic firms, the government's best policy is output subsidy if the fraction of foreign ownership of private firms is less than one. When the equity shares held by foreign investors are relatively lower (higher), the optimal output subsidy under entry restriction is higher (lower) than that in the free-entry equilibrium. Under mixed oligopoly and free market entry, the government's output subsidies are positive and will not be affected by foreign holdings; under complete privatization and free market entry, the government will impose a production tax due to excessive market entry. We further demonstrate that the social welfare with privatization will be lower than that without privatization regardless of the shareholding of foreign owners in the free-entry equilibrium, so privatization will instead reduce the social welfare. This result indicates that when the market is completely free and open, it is necessary for state-owned enterprises to enter the market to ease excessive market competition.

Conflicts of Interest

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

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