COMPETITIVE PRIVATIZATION AND TARIFF POLICIES IN AN INTERNATIONAL MIXED DUOPOLY*

by

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We consider the interaction of two countries regarding strategic choices on privatization policy in an international mixed market under an open economy. We demonstrate that the equilibrium degree of privatization depends not only on the relative efficiency of the state-owned enterprise, but also on trade policy. We show that, if the state-owned enterprise is relatively inefficient, the competitive optimal degree of privatization is lower in open competition than in closed competition. We also show that the international competitive equilibrium involves less privatization and a higher tariff, even though they are jointly suboptimal.

1 INTRODUCTION

In recent decades, we have witnessed a widespread wave of privatization. It is widely accepted that privatization has had a remarkable impact on society. For example, based on the various empirical results, Megginson and Netter (2001) and Megginson and Sutter (2006) have reported that privatization generates positive effects in the society as well as at the privatized firms.

 Earlier studies on privatization policy in a mixed oligopoly market, pioneered by De Fraja and Delbono (1989), are mostly based on decisions of privatization under a closed (domestic) economy. However, as the global open economy grows, international competition in mixed markets, where a public firm competes with domestic and foreign private firms, is very popular in the world economy. Thus, an increasingly important and interesting issue is to investigate privatization policy in an international mixed market involving trade policy.

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According to the World Bank Group (2008), 48 developing countries carried out 249 privatization transactions valued at US$104.9 billion in 2006, and 51 developing countries carried out 236 privatization transactions valued at US$132.6 billion in 2007. This result was mostly driven by partial privatizations through initial public offerings.
Some theoretical literature has analyzed privatization policy, whether it involves complete privatization or nationalization, and strategic trade policy, a tariff or a production subsidy, in a mixed market. For example, Fjell and Pal (1996) constructed an international mixed oligopoly model where a domestic public firm competes with both domestic and foreign private firms. Pal and White (1998) examined a production subsidy and an import tariff to determine the interaction between privatization and strategic trade policies. Fjell and Heywood (2002, 2004) and Wang et al. (2009) considered the role of leadership to determine the effects of an open door policy on privatization. Extending to a two-country model with free trade, Bárcena-Ruiz and Garzón (2005) considered the strategic interaction between two governments to examine the optimal decision on privatization and showed that the relative efficiency of the public firm determines the decision on privatization of the home country.

However, these works discussed the case of complete privatization only. As initiated by Matsumura (1998), partially privatized firms are quite common in many countries. Some works have examined partial privatization and international trade. Chang (2005) used a mixed duopoly model with cost asymmetry to examine optimal trade policy and privatization policy. Chao and Yu (2006) constructed a mixed oligopoly model to examine how partial privatization or foreign competition affects the optimal import tariff. Han (2011) and Yu and Lee (2011) examined strategic privatization and trade policies in a mixed oligopoly model and analyzed the welfare effect of subsidy and tariff policies. All this research on international competition has focused on the single home market model.

The purpose of this paper is to investigate the interaction of two governments regarding the strategic choice on privatization. In particular, we consider the two-country model with a tariff in international trade under an open economy and show that the equilibrium degree of privatization depends not only on the relative efficiency between a state-owned enterprise (SOE) and private firms, but also on whether there is open competition. We show that, if an SOE is relatively inefficient, the equilibrium degree of privatization in an open economy is lower than in a closed economy. We also incorporate a tariff policy to examine the relationship between optimal privatization and

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2 In the recent literature on mixed markets, the partial privatization approach is popular and extensively used in many contexts. Research topics include the agency problem (Lee and Hwang, 2003), endogenous market structure (Matsumura and Kanda, 2005; Fujiwara, 2007), vertical structure (Lee, 2006), product differentiation (Fujiwara, 2007; Lu and Poddar, 2007), the role of leadership (Matsumura and Ogawa, 2010), trade policy (Chang, 2005; Chao and Yu, 2006; Han, 2011; Yu and Lee, 2011) and so on.

3 Similar to Bárcena-Ruiz and Garzón (2005) and Han and Ogawa (2008), we consider a two-country model to incorporate the strategic interaction between two governments. Unlike them, however, we incorporate a tariff policy to show the interaction between privatization policy and tariff policy. More importantly, we also take an approach based on an international strategic game and point out the competitive equilibrium of privatization policies between the two countries.
till policies in an international market and show that the competitive optimal degree of privatization in the local country is always lower than the global optimum, but the competitive optimal degree of tariff in the local country is always higher than the global optimum. Therefore, the international competitive equilibrium involves less privatization and a higher tariff, even though they are jointly suboptimal.

This paper is organized as follows. In Section 2, we introduce the model for the general case, which is the open economy with a tariff in an international mixed market. In Section 3, we analyze two special cases; the closed economy model with infinite tariff (one country case) and open economy model with zero tariff (two countries case). The effects of privatization on welfare under these two different competition models are compared. We finally discuss the general case of the open economy with a tariff in an international mixed market, and analyze the effects of competitive equilibrium of privatization and tariff policies on welfare. Finally, we summarize and conclude in Section 4.

2 The Model

Suppose that there are two countries: one is the home country (country 1) and the other is the foreign country (country 2). They produce homogeneous products and can trade those products. The home country and foreign country both have symmetric duopoly situations, i.e. they both have an SOE and a private enterprise (PE), which produce homogeneous products and have the same technologies. We assume that the home PE in each country can produce products and export them to the foreign country. Each country would impose a tax on the imports that are produced by the PE in the other country and investigate the interaction between privatization and tariff policies. The import tariff is defined by $t_i (\geq 0)$ for country $i$.

We denote the home SOE’s output as $q_{s1}$ and the foreign SOE’s output as $q_{s2}$. For the PE, the home PE’s output for home market 1 is denoted by $q_{h1}$ and its export output for foreign market 2 is $q_{e1}$. Similarly, the foreign PE’s output for its home market 2 is $q_{h2}$ and its export output for market 1 $q_{e2}$. The inverse demand functions of both markets are the same and given by $P_i = \alpha - Q_i$, $i = 1, 2$, where the price of market $i$ is denoted by $P_i$ and the output of market $i$ is $Q_i = q_{h1} + q_{h2} + q_{e2}$ where $I \neq j = 1, 2$.

When we introduce trade between the two countries under an open economy, both the SOE and the PE might participate in export strategies. However, some existing literature shows that the exposure to trade will induce only the more productive firms to enter the export market, while some less productive firms will continue to produce only for the domestic market when there exist export market entry costs (Melitz, 2003; Helpman et al., 2004). Appendix B provides an example to show the existence of a no-export strategy for the SOE in an open economy. Furthermore, in the standard approach to export strategy in a single home market model, it is assumed that only an efficient, foreign PE uses an export strategy. For analytic convenience, we assume that only the PE, which is relatively efficient, exports in the following analysis.

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We assume that the cost function of the SOE is given as \( C(q_s) = k_c q_s \) while that of the PE is \( C(q_h + q_e) = c(q_h + q_e), \) for \( i = 1, 2, \) where \( k > 1 \) and \( k \) is constant.\(^5\)

3 The Analysis

We begin the discussion with the model for the two special cases: the closed economy case and open economy case with free trade.

3.1 Closed Economy Model: One-country Case

Suppose \( t_i = +\infty; \) the model is then reduced to the closed economy model, where in the domestic market one SOE competes with one PE. Since it is the one country case, we ignore the subscript \( i \) in this part for simplicity.

Then, the profits of the SOE and the PE are expressed, respectively, as follows:

\[
\pi_s = Pq_s - k_c q_s = (\alpha - q_s - q_h)q_s - k_c q_s \\
\pi_h = Pq_h - c q_h = (\alpha - q_s - q_h)q_h - c q_h 
\]

Finally, social welfare \( W \) is defined as the simple sum of consumer surplus and industry profits: \( W = CS + \pi_s + \pi_h \) where \( CS = Q^2/2. \)

The firm’s behavior is constrained by its ownership structure. We suppose that the PE, which has characteristics of private property rights, maximizes its profits, while the SOE, which is fully owned by the government, maximizes the objective of the government, which is defined as social welfare. Following the partial privatization model of Matsumura (1998), we also assume that the manager of the partially state-owned enterprise—a semi-SOE—maximizes the share-weighted objectives between social welfare and profit. In the process of privatization, the government transforms the complete SOE into a semi-SOE, which is jointly owned by both the government and private investors. Then, decision-making behaviors of the SOE should take into account both the objectives of the government and the private sector.

Let \( \theta \) refer to shares owned by private investors (or weights put on the profit). Then, \( \theta \) can be used to measure the degree of privatization, i.e. the government owns a share of \( (1 - \theta) \in (0, 1) \) of the SOE. When \( \theta = 0, \) this firm is a complete SOE, which maximizes social welfare, and when \( \theta = 1, \) it is a PE.

\(^5\)The assumption of higher marginal cost of SOE is for the purpose of guaranteeing the interior solution of the privatization degree. If the SOE has lower marginal cost, then we have the trivial solution that the SOE should not be privatized at all. Following a standard approach, we also assume that privatization does not improve the efficiency of a public firm. In the literature on mixed duopoly markets, however, firms with different productivity levels coexist in an industry. Matsumura and Shimizu (2010) pointed out that there is an endogenous cost differential between the privatized firms.
which maximizes its profit. Therefore, SOE maximizes the share-weighted objectives between social welfare and profits, which are defined as $T = (1 - \theta)W + \theta\pi_s$, where changes of $\theta$ indicate the tendency of the SOE to seek social welfare or profits in the process of privatization.

From the first-order conditions of the SOE and the PE, in which the SOE maximizes $T$ and PE maximizes $\pi_h$, we have the following equilibrium outputs: $q_s = (\alpha + c - 2kc)/(1 + 2\theta)$ and $q_h = [(\alpha - c)\theta + (k - 1)c]/(1 + 2\theta)$. Then, market output and price are $Q = [(\alpha - c)\theta + \alpha - kc]/(1 + 2\theta)$ and $P = [(\alpha + c)\theta + kc]/(1 + 2\theta)$. The resulting profits of each firm are $\pi_s = [(\alpha + c - 2kc)^2\theta]/(1 + 2\theta)^2$ and $\pi_h = [(\alpha - c)\theta + (k - 1)c]^2/(1 + 2\theta)^2$, and the consumer surplus is $CS = [(\alpha - c)\theta + \alpha - kc]^2/[2(1 + 2\theta)^2]$.

Then, we have the following welfare function from equilibrium outputs:

$$W = \frac{3(\alpha - c)^2 \theta^2 + [2(\alpha - kc)(2\alpha - kc - c) + 6(k - 1)^2 c^2] \theta}{2(1 + 2\theta)^2}$$

**Proposition 1:** Under a closed economy, the optimal degree of privatization is full privatization only if the SOE is very inefficient.

**Proof:** The differentiation of $W$ with respect to $\theta$ yields

$$\frac{\partial W}{\partial \theta} = \frac{(\alpha + c - 2kc)[-(\alpha + 3c - 4kc)\theta + (k - 1)c]}{(1 + 2\theta)^3}$$

Assuming the interior solutions, we get the following socially optimal degree of privatization in a closed economy: $\theta^* = [(k - 1)c]/(\alpha - 4kc + 3c)$ when $k < (\alpha + 4c)/5c$. However, if $k > (\alpha + 4c)/5c$, $\theta^* = 1$. Finally, from the second-order condition for the maximization problem, we have

$$\left.\frac{\partial^2 W}{\partial \theta^2}\right|_{\theta = \theta^*} = \frac{-(\alpha + c - 2kc)^2}{(1 + 2\theta^*)^4} < 0$$

The economic intuition is as follows: privatization policy induces the SOE to reduce output and the PE to increase output, but industry output will decrease because of duopolistic competition with strategic substitutes. Since the PE will substitute only a partial amount of output of the SOE, the cost-saving effect from increasing output of the PE will not dominate the industry output-reducing effect as far as the SOE is not very inefficient. Therefore, partial privatization is optimal when the SOE is not too inefficient under a closed economy. Notice that the optimal degree of privatization in a closed economy is increasing in $k$, i.e. $\partial \theta^*/\partial k > 0$.

We assume that $\alpha + c - 2kc > 0$ or $k < (\alpha + c)/2c$ is always satisfied, so that $k$ is not large enough to drive the SOE out of the market under full privatization.
3.2 Open Economy Model: Two-country Case

Suppose now $t_i = 0$; the model then is reduced to a two country case of an open economy with free trade. Then, the profits of the SOEs and the PEs in the home country will be expressed as $\pi_{si}$, $\pi_{pi}$, where

$$
\pi_{si} = P_i q_{si} - kc q_{si} = (\alpha - q_{si} - q_{hi} - q_{ej}) q_{si} - kc q_{si}
$$

$$
\pi_{pi} = \pi_{hi} + \pi_{ei} = (P_i q_{hi} - c q_{hi}) + (P_j q_{ei} - c q_{ei})
$$

The home country’s social welfare is defined as the sum of the consumer surplus in the home market and the home industry profit, $W_i = CS_i + \pi_{si} + \pi_{pi}$, where $CS_i = \frac{1}{2} Q_i^2 = \frac{1}{2} (q_{si} + q_{hi} + q_{ej})^2$. Again, the PE maximizes its profit, and the SOE maximizes the share-weighted objectives between social welfare and its profits, which are defined as $T_i = (1 - \theta) W_i + \theta \pi_{si}$.

From the first-order conditions of the two SOEs and the two PEs in the two markets, we have the equilibrium outputs:

$$
q_{hi} = \frac{2\alpha - 3kc + c - (\alpha - c)\theta_i}{2(1 + \theta_i)}
$$

$$
q_{ei} = \frac{(\alpha - c)\theta_i + (k - 1)c}{2(1 + \theta_i)}
$$

and

$$
q_{ji} = \frac{(\alpha - c)\theta_j + (k - 1)c}{2(1 + \theta_j)}
$$

where $i = 1, 2$. Then, market output and price are

$$
Q_i = \frac{2\alpha - kc - c + (\alpha - c)\theta_i}{2(1 + \theta_i)}
$$

and

$$
P_i = \frac{(k + 1)c + (\alpha + c)\theta_i}{2(1 + \theta_i)}
$$

The resulting consumer surplus of country $i$,

$$
CS_i = \frac{2\alpha - kc - c + (\alpha - c)\theta_i}{8(1 + \theta_i)^2}
$$

and the profits of each firm are

$$
\pi_{si} = \frac{[2\alpha - 3kc + c - (\alpha - c)\theta_i][(\alpha - 2kc + c)\theta_i - (k - 1)c]}{4(1 + \theta_i)^2}
$$

and
\[ \pi_{pi} = \frac{[(k-1)c + (\alpha - c)\theta_i]^2}{4(1 + \theta_i)^2} + \frac{[(k-1)c + (\alpha - c)\theta_j]^2}{4(1 + \theta_j)^2} \]

Then, we get the social welfare function of country \( i \):

\[ W_i = \frac{(\alpha - c)(\alpha + 4kc - 5c)\theta_i^2}{8(1 + \theta_i)^2} + \frac{2(4\alpha^2 - 5\alpha kc - 3\alpha c + 6k^2 c^2 - 7kc^2 + 5c^2)\theta_i}{8(1 + \theta_i)^2} \]

\[ + \frac{4\alpha^2 - 8\alpha kc + 9k^2 c^2 - 10kc^2 + 5c^2}{8(1 + \theta_i)^2} + \frac{[(k-1)c + (\alpha - c)\theta_j]^2}{4(1 + \theta_j)^2} \]

**Proposition 2:** Under an open economy, the competitive optimal degree of privatization is lower than that under a closed economy when the SOE is inefficient.

**Proof:** The differentiation of \( W_i \) with respect to \( \theta \) yields

\[ \frac{\partial W_i}{\partial \theta_i} = \frac{3(\alpha - kc)[-(\alpha + c - 2kc)\theta_i + (k - 1)c]}{4(1 + \theta_i)^3} \]

Assuming interior solutions, we have the following socially optimal degree of privatization in an open economy: \( \theta^o_i = [(k-1)c]/(\alpha - 2kc + c) \) when \( k < (\alpha + 2c)/3c \). However, if \( k > (\alpha + 2c)/3c \), \( \theta^o_i = 1 \). Finally, from the second-order condition for the maximization problem, we have

\[ \frac{\partial^2 W_i}{\partial \theta_i^2} \bigg|_{\theta_i = \theta^o_i} = -\frac{3(\alpha - kc)^2}{4(1 + \theta_i)^4} < 0 \]

Notice that the competitive optimal degree of privatization in an open economy is also increasing in \( k \), i.e.

\[ \frac{\partial \theta^o_i}{\partial k} = \frac{(\alpha - c)c}{(\alpha - 2kc + c)^2} > 0 \]

Therefore, we have

\[ \theta^c = \frac{(k-1)c}{\alpha - 4kc + 3c} > \theta^o_i = \frac{(k-1)c}{\alpha - 2kc + c} \]

when \( k > 1 \).

Compared with the case of a closed economy, there is another effect from export output of the PEs under an open economy. Even though industry output increases because of increasing competition, it will be shared with the foreign firm (i.e. the business-stealing effect from the foreign firm) and thus the home PE will substitute a smaller amount of output of the SOE in the
home market. This implies that the effect of privatization on the cost saving from increasing output of the PEs will be minimal, compared with the case of no trade. Then, from the perspective of strategic interaction, given the other country’s lower privatization level, it is beneficial for the home country to have less privatization to reduce the business-stealing effect in its home country. Thus, welfare increases slower with \( \theta \) in an open economy where the two countries compete in privatization policy.

**Corollary 1:** When the SOE is relatively less inefficient, even though full privatization is optimal under a closed economy, it is not under an open economy.

**Proof:** From \( \theta^c = [(k - 1)c]/(\alpha - 4kc + 3c) \geq 1 \), we get \( k \geq (\alpha + 4c)/5c \); from \( \theta^o = [(k - 1)c]/(\alpha - 2kc + c) < 1 \), we get \( k < (\alpha + 2c)/3c \). So when \( (\alpha + 4c)/5c \leq k < (\alpha + 2c)/3c \), \( \theta^c = 1 \) and \( \theta^o < 1 \).

Finally, we define global welfare, \( \bar{W} = W_1 + W_2 \), as the sum of the social welfare of each country:

\[
\bar{W} = \sum_{i=1}^{2} \left( 3(\alpha - c)^2 \theta_i^2 + 2(4\alpha^2 - 5\alpha kc - 3\alpha c + 4k^2c^2 - 3kc^2 + 3c^2)\theta_i + 4\alpha^2 - 8\alpha kc + 7k^2c^2 - 6kc^2 + 3c^2 \right) / 8(1 + \theta_i)^2
\]

**Proposition 3:** The global optimum, which maximizes global welfare, requires a higher degree of privatization than the local country optimum under open competition when the SOE is relatively inefficient.

**Proof:** The differentiation of \( \bar{W} \) with respect to \( \theta_i \) yields

\[
\frac{\partial \bar{W}}{\partial \theta_i} = \frac{(\alpha - kc)[-(\alpha + 5c - 6kc)\theta_i + 5(k - 1)c]}{4(1 + \theta_i)^3}
\]

Assuming interior solutions, we have the following socially optimal degree of privatization in an open economy: \( \theta^* = [5(k - 1)c]/(\alpha - 6kc + 5c) \) when \( k < (\alpha + 10c)/11c \). However, if \( k \geq (\alpha + 10c)/11c \), \( \theta^* = 1 \). Finally, from the second-order condition for the maximization problem, we have

\[
\frac{\partial^2 \bar{W}}{\partial \theta_i^2} \bigg|_{\theta = \theta^*} = \frac{-(\alpha - kc)^2}{4(1 + \theta^*)^4} < 0
\]

Therefore, \( \theta^* > \theta^o \iff k < \alpha/c \).

The intuition comes from the strategic interaction between the two independent countries. As shown in Proposition 2, there is a business stealing effect
from the foreign firm under an open economy, and thus, concerning its own
country’s welfare, each government will strategically reduce the degree of
privatization to lessen the business-stealing effect. However, from the per-
spective of global welfare where both governments do not take the business-
stealing effect into consideration at all, increasing the degree of privatization
will increase the cost-saving effect from the PEs, and thus increase both the
home country’s welfare and the other country’s welfare, i.e. global welfare.
Notice that the global optimum in Proposition 3 is also increasing in $k$, but its
increasing rate is faster than the local county optimum in Proposition 2, i.e.
$\frac{\partial \theta^*}{\partial k} > \frac{\partial \theta^j}{\partial k} > 0$.

### 3.3 Competitive Privatization and Tariff Policies

We now consider the general case with a tariff policy. Then, profits of the PE
in country $i$ will be expressed as $\pi_{pi} = \pi_{hi} + \pi_{ci} = (P_i q_{hi} - c q_{hi}) + (P_i q_{ci} - c q_{ci}) - t q_{ei}$. The home country’s social welfare is then defined as the sum of the
consumer surplus in the home market, the home industry profit and the
foreign PE’s export tariff: $W_i = CS_i + \pi_{si} + \pi_{pi} + t_i q_{ei}$. Again, the PE maximizes its
profit, and the SOE maximizes the share-weighted objectives between social
welfare and profits, $T_i = (1 - \theta) W_i + \theta \pi_{si}$.

From the first-order conditions of the two SOEs and the two PEs in the
two markets, we have equilibrium outputs,

$$q_{hi}^* = \frac{(\alpha - c) \theta_i + (k - 1)c + t_i}{2(1 + \theta_i)}$$

and

$$q_{ci}^* = \frac{(\alpha - c - 2t_j) \theta_j + (k - 1)c - t_j}{2(1 + \theta_j)}$$

Then, market output and price are

$$Q_{i}^* = \frac{2\alpha - kc - c - t_i + (\alpha - c) \theta_i}{2(1 + \theta_i)}$$

and

$$P_i^* = \frac{(k + 1)c + t_i + (\alpha + c) \theta_i}{2(1 + \theta_i)}$$

The resulting profits are

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\[ \pi^T_{si} = \frac{A_i}{4(1 + \theta_i)^2} \]

and

\[ \pi^T_{pi} = \frac{B_i}{4(1 + \theta_i)^2} + \frac{D_j}{4(1 + \theta_j)^2} \]

where

\[ A_i = [2\alpha + c - 3kc - (\alpha - c)\theta_i][(\alpha + c - 2kc)\theta_i - (k-1)c] + 2[\alpha - kc - (\alpha - c)\theta_i + (\alpha + c - 2kc)\theta_i^2]t_i + (2\theta_i - 1)t_i^2 \]

\[ B_i = [(\alpha - c)\theta_i + (k-1)c]^2 + 2[(\alpha - c)\theta_i + (k-1)c]t_i + t_i^2 \]

and

\[ D_j = [(\alpha - c)\theta_j + (k-1)c]^2 - 2(1 + 2\theta_j)[(\alpha - c)\theta_j + (k-1)c]t_j + (1 + 2\theta_j)^2t_j^2 \]

Finally, the consumer surplus of country \( i \),

\[ CS_i = \frac{[2\alpha - kc - c - t_i + (\alpha - c)\theta_i]c}{8(1 + \theta_i)^2} \]

provides the social welfare function of country \( i \), \( W_i = CS_i + \pi^T_{si} + \pi^T_{pi} + t_i q_{ij} \).

Proposition 4: Under an open economy with a tariff, the competitive equilibrium degree of privatization is partial privatization and is higher than without a tariff when the SOE is not very inefficient.

Proof: The differentiation of \( W_i \) with respect to \( \theta_i \) and \( t_i \) yields

\[ \frac{\partial W_i}{\partial \theta_i} = \frac{-(\alpha - t_i - kc)[3(\alpha + c - 2kc)\theta_i - 3(k-1)c - (1 + 4\theta_i)t_i]}{4(1 + \theta_i)^3} \]

\[ \frac{\partial W_i}{\partial t_i} = \frac{3(k-1)c + (\alpha + 2kc - 3c)\theta_i + 4(\alpha - kc)\theta_i^2 - (8\theta_i^2 + 8\theta_i + 3)t_i}{4(1 + \theta_i)^3} \]

Assuming the interior (non-zero) solutions for equilibrium, we have the following equilibrium of privatization and tariff: \( \theta^o_{it} = [3(k-1)c]/[2(\alpha - 4kc + 3c)] \) and \( t^o_{it} = \frac{3}{4}(k-1)c \). Thus, \( \theta^o_{it} < 1 \) when \( k < (2\alpha + 9c)/11c \). Notice that both equilibriums of privatization and tariff are increasing in \( k \). Therefore, we have

\[ \theta^o_{it} = \frac{3(k-1)c}{2(\alpha - 4kc + 3c)} > \frac{(k-1)c}{\alpha - 2kc + c} \]

The intuition is as follows. Compared with the free trade case, the government can use the tariff strategically to control the business-stealing.
effect from foreign countries. Furthermore, the home country has an additional income source from the tariff, which provides the home country with an incentive to increase the degree of privatization in order to increase revenue from the tariff.\(^7\) Then, from the perspective of strategic interaction, given the other country’s lower privatization level and higher tariff level, it is beneficial for the home country to have less privatization and a higher tariff to reduce the business-stealing effect in its home country and raise tariff revenue.

It is noteworthy that the globally optimal degree of privatization with a tariff is equal to that without a tariff since the global optimal tariff is zero, which means free trade yields global optimum (see Appendix A).

**Corollary 2:** If each country sets the local country optimal tariff under an open economy, the equilibrium degree of privatization is lower than the degree of global optimal privatization without a tariff.

**Proof:** The differentiations yields
\[
\frac{\partial \bar{W}}{\partial \theta_i} = -\frac{(\alpha - t_i - kc)[(\alpha + 5c - 6kc)\theta_i - 5(k-1)c + t_i]}{4(1 + \theta_i)^3}
\]
and
\[
\frac{\partial \bar{W}}{\partial t_i} = -\frac{4(k-1)c\theta_i^3 + (\alpha + 2kc - 3c)\theta_i - (k-1)c + t_i}{4(1 + \theta_i)^2}
\]
Then, from the global optimum condition for the tariff, \(t_i^{*T} = 0\), we have the following global optimum for privatization: \(\theta_i^{*T} = \frac{5(k-1)c}{(\alpha - 6kc + 5c)}\) when \(k < (\alpha + 10c)/11c\) and if \(k \geq (\alpha + 10c)/11c\), \(\theta_i^{*T} = 1\). Notice that the second-order condition satisfies the global optimum, i.e.
\[
\left. \frac{\partial^2 \bar{W}}{\partial \theta_i^2} \right|_{\theta = \theta_i^{*T}} = -\frac{(\alpha - kc)^2}{4(1 + \theta_i^{*T})^4} < 0
\]
Therefore, we have \(\theta_i^{*T} > \theta_i^{OT}\) when \(k < (2\alpha + 9c)/11c\); otherwise, \(\theta_i^{*T} = \theta_i^{OT} = 1\).

Notice that although the global optimum for privatization is increasing in \(k\), its increasing rate is faster than the local country optimum, i.e. \(\partial \theta_i^{*T} / \partial k > \partial \theta_i^{OT} / \partial k > 0\).

This implies that even though both countries can get higher welfare from higher privatization and zero tariff policies, they would use a tariff instrument and less privatization to increase their own welfare in a com-

\(^7\)This indicates that welfare will be increased when adopting a tariff under an open economy from the revelation property; otherwise, a zero tariff and less than full privatization should be chosen to increase welfare.
petitive equilibrium. This competitive result can be seen as the prisoner’s dilemma in an international game situation: international competitive equilibrium involves less privatization and a higher tariff, even though they are jointly suboptimal.

In Fig. 1, we show how $\theta^c$, $\theta^o$, $\theta^*$, $\theta^{oT}$ and $\theta^{*T}$ change with respect to $k$.

4 Conclusion

This paper introduced the competitive privatization and tariff policies in an international mixed market in which the SOE competes with the PE in both the home and foreign markets and investigated the interaction of the two governments regarding the strategic choice of privatization. Both governments taking the approach of partial privatization and adopting a tariff policy provide the following results.

First, comparing the optimal degree of privatization between closed and open competition provides that the equilibrium degree of privatization depends not only on the relative efficiency between the SOE and the PE, but also on whether there is open competition or not. In particular, if the SOE is relatively inefficient, the competitive degree of privatization is lower in an open economy than that in a closed economy, which is increasing in the cost-inefficiency parameter of the SOE in both cases.

Second, we show that privatization policy and tariff policy are complementary. In particular, by comparing the equilibrium degree of privatization with and without a tariff in open competition, we found that competitive...
privatization with a tariff achieves a higher degree of privatization than without a tariff. Thus, when opening the home market to the foreign country, if the government wants to maximize the home country’s social welfare, mutual increases in the degree of privatization from the equilibrium levels improve the local country’s welfare and, thus, global welfare.

Third, by comparing the equilibrium degree of privatization and tariff in open competition and a global optimum, we found that the global optimum requires a higher degree of privatization than a local country optimum. In addition, the local country optimal degree of tariff is always greater than the global optimum, which is zero tariff. Thus, the global optimum requires a higher degree of privatization and a lower degree of tariff than the local country optimum. This implies that the international competitive equilibrium involves less privatization and a higher tariff, even though they are jointly suboptimal. This competitive equilibrium can be seen as the prisoner’s dilemma.

Finally, one of the limitations of the analysis is that, similar to previous studies, the linear inverse demand and linear cost functions have been used for tractability. The extension for the specification on these functions to get robust results remains for future research. Furthermore, it is worthwhile to incorporate the general case that the inefficient SOE can export in equilibrium and consider other trade policies, such as an export-subsidy strategy (for the SOE or the PE) or a combination of subsidy and import tariff, in light of the optimal policies for privatization and international trade.

**Appendix A**

**The Optimality of Free Trade Policy**

Suppose that the globally optimal tariff is non-zero: \( t_i^{*T} > 0 \).

Then, from the differentiation of

\[
\frac{\partial \bar{W}}{\partial t_i} = - \frac{4(k - 1)c \theta_i^2 + (\alpha + 2kc - 3c)\theta_i - (k - 1)c + t_i}{4(1 + \theta_i)^2} = 0
\]

we get

\[
t_i^{*T} = (k - 1)c - 4(k - 1)c \theta_i^2 - (\alpha + 2kc - 3c)\theta_i.
\]

Thus, we have

\[
\frac{\partial \bar{W}}{\partial \theta_i} = \frac{-(\alpha - t_i - kc)[(\alpha + 5c - 6kc)\theta_i - 5(k - 1)c + t_i]}{4(1 + \theta_i)^3} = \frac{(\alpha - t_i - kc)(k - 1)c}{1 + \theta_i}
\]

There are three possibilities. (i) If \( t_i^{*T} = \alpha - kc \), the optimal degree of privatization is indeterminate. Thus, a unique interior solution of privatization degree requires \( t_i^{*T} \neq \alpha - kc \). (ii) If \( t_i^{*T} > \alpha - kc \), then \( \frac{\partial \bar{W}}{\partial \theta_i} < 0 \), so \( \theta_i^{*T} = 0 \). From \( \frac{\partial \bar{W}}{\partial t_i} = 0 \), we get \( t_i^{*T} = (k - 1)c \) and \( k > (\alpha + c)/2c \). Thus, there is a contradiction when \( k < (\alpha + c)/2c \). (iii) \( 0 < t_i^{*T} < \alpha - kc \), then \( \frac{\partial \bar{W}}{\partial \theta_i} > 0 \), so \( \theta_i^{*T} = 1 \). We get
\[ \frac{\partial W}{\partial t_i} = -\frac{\alpha + 5k c - 6c + t_i}{16} < 0 \]

so \( t_i^* \) should never be positive.

Therefore, we know that the only feasible global optimum is a zero tariff: \( t_i^* = 0 \).

**Appendix B**

*The Existence of No-export Strategy of the SOE*

Suppose that the inverse demand functions of both countries are the same and given by \( P_i = 1 - Q_i, i = 1, 2 \), where \( Q_i = q_{i}^h + q_{i}^e + q_{j}^h + q_{j}^e, I \neq j = 1, 2 \), in which domestic and export outputs for the foreign market of an SOE and a PE in country \( i \) are denoted as \( q_{i}^h, q_{i}^e, q_{j}^h, q_{j}^e \), respectively. For convenience, we also assume that the cost function of the PE is zero and that of the SOE is constant and given by \( C(q_{i}^h + q_{i}^e) = k(q_{i}^h + q_{i}^e) \), where \( 0 < k < 3/7 \), which supports a positive home outputs for the SOE in a mixed market. Then, the profit functions of the SOE and the PE, the consumer surplus and welfare function of country \( i \) are given as, respectively,

\[
\pi_{si} = P_i q_{hi}^e + P_i q_{ei}^e - k(q_{hi}^h + q_{ei}^h) - t_i q_{ei}^e \quad \pi_{pi} = P_i q_{hi}^p + P_i q_{ei}^p - k(q_{hi}^h + q_{ei}^h) - t_i q_{ei}^p
\]

\[
CS_i = \frac{1}{2} Q_i^2 = \frac{1}{2} (q_{hi}^h + q_{ei}^h + q_{hi}^e + q_{ei}^e)^2 \quad W_i = CS + \pi_{si} + \pi_{pi} + t_i(q_{ei}^h + q_{ei}^e)
\]

Finally, the objective of the SOE is given by \( T_i = (1 - \theta_i)W_i + \theta_i \pi_{si} \). Allowing boundary solutions for the SOE’s export output, i.e. non-zero export output, require Kuhn–Tucker conditions for the maximization problem. However, for the time being, we assume that the optimal output of SOE’s export output is zero. Then, we have the following optimal solutions of the outputs.

\[
q_{hi}^e = \frac{2 - 3k - t_i - (1 - 2t_i)\theta_i}{2(1 + \theta_i)} \quad q_{hi}^p = \frac{\theta_i + k + t_i}{2(1 + \theta_i)} \quad q_{ei}^e = \frac{(1 - 2t_j)\theta_j + k - t_j}{2(1 + \theta_j)}
\]

Then, we have

\[
Q_i^* = \frac{2 - k - t_i + \theta_i}{2(1 + \theta_i)} \quad P_i^* = \frac{k + t_i + \theta_i}{2(1 + \theta_i)} \quad CS_i = \frac{(2 - k + t_i + \theta_i)^2}{8(1 + \theta_i)^3}
\]

\[
\pi_{si}^* = \frac{[2 + 3k + t_i(1 - 2\theta_i) + \theta_i][k - t_i + (1 - 2k)\theta_i]}{4(1 + \theta_i)^3} \quad \pi_{pi}^* = \frac{(k + t_i + \theta_i)^2}{4(1 + \theta_i)^3}
\]

Then, welfare-maximizing optimal privatization and tariff policies are as follows:
\[ \theta^R_i = \frac{3k}{2(1-4k)} \quad \text{and} \quad t^R_i = \frac{3}{2} \quad \text{when } 0 < k < 2/11 \]

\[ \theta^R_i = 1 \quad t^R_i = \frac{5+k}{19} \quad \text{when } 2/11 < k < 3/7 \]

Therefore, there are two cases depending on the degree of inefficiency of SOE.

(i) First, when \( 0 < k < 2/11 \), we have the following optimal outputs at equilibrium:

\[ q^*_i = q^0_i = 1 - \frac{9k}{2} \quad q^p_i = q^p_j = 2k \quad \text{and} \quad q^p_i = q^p_j = \frac{k}{2} \]

Notice that \( q^*_i = q^0_i = 1 - 9k/2 > 0 \) at equilibrium when \( 0 < k < 2/11 \). Finally, from the Kuhn–Tucker conditions for maximizing the objective of the SOE, i.e. \( q^*_i \geq 0 \), \( \partial T_i / \partial q^*_i \leq 0 \) and \( q^*_i \cdot \partial T_i / \partial q^*_i = 0 \), we have the necessary conditions for having a boundary solution for zero SOE’s export output as follows:

\[ \frac{\partial T_i}{\partial q^*_i} = (1 - k - 2q^*_i - q^p_i - 2q^*_i - q^0_i - t_i - q^p_i \theta) = \frac{(4 - 19k)k}{-4 + 16k} < 0. \]

It is easily shown that when \( 0 < k < 2/11 \), then \( \partial T_i / \partial q^*_i < 0 \). Therefore, the optimal export output of the SOE is zero, and thus the SOE would not participate in exporting in an open economy.

(ii) Second, when \( 2/11 < k < 3/7 \), we have the following optimal outputs at equilibrium:

\[ q^*_i = q^0_i = \frac{2(3 - 7k)}{19} \quad q^0_i = q^p_i = \frac{6 + 15k}{19} \quad \text{and} \quad q^p_i = q^p_j = \frac{1 + 4k}{19} \]

Notice that \( q^*_i = q^0_i = 2(3 - 7k)/19 > 0 \) at equilibrium when \( 2/11 < k < 3/7 \). This reports that, if the SOE is very inefficient where \( k > 3/7 \), the market configuration of mixed duopoly is not an optimal choice of government and thus privatization policy is not relevant in this case. Finally, from the Kuhn–Tucker conditions for maximizing the objective of the SOE, i.e. \( q^*_i \geq 0 \), \( \partial T_i / \partial q^*_i \leq 0 \) and \( q^*_i \cdot \partial T_i / \partial q^*_i = 0 \), we have the necessary conditions for having a boundary solution for zero SOE’s export output as follows:

\[ \frac{\partial T_i}{\partial q^*_i} = (1 - k - 2q^*_i - q^p_i - 2q^*_i - q^0_i - t_i - q^p_i \theta) = \frac{-1 - 23k}{19} < 0. \]

It is easily shown that when \( 2/11 < k < 3/7 \), then \( \partial T_i / \partial q^*_i < 0 \). Therefore, the optimal export output of the SOE is also zero, and thus the SOE would not participate in exporting in an open economy.
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