Privatization and Free Trade Policies with Excess Burden of Taxation

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Abstract

We consider free trade policies within bilateral mixed markets where a state-owned enterprise in each country competes with both domestic and foreign private enterprises. We analyze the strategic interaction of two countries' optimal choices on free trade agreement (FTA) and privatization policy with excess burden of taxation. We show that the welfare effect of privatization depends on the implementation of FTA while the welfare effect of FTA depends on the shadow cost of excess burden. We also show that FTA accompanied with privatization policy can be welfare-improving payoff-dominance equilibrium when shadow cost is small while nationalization policy without FTA can be also welfare-improving equilibrium when shadow cost is large. However, the latter equilibrium can be welfare-distorting when shadow cost is very small.

***Keywords*:** bilateral mixed market; excess taxation burden; FTA; privatization

JEL Codes: L33; D43; F12

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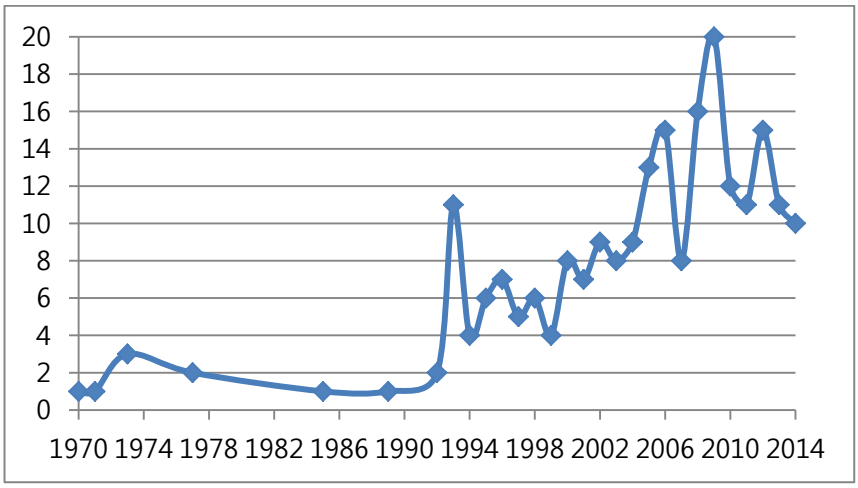
1. Introduction

Since the mid-1990s, the pace of globalization was quickened by the multilateral free trade negotiations, the liberalization of trade and foreign investment, deregulation and privatization of national industries. At the same time, many developed and developing countries have also sought to embrace the bilateral and regional routes of trade liberalization by creating their own free trade agreement (FTA) or joining existing FTAs as a key strategy of trade liberalization and regional integration. According to the WTO (2015), the regional trade agreements (RTAs) which are reciprocal agreements on trade between two or more partners are the prominent feature of international trade. For example, among 406 RTAs which are in force from 1970 to 2015 in the world, the number of FTAs is 232, i.e., more than half of the countries choose to join the FTA. As shown in Figure 1, the trend of FTAs according to the date of entry into force shows that the annual increase of new FTAs is over ten percent from 1990s in the worldwide. As of 2014, 227 FTAs are in force and more FTAs are in the process of being enacted.



<Figure 1> Numbers of FTAs according to the date of entry into force

Source: Database of World Trade Organization (2015)

One of the objectives of FTA is to stimulate trade between countries and increase trade of goods and services with each other by removing trade barriers such as tariffs and quotas. FTAs are also cascadable to some degrees in the growth.[2] For example, if some countries sign agreements to form a FTA and choose to negotiate together another FTA with another countries, then the new FTA will consist of the old FTA plus the new countries. Hence, more and more countries are experiencing the negotiation for creating

* Urata (2002) describes some characteristics of the growth in FTAs. Some well-known inter-regional economic cooperation agreements on FTAs include the European Economic Community (EEC), North American Free Trade Agreement (NAFTA), Southern Common Market (MERCOSUR), and ASEAN Free Trade Area.

or joining the existing FTAs in the recent decades. Furthermore, current FTAs are moving to include not only liberalization and facilitation of service trade and foreign investment, but also agreements on dispute settlement and common rules such as labor market mobility, intellectual property, and competition policy.

Some strategic approaches of external and internal factors are behind the expansion, intensification and diversification of FTAs. External factors include securing products markets by accessing to important foreign markets and providing export opportunities for domestic firms by dismantling the trade barriers between participating countries. Internal factors include economic growth from increased efficiency due to greater competition as a result of the markets being opened.

However, even under the global trends of trade liberalization and privatization, state-owned enterprises (SOEs) are still strongly concentrated in a few strategic sectors and thus, they still control large portions of the world's resources. According to OECD report by Kowalski *et al.* (2013), among the 2000 largest public companies in the world, over 10% SOEs have significant government ownership and their sales are equivalent to approximately 6% of worldwide GDP. Over half (in values terms) of all SOEs in OECD countries are significant players in sectors such as transportation, telecommunications, power generation, electricity, finance, manufacturing, and other energy industries. FTA has inspired foreign firms' entry into those industries and thus, not only SOEs but also domestic and foreign private firms coexist in mixed markets. Hence, it is important to understand the strategic interaction of countries' optimal choice on FTA and privatization policy in the context of international mixed markets.

Fjell and Pal (1996) firstly formulated the economic modelling of a mixed oligopoly with foreign competitors and investigated the effect of introducing foreign private firms on the market price and allocation of production. Pal and White (1998) also examined the interaction between privatization and strategic trade policies,[3] and found that the welfare is always increased with privatization if production subsidy is used only. Also, privatization increases welfare over much of the parameter space if import tariff is used only. Pal and White (2003) showed that the existence of SOE lowers optimal tariffs and subsidies, but also lowers the total volume of trade between the two countries. The lower volume of trade, however, does not translate into lower levels of welfare for the trading countries. Chang (2005) examined a mixed duopoly model with a more efficient foreign firm and showed that the optimal level of

[3] In the strategic trade literature, Brander and Spencer (1984, 1985) firstly showed that government could improve its terms of trade through tariff or subsidy to take a leader position transferring a foreign firm's revenue to a domestic firm. Eaton and Grossman (1986) and Collie (1993) also analyzed the welfare effects of trade and industrial policies for a range of specifications of an oligopolistic industry and cost asymmetry. Van Long and Stähler (2009) examined that the home government can simultaneously subsidize domestic firms and impose tariffs. It is well-known proposition of trade theory that in the absence of directly trade-related distortions or policy goals, subsidies are superior to tariffs for achieving any economic objective.

privatization depends crucially upon the strategic substitutability-complementarity assumption. Chao and Yu (2006) found that foreign competition lowers the optimal tariff rate but partial privatization raises it. Yu and Lee (2011) and Han (2012) also examined the optimal degree of privatization and trade policies in a mixed oligopoly market and showed that privatization strategy is affected strongly by trade instruments and cost difference between firms.

On the other hand, as pointed out by Lin *et al.* (1998) and Lin and Tan (1999), SOEs often undertake the public policy of the government, such as retaining redundant workers or providing social goods for governmental responsibility on society, which causes the welfare loss; that is, there is an excess burden of taxation for public funding. Laffont and Tirole (1986) incorporated the shadow cost of public funds in regulating public monopolist's optimal subsidy. Capuano and De Feo (2008) examined the effect of the shadow cost of public funds in mixed duopoly on privatization and market structure. Wang and Chen (2011) investigated the subsidy policy in mixed duopoly market with excess burden of taxation and showed that different degree of efficiency gain sharply changes the comparisons of optimal subsidy, total outputs and social welfare between mixed and private duopoly. Matsumura and Tomaru (2013) analyzed the endogenous market structure with optimal tax-subsidy policies in mixed and private oligopolies with excess taxation burden and found out that privatization affects the welfare which is in contrast to the existing works on the privatization neutrality theorem.[4]

All those previous studies have explored the welfare consequences of privatization policy in a unilateral mixed market framework, where the domestic SOE competes with domestic or/and foreign firms in the home country. However, as FTA has recently inspired foreign competition into domestic market, the strategic interaction between two countries plays an important role to promote the expansion of FTAs and the establishment of privatization policies.

Barcena-Ruiz and Garzon (2005) considered an integrated market, comprising of two countries. Assuming that SOEs are less efficient than private firms, they obtained that when the marginal cost of the SOE takes an intermediate value, each government wants the other government in other country to privatize its SOE. Dadpay and Heywood (2006) showed that two competing (domestic and foreign) SOEs play the role of trade barriers and the strategic interaction of the two governments usually serves to reduce welfare. Han and Ogawa (2008) and Lee *et al.* (2013) incorporated import tariff and

[4] Privatization neutrality theorem states that privatization does not affect welfare regardless of time structure, competition mode, the number of firms, product differentiation, and the degree of privatization under the optimal tax-subsidy policy. This well-known theorem has been discussed in White (1996), Poyago-Theotoky (2001), Tomaru (2006), Hashimzade et al. (2007) and Matsumura and Okumura (2013). However, if there are foreign competitors, privatization matters on the welfare even under the optimal tax-subsidy policy. See, for example, Matsumura and Tomaru (2013).

examined the interaction of two countries regarding strategic choices of privatization policy and import tariff in a bilateral mixed market. They also demonstrated that the equilibrium degree of privatization depends not only on the relative efficiency of the SOE, but also on choice of trade policy.

In this paper, we consider free trade policies within bilateral mixed markets where SOE in each country competes with both domestic and foreign private enterprises, and examine the strategic interaction of two countries' optimal choices on FTA and privatization policy with excess burden of taxation. We show that the welfare effect of privatization depends on the implementation of FTA. In particular, privatization will reduce social welfare before FTA while it will improve after FTA. We also show that the welfare effect of FTA depends on the shadow cost of excess burden. In particular, free trade will reduce social welfare in the mixed market. However, in the private market FTA will improve welfare when shadow cost is small, but FTA will reduce welfare when shadow cost is large. Finally, we examine a FTA coordination game and show that FTA accompanied with privatization policy can be welfare-improving payoff-dominance equilibrium when shadow cost is relatively small while nationalization policy without FTA can be also welfare-improving equilibrium when shadow cost is relatively large. However, the latter equilibrium can be welfare-distorting when shadow cost is very small.

The remainder of this paper is organized as follows. Section 2 introduces the basic model of bilateral mixed market. In section 3, we investigate four different choices of privatization and free trade policies with excess burden of taxation. In section 4, we compare the four equilibria and examine the welfare effect of privatization and free trade policies. In section 5, we investigate a FTA coordination game between two countries to examine whether or not both countries sign on FTA. In section 6, we provide conclusion.

2. The Basic Model

Suppose that there are two countries: one is home country (country *i*) and the other is foreign country (country *j*). Both home and foreign countries have symmetric duopoly situations in homogeneous product markets; that is, each country has a state-owned enterprise (SOE) and a private enterprise (PE). We assume that SOE and PE can supply not only for their domestic but also for foreign markets and two countries are engaged in intra-industry trade.

Let us denote SOE's outputs in country *i* as q_{hi}^{SOE} and their export outputs as q_{ei}^{SOE}. Similarly, q_{hi}^{PE} and q_{ei}^{PE} are PE's outputs in country *i*. The inverse demand functions of both markets are the same and given by $P_i = 1 - Q_i$, i =1, 2, where the price of market i is denoted by P_i and the output of market i is $Q_i = q_{hi}^{SOE} + q_{ej}^{SOE} + q_{hi}^{PE} + q_{ej}^{PE}$

where $i \neq j = 1,2$. The consumer surplus is denoted as $CS_i = \frac{1}{2}Q_i^2$.We assume that the cost functions of SOE and PE in the two countries are same and quadratic[5], $C(q_{hi}^M + q_{ei}^M) = \frac{1}{2}(q_{hi}^M + q_{ei}^M)^2$, where *M = SOE, PE.*

Both governments adopt a complete set of trade policy instruments, including a production subsidy $s_i(\geq 0)$ per unit of output provided to the domestic firms and an import tariff $t_i(\geq 0)$ per unit of output imposed on the foreign firms. Then the subsidy expenditure and tariff revenue of country *i* can be defined as: $S_i = s_i(q_{hi}^{SOE} + q_{ei}^{SOE} + q_{hi}^{PE} + q_{ei}^{PE})$ and $T_i = t_i(q_{ej}^{SOE} + q_{ej}^{PE})$. Hence, the government revenue is $GR_i = T_i - S_i$. We also assume that the government finances the specific subsidy for the firms by taxation with excess burden.

The profits of the SOE and PE in country *i* are:

$$\pi_i^M = (P_i + s_i)q_{hi}^M + (P_j + s_i - t_j)q_{ei}^M - \frac{1}{2}(q_{hi}^M + q_{ei}^M)^2, \ \ where\, M = SOE, PE \tag{1}$$

We allow the profit of SOE to be either negative or positive in the mixed market. Then, the government finances the subsidies for the two firms from taxation outside the market and from the profit of SOE, if it is positive. Thus, the social welfare in country *i* is defined as the sum of consumer surplus, producer surplus, government revenue, and the excess burden of taxation.

$$W_i = CS_i + (\pi_i^{SOE} + \pi_i^{PE}) + (T_i - S_i) + \lambda(\pi_i^{SOE} + T_i - S_i) \tag{2}$$

$$= CS_i + \pi_i + GR_i + \lambda EB_i \tag{3}$$

where $\lambda \in [0,1]$ represents the shadow cost of government's excess burden of taxation, $EB_i = \pi_i^{SOE} + T_i - S_i$. Note that all the (positive or negative) profit of SOE comprises a part of excess burden of taxation in mixed market. However, in a private market, where the SOE in each country is fully privatized, the profit of SOE will be determined by the profit of domestic private firm ex post. Thus, following the suggestions on the order of policy decision making in Matsumura and Tomaru (2013), we assume that after privatization π_i^{SOE} becomes ex post π_i^{PE}, which is given as *V* ex ante, and thus, EB_i equals to $V + T_i - S_i$, where *V* is the revenue from selling the stocks of SOE, and thus

[5] In the mixed market literature, asymmetric costs between SOE and PE proposed the desirability of privatization. See, for example, Lee and Hwang (2003), Chang (2005), Lee (2006), and Wang *et al.* (2009). However, early studies of mixed oligopoly, including De Fraja and Delbono (1989), Matsumura (1998), and Pal and White (1998), assumed the same increasing marginal cost. See also Matsumura and Kanda (2005), Tomaru and Kiyono (2010), and Xu and Lee (2015) for the policy importance of increasing marginal costs in mixed markets.

does not affect the excess burden of taxation.[6]

Finally, the firms' objective functions are subject to their 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.

The three-stage game is constructed. In the first stage, both governments decide whether or not they implement free trade and privatization policies. In the second stage they choose the levels of tariff and subsidy to maximize their domestic social welfares. In the third stage, observing the decision on privatization and the levels of tariff and subsidy, the firms choose their output levels.

3. The Analysis

In this section, we investigate four different regime choices of production subsidy and import tariff with excess burden of taxation in bilateral markets: NB (Nationalization Before free trade) model, NA (Nationalization After free trade) model, PB (Privatization Before free trade) model and PA (Privatization After free trade) model.

3.1. NB Model

We consider a bilateral mixed market where both SOEs compete with domestic and foreign private enterprises under the production subsidy and import tariff policies with excess burden of taxation. In the last stage, the SOEs maximize their domestic social welfares, W_i, and the PEs maximize their own profits, π_i^{PE}, after observing the levels of production subsidy and import tariff.

From the first-order conditions, we have the following equilibrium outputs of the SOE and PE:

$$q_{hi}^{SOE} = \frac{(4+3\lambda)(5+7\lambda)-(7+\lambda(15+7\lambda))s_i+(2-\lambda(2+7\lambda))s_j+5(-1+2\lambda^2)t_i-5t_j-3\lambda(3+\lambda)t_j}{(5+7\lambda)(9+13\lambda)}$$

$$q_{hi}^{PE} \frac{15+51\lambda+42\lambda^2+(42+\lambda(114+77\lambda))s_i-(12+\lambda(27+14\lambda))s_j+(30+\lambda(75+46\lambda))t_i+30t_j+\lambda(84+59\lambda)t_j}{3(5+7\lambda)(9+13\lambda)}$$

$$q_{ei}^{PE} = \frac{3(1+2\lambda)(5+7\lambda)+(33+\lambda(101+77\lambda))s_i-(3+14\lambda(1+\lambda))s_j-(3+4\lambda)(5+8\lambda)t_i+60t_j-\lambda(181+136\lambda)t_j}{3(5+7\lambda)(9+13\lambda)}$$

Note that the equilibrium output of SOE for export is $q_{ei}^{SOE}=0$. This is because

[6] Note that we assume that the government chooses the optimal levels of subsidy and tariff after privatization. Then, V must be given exogenously and the government maximizes the welfare in (3). However, if we assume that the government chooses the optimal levels of subsidy and tariff before privatization, the government should anticipate how the optimal levels of subsidy and tariff affect $\pi_i^{PE}=V$ ex ante.

$q_{hi}^{SOE} > q_{hi}^{PE} + q_{ei}^{PE}$ at equilibrium and thus marginal production cost of the SOE is higher than that of the PE, conferring cost disadvantages of export to the SOE[7]. It is noteworthy that the government will strategically use the SOE at home market to act as the role of trade barriers and promote domestic market competition for reaching a higher domestic social welfare.

Then, differentiations of W_i with respect to s_i and t_i yield the following two results.

1) If $0 \le \lambda \le 0.195$, then the optimal subsidy and tariff are:

$$s_i^{NB} = \frac{54 + \lambda(39 - 2\lambda(465 + \lambda(1,447 + \lambda(1,615 + 631\lambda))))}{\Delta_1}$$

$$t_i^{NB} = \frac{(1+\lambda)(57 + \lambda(395 + \lambda(1,079 + \lambda(1,350 + 643\lambda))))}{\Delta_1}$$

where $\Delta_1 = (2+3\lambda)(183 + \lambda(1211 + \lambda(2959 + 10\lambda(317 + 125\lambda))))$.

Substituting the subsidy and tariff yields the following market output and price:

$$Q_i^{NB} = \frac{(1+\lambda)(243 + \lambda(1,545 + \lambda(3,666 + \lambda(3,865 + 1,532\lambda))))}{\Delta_1}$$

$$P_i^{NB} = \frac{123 + \lambda(1,183 + \lambda(4,340 + \lambda(7,686 + \lambda(6,613 + 2,218\lambda))))}{\Delta_1}$$

2) If $0.195 \le \lambda \le 1$, then the optimal subisdy is zero, and the optimal tariff is:

$$t_i^{NB} = \frac{120 + \lambda(791 + \lambda(1,939 + \lambda(2,077 + 816\lambda)))}{\Delta_2}$$

where $\Delta_2 = 870 + \lambda(5,059 + 2\lambda\ (5,521 + \lambda(5,345 + 1,931\lambda))))$.

Substituting the tariff yields the following market output and price:

$$Q_i^{NB} = \frac{50 + \lambda(2,979 + \lambda(6,171 + 2\lambda(2,839 + 977\lambda)))}{\Delta_2}$$

$$P_i^{NB} = \frac{330 + \lambda(2,080 + \lambda(4,871 + 4\lambda(1,253 + 477\lambda)))}{\Delta_2}$$

[7] In reality, the domestic SOEs have significant market shares in sectors such as transportation, telecommunications, power generation, electricity, finance, manufacturing, and other energy industries. Thus, for some governmental purposes such as to stabilize domestic market prices, SOEs seldom participate in export. Existing literature also shows that international trade will induce only the more productive private firms to enter the export market, while some less productive firms will continue to produce only for the domestic market when export market entry costs exist (Melitz, 2003; Helpman *et al.* 2004) or cost inefficiency of the SOE (Lee *et al*. 2013).

Table 1 provides consumer surplus, producer surplus, and welfare in NB model.

<Table 1: Results in NB model>

$0 \le \lambda \le 0.195$	
CS_i	$\frac{(1+\lambda)^2(243+\lambda(1,545+\lambda(3,666+\lambda(3,865+1,532\lambda))))^2}{2(\Delta_1)^2}$
π_i	$\frac{(1+\lambda)^2}{2(\Delta_1)^2}\left(\begin{array}{l}(53,091+\lambda(634,410+\lambda(3,329,967+\lambda(10,050,006+\lambda(19,115,630\\+\lambda(23,515,354+\lambda(18,311,311+2\lambda(4,135,080+830,917\lambda))))))))\end{array}\right)$
GR_i	$\frac{1+\lambda}{(\Delta_1)^2}\left(\begin{array}{l}(-11,925+\lambda(-78,570+\lambda(41,078+\lambda(1,990,708+\lambda(8,734,659\\+\lambda(19,607,777+\lambda(26,210,033+\lambda(9,548,247+1,862,654\lambda))))))))\end{array}\right)$
EB_i	$\frac{1+\lambda}{(\Delta_1)^2}\left(\begin{array}{l}(6,390+\lambda(238,740+\lambda(2,378,350+\lambda(11,742,718+\lambda(34,342,287+\lambda\\(63,710,055+\lambda(76,185,951+\lambda(57,151,137+5\lambda(49,808,965+923,167\lambda))))))))\end{array}\right)$
W_i	$\frac{(1+\lambda)^2}{2(\Delta_1)^2}\left(\begin{array}{l}(88,290+\lambda(1,258,380+\lambda(7,946,464+\lambda(29,168,306+\lambda(68,542,654+\lambda\\(106,845,189+\lambda(110354506+\lambda(72705853+\lambda(27,663,156+4,615,835\lambda))))))))\end{array}\right)$
$0.195 \le \lambda \le 1$	
CS_i	$\frac{(540+\lambda(2,979+\lambda(6,171+2\lambda(2,839+977\lambda))))^2}{2(\Delta_2)^2}$
π_i	$\frac{1}{2(\Delta_2)^2}\left(\begin{array}{l}(187,200+\lambda(2,384,640+\lambda(13,055,163+\lambda(40,264,362+\lambda(76,703,181\\+2\lambda(4,0287,370+\lambda(34,605,031+22\lambda(666,543+122,641\lambda)))))))\end{array}\right)$
GR_i	$\frac{1}{(\Delta_2)^2}\left(\begin{array}{l}(30+\lambda(166+\lambda(331+286\lambda+92\lambda^2)))\\(120+\lambda(791+\lambda(1,939+\lambda(2,077+816\lambda))))\end{array}\right)$
EB_i	$\frac{1}{2(\Delta_2)^2}\left(\begin{array}{l}(115,200+\lambda(1,473,540+\lambda(8,027,536+\lambda(24,468,062+\lambda(45,808,770\\+\lambda(54,077,564+\lambda(39,378,295+4\lambda(4,047,787+720,123\lambda)))))))\end{array}\right)$
W_i	$\frac{1}{2(\Delta_2)^2}\left(\begin{array}{l}(486,000+\lambda(5,804,460+\lambda(30,526,216+\lambda(92,551,606+\lambda(177,689,002+\lambda(\\223,003,856+\lambda(181,728,590+\lambda(91,744,731+4\lambda(6,388,903+720,123\lambda))))))))\end{array}\right)$

3.2. NA Model

We consider the other bilateral mixed market where two countries sign on the FTA, but keep SOE in the mixed market. Then, government uses production subsidy only to maximize the domestic social welfare after FTA. Setting $t_i = t_j = 0$ into the equilibrium and welfare in the previous NB model, we can have the following optimal results:

1) If $0 \le \lambda \le 0.222$, then the optimal subsidy is:

$$s_i^{NA} = \frac{87 - \lambda(5 + \lambda(1,156 + \lambda(2,284 + 1,281\lambda)))}{\Delta_3}$$

where $\Delta_3 = 501 + \lambda(3,331 + \lambda(8,168 + \lambda(8,791 + 3,514\lambda)))$.

Substituting the optimal subsidy yields the following market output and price:

$$Q_i^{NA} = \frac{(1+\lambda)(363+2\lambda(880+\lambda(1,411+749\lambda)))}{\Delta_3}$$

$$P_i^{NA} = \frac{138+\lambda(1,208+\lambda(3,586+\lambda(4,471+2,016\lambda)))}{\Delta_3}$$

2) If $0.222 \le \lambda \le 1$, then the optimal subisdy is zero. Then, we obtain the market output and price: $Q_i^{NA} = \frac{6+7\lambda}{9+13\lambda}$ and $P_i^{NA} = \frac{3+6\lambda}{9+13\lambda}$.

Table 2 provides consumer surplus, producer surplus, and welfare in NA model.

<Table 2: Results in NA model>

	$0 \le \lambda \le 0.222$	$0.222 \le \lambda \le 1$
CS_i	$\frac{(1+\lambda)^2(363+2\lambda(880+\lambda(1,411+749\lambda)))^2}{2(\Delta_3)^2}$	$\frac{(6+7\lambda)^2}{2(9+13\lambda)^2}$
π_i	$\frac{1}{2(\Delta_3)^2}\left(\begin{array}{l}(1+\lambda)^2(95,481+2\lambda(417,210+\lambda(1,516,820 \\ +\lambda(2,945,719+7\lambda(136,151+33,782\lambda))))\end{array}\right)$	$\frac{16+\lambda(74+59\lambda)}{2(9+13\lambda)^2}$
GR_i	$\frac{1}{(\Delta_3)^2}\left(\begin{array}{l}(1+\lambda)(363+2\lambda(880+\lambda(1,411+749\lambda))) \\ (-87+\lambda(5+\lambda(1,156+\lambda(2,284+1,281\lambda))))\end{array}\right)$	0
EB_i	$\frac{1}{2(\Delta_3)^2}\left(\begin{array}{l}(1+\lambda)(-12,681+\lambda(191,,091+2\lambda(1,205,840+\lambda(5,085,199 \\ +2\lambda(5,473,851+\lambda(6,522,930+7\lambda(587,624+153,699\lambda)))))))\end{array}\right)$	$\frac{(4+3\lambda)(2+9\lambda)}{2(9+13\lambda)^2}$
W_i	$\frac{1}{2(\Delta_3)^2}\left(\begin{array}{l}(1+\lambda)^2(164,088+\lambda(1,860,051+2\lambda(4,494,530+\lambda(12,004,965 \\ +2\lambda(9,571,004+\lambda(9,110,928+7\lambda(684,917+153,699\lambda)))))))\end{array}\right)$	$\frac{(2+3\lambda)(26+\lambda(44+9\lambda))}{2(9+13\lambda)^2}$

3.3. PB Model

We consider a bilateral private market before FTA where SOEs in each country are fully privatized. After observing s_i and t_i, both firms independently choose their outputs to maximize their profits.

From the first-order conditions, we have the following equilibrium outputs of the four firms of country i and j: $q_{hi}^{SOE} = q_{hi}^{PE} = \frac{15+25s_i-10s_j+26t_i+19t_j}{105}$ and $q_{ei}^{SOE} = q_{ei}^{PE} = \frac{15+25s_i-10s_j-16t_i-44t_j}{105}$ The market output and price are $Q_i = \frac{2(10+5s_i+5s_j-6t_i+t_j)}{35}$ and $P_i = \frac{15-10s_i-10s_j+12t_i-2t_j)}{35}$.

Then, differentiation of W_i with respect to s_i and t_i yields the following optimal results:

1) If $0 \le \lambda \le 0.167$, then the optimal degree of subsidy and tariff are:

$s_i^{PB} = \frac{19 - \lambda(80 + 203\lambda)}{171 + \lambda(620 + 553\lambda)}$ and $t_i^{PB} = \frac{10(1+\lambda)(3+7\lambda)}{171 + \lambda(620 + 553\lambda)}$. Substituting the optimal subsidy and tariff yields $Q_i^{PB} = \frac{20(1+\lambda)(5+9\lambda)}{171 + \lambda(620 + 553\lambda)}$ and $P_i^{PB} = \frac{71 + \lambda(340 + 373\lambda)}{171 + \lambda(620 + 553\lambda)}$.

2) If $0.167 \le \lambda \le 1$, then the optimal subisdy is zero. And the optimal degree of tariff is: $t_i^{PB} = \frac{73 + 105\lambda}{2(209 + 364\lambda)}$. Substituting the optimal tariff, we can obtain: $Q_i^{PB} = \frac{109 + 193\lambda}{209 + 364\lambda}$ and $P_i^{PB} = \frac{100 + 171\lambda}{209 + 364\lambda}$

Table 3 provides consumer surplus, producer surplus, and welfare in PB model.

<Table 3: Results in PB model>

	$0 \le \lambda \le 0.167$	$0.167 \le \lambda \le 1$
CS_i	$\frac{(20(1+\lambda)(5+9\lambda))^2}{2(171+\lambda(620+553\lambda))^2}$	$\frac{(109+193\lambda)^2}{2(209+364\lambda)^2}$
π_i	$\frac{100(1+\lambda)^2(59+\lambda(222+221\lambda))}{(171+\lambda(620+553\lambda))^2}$	$\frac{29,091+\lambda(99,478+85,523\lambda)}{4(209+364\lambda)^2}$
GR_i	$\frac{20(1+\lambda)(-65+\lambda(359+\lambda(1,905+1,897\lambda)))}{(171+\lambda(620+553\lambda))^2}$	$\frac{(9+22\lambda)(73+105\lambda)}{(209+364\lambda)^2}$
EB_i	$\frac{10(1+\lambda)(165+\lambda(2,123+\lambda(5,957+4,849\lambda)))}{(171+\lambda(620+553\lambda))^2}$	$\frac{34,347+\lambda(119,886+104,003\lambda)}{8(209+364\lambda)^2}$
W_i	$\frac{10(1+\lambda)^2(960+\lambda(5,033+\lambda(8,650+4,849\lambda)))}{(171+\lambda(620+553\lambda))^2}$	$\frac{110,962+\lambda(422,007+\lambda(458,408+104,003\lambda))}{8(209+364\lambda)^2}$

3.4. PA Model

We consider the other bilateral private market where the government uses production subsidy only after FTA. Setting $t_i = t_j = 0$ into the equilibrium and welfare in the previous PB model, we can have the following optimal results:

1) If $0 \le \lambda \le 0.238$, then the optimal degree of subsidy is: $s_i^{PA} = \frac{5 - 21\lambda}{30 + 56\lambda}$. Substituting the optimal subsidy yields: $Q_i^{PA} = \frac{10(1+\lambda)}{15 + 28\lambda}$ and $P_i^{PA} = \frac{5 + 18\lambda}{15 + 28\lambda}$.

2) If $0.238 \le \lambda \le 1$, then the optimal subisdy is zero. Then the market output, price and are $Q_i^{PA} = \frac{4}{7}$ and $P_i^{PA} = \frac{3}{7}$.

Table 4 provides consumer surplus, producer surplus, and welfare in PA model.

<Table 4: Results in PA model>

	$0 \le \lambda \le 0.238$	$0.238 \le \lambda \le 1$
CS_i	$50(1+\lambda)^2/(15+28\lambda)^2$	$8/49$
π_i	$50(1+\lambda)^2/(15+28\lambda)^2$	$8/49$
GR_i	$5(1+\lambda)(-5+21\lambda)/(15+28\lambda)^2$	0
EB_i	$130\lambda(1+\lambda)/(15+28\lambda)^2$	$4/49$
W_i	$5(1+\lambda)^2(15+26\lambda)/(15+28\lambda)^2$	$4(4+\lambda)/49$

4. Comparisons

In this section, we compare the optimal equilibria of four scenarios and examine the welfare effect of privatization and free trade policies.

4.1. Does privatization policy matter?

We compare the results between bilateral mixed market and bilateral private market before FTA and after FTA, respectively.

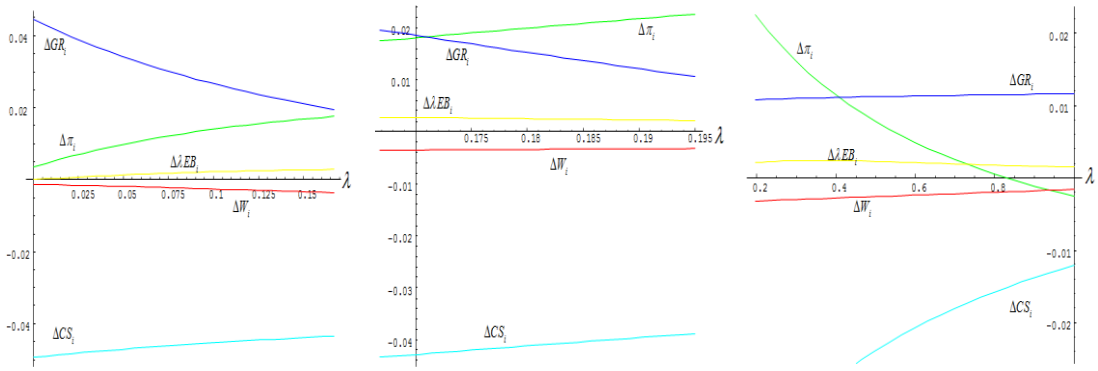
4.1.1. Comparisons between NB and PB models

Without free trade, the optimal tariff is affected by the shadow cost of excess burden: $t_i^{NA} \le t_i^{PA}$ if $0 \le \lambda \le 0.350$ while $t_i^{NA} \ge t_i^{PA}$ if $0.350 \le \lambda \le 1$. That is, when the shadow cost is small, the government raises the tariff to increase government revenue, which can lead to welfare-improving result. However, when the shadow cost is large, the government reduces the tariff to stimulate the production of foreign firms due to the underproduction after privatization. Also, the optimal subsidy decreases after privatization, $s_i^{NB} \ge s_i^{PB}$. Especially, the higher shadow cost reduces the optimal subsidy rate to become zero in mixed and private markets when $0.195 \le \lambda \le 1$. Finally, we have $Q_i^{NB} > Q_i^{PB}$ and $P_i^{NB} < P_i^{PB}$. Thus, consumer surplus decreases after privatization without free trade.

Figure 2 shows the change of social welfare between NB and PB models before FTA. First, privatization reduces consumer surplus. Second, mostly privatization improves producer surplus because privatization can reduce the total production cost of industry. Only when the shadow cost is quite large, $0.875 \le \lambda \le 1$, privatization will reduce producer surplus because the government chooses zero subsidy to domestic firms. Third, privatization improves both the government revenue and excess burden. Finally, we find that the decrease of consumer surplus is much larger than the increase

of the sum of producer surplus, government revenue and excess burden. Thus, privatization reduces social welfare before FTA, $W_i^{NB} > W_i^{PB}$

(1) $0 \le \lambda \le 0.167$ (2) $0.167 \le \lambda \le 0.195$ (3) $0.195 \le \lambda \le 1$

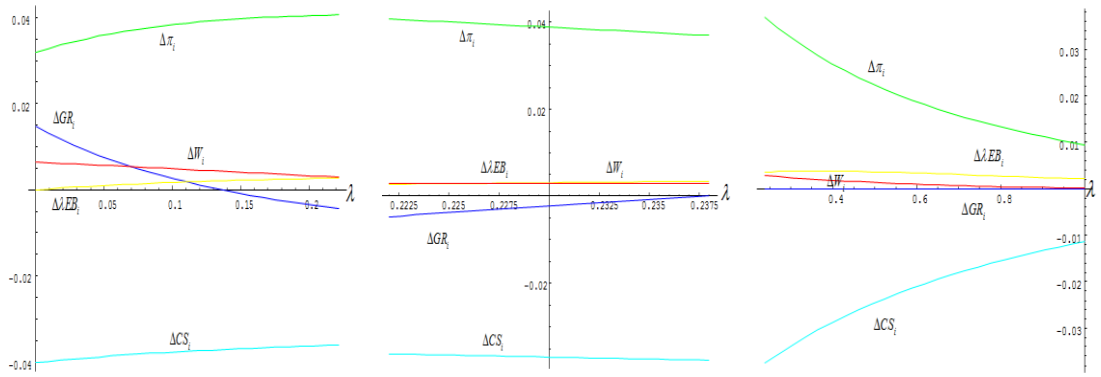


<Figure 2> Comparisons between NB and PB models

4.1.2. Comparisons between NA and PA models

Under free trade, the optimal subsidy is affected by the shadow cost of excess burden: $s_i^{NA} > s_i^{PA}$ if $0 \le \lambda \le 0.059$ while $s_i^{NA} \le s_i^{PA}$ if $0.059 \le \lambda \le 0.238$. Especially, the higher shadow cost reduces the optimal subsidy rate to become zero in mixed and private markets when $0.238 \le \lambda \le 1$. That is, when the shadow cost is quite small, the government decreases the optimal subsidy to increase government revenue. However, when the shadow cost is large, the underproduction after privatization becomes more serious under free trade. Hence, the government increases the optimal subsidy to stimulate the production of privatized firms. Finally, we have $Q_i^{NA} > Q_i^{PA}$ and $P_i^{NA} < P_i^{PA}$. Thus, consumer surplus decreases after privatization under free trade.

(1) $0 \le \lambda \le 0.222$ (2) $0.222 \le \lambda \le 0.238$ (3) $0.238 \le \lambda \le 1$



<Figure 3> Comparisons between NA and PA models

Figure 3 shows the change of social welfare between NA and PA models under FTA. First, privatization reduces consumer surplus, which is the same with the result

before FTA. Second, privatization after FTA improves producer surplus because of increased efficiency and export. The privatization can reduce the total production cost of industry and accompanied with free trade policy, encourage both domestic firms to enter foreign market which can improve producer consumer. In sum, the profits of privatized and private firms increase, $\Delta\pi_i^{SOE} > 0, \Delta\pi_i^{PE} > 0$. Third, privatization reduces government revenue but improves excess burden. After FTA, the governments cannot impose tariff to foreign firms which is the main reason why the government revenue decreases, but it can increases its revenue due to the increased profits of privatized firm. Note that when $0.238 \le \lambda \le 1$, $s_i^{NA} = s_i^{PA} = 0$. That is, because of zero tariff and subsidy, the change of government revenue and excess burden is relatively small after FTA. Hence, privatization improve social welfare after FTA, $W_i^{NA} < W_i^{PA}$.

Proposition 1: *The welfare effect of privatization depends on the implementation of FTA. In particular, privatization will reduce the social welfare before FTA while it will improve after FTA.*

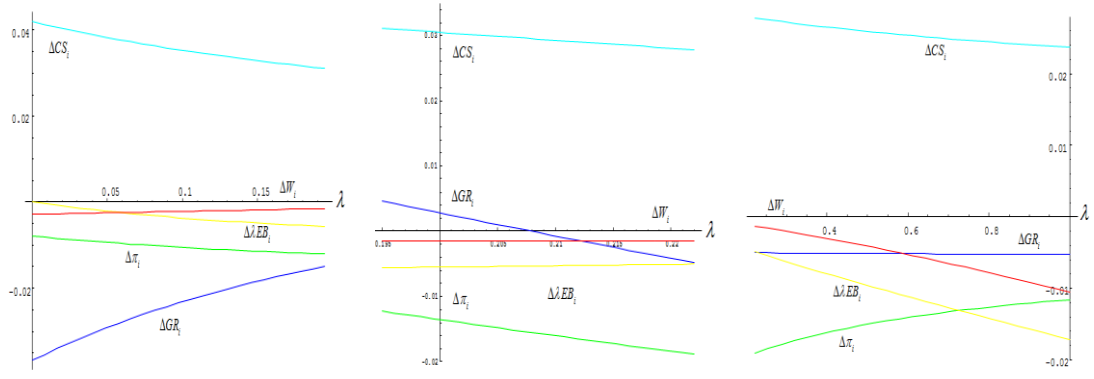
4.2. Does FTA policy matter?

We compare the results between before FTA and after FTA under bilateral mixed market and bilateral private market, respectively.

4.2.1. Comparisons between NB and NA models

In a mixed market, FTA will eliminate the tariff, $t_i^{NB} > t_i^{NA} = 0$, and in return, the optimal subsidy increases, $s_i^{NB} \le s_i^{NA}$. The government will stimulate the production of domestic firms, but its effect on government revenue is negative. Finally, we have: $Q_i^{NB} < Q_i^{NA}$ and $P_i^{NB} > P_i^{NA}$.

(1) $0 \le \lambda \le 0.195$ (2) $0.195 \le \lambda \le 0.222$ (3) $0.222 \le \lambda \le 1$



<Figure 4> Comparisons between NB and NA models

Figure 4 shows the change of social welfare between NB and NA models in mixed markets. First, free trade improves consumer surplus because of market enlargement

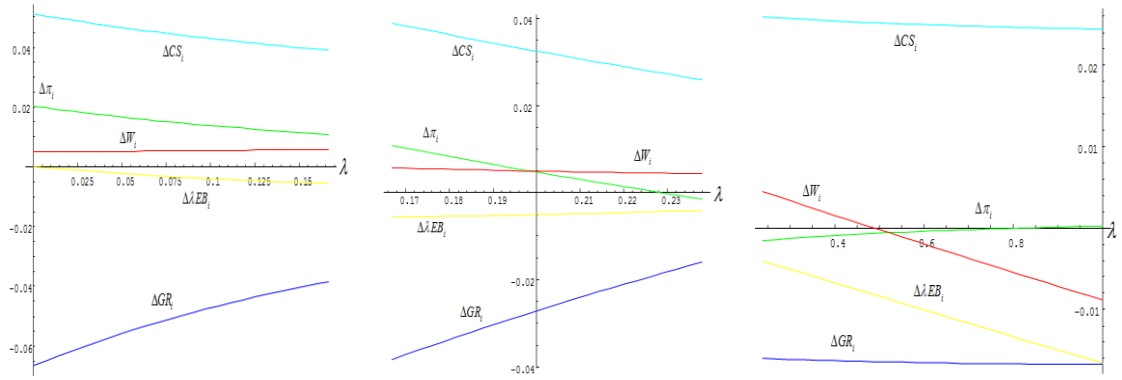
effect. Second, free trade also reduces producer surplus because of rent displacement effect. Third, free trade leads to zero tariff revenue and reduce the government revenue and excess burden. Hence, free trade decreases social welfare after FTA, $W_i^{NB} > W_i^{NA}$.

Proposition 2: *FTA will decrease social welfare in mixed market.*

4.2.2. Comparisons between PB and PA models

In a private market, FTA will eliminate the tariff, $t_i^{PB} > t_i^{PA} = 0$, but the shadow cost of excess burden matters on the optimal subsidy only when it is small: $s_i^{PB} \le s_i^{PA}$ if $0 \le \lambda \le 0.238$ while $s_i^{PB} = s_i^{PA} = 0$ if $0.238 \le \lambda \le 1$. The government increases subsidy to stimulate the production of both domestic firms after FTA, which will reduce government revenue. Finally, we have $Q_i^{PB} < Q_i^{PA}$ and $P_i^{PB} > P_i^{PA}$.

(1) $0 \le \lambda \le 0.167$ (2) $0.167 \le \lambda \le 0.238$ (3) $0.238 \le \lambda \le 1$



<Figure 5> Comparisons between PB and PA models

Figure 5 shows the change of social welfare between PB and PA models in private markets. First, free trade also improves consumer surplus through the market enlargement effect. Second, free trade improves producer surplus mostly but reduces producer surplus if shadow cost is large. Third, free trade leads to zero tariff and thus reduce both government revenue and excess burden. Finally, when shadow cost is small, $0 \le \lambda \le 0.487$, free trade improves social welfare, $W_i^{PB} < W_i^{PA}$, but when shadow cost is large, $0.487 \le \lambda \le 1$, free trade reduces social welfare $W_i^{PB} > W_i^{PA}$.

Proposition 3: *FTA will increase social welfare when the shadow cost of excess burden is small, but decrease when it is large in private market.*

4.3. Do both privatization and FTA policies matter?

Finally, we compare the results between mixed market without FTA and private market with FTA. Comparing the optimal subsidy and tariff levels, we have $s_i^{NB} \le s_i^{PA}$

and $t_i^{NB} > t_i^{PA} = 0$. The government increases the subsidy to stimulate the production of both domestic firms. A few findings are in order. First, free trade with privatization can reduce or improve consumer surplus. Second, free trade with privatization improves producer surplus mostly, but also reduces if the shadow cost is large. Third, free trade with privatization reduces both government revenue and excess burden. Finally, when shadow cost is small, $0 \le \lambda \le 0.321$, free trade with privatization improves social welfare, $W_i^{NB} < W_i^{PA}$, but when shadow cost is large, $0.321 \le \lambda \le 1$, free trade with privatization reduces social welfare, $W_i^{NB} > W_i^{PA}$.

Proposition 4: *FTA accompanied with privatization policy will increase social welfare only when the shadow cost of excess burden is small, but decrease when it is large.*

It implies that FTA can work as a commitment device to increase social welfare ex post privatization only when the shadow cost of excess burden is small. For example, if both countries do not care for the shadow cost and adopt a privatization policy together under FTA, then these policies could reduce entry barriers for both countries and thus achieve higher social welfare levels.

5. FTA policy coordination game

In this section, we extend the analysis into the policy coordination game on FTA to investigate the cooperative condition under which both countries sign on the FTA. We first examine the equilibrium in the privatization choice game before and after FTA, respectively, and combine these two cases to find out the equilibrium of a FTA policy coordination game between two countries.

5.1. Privatization choice game before FTA

We first consider a privatization choice game before FTA between two countries, which is described in Table 7. Then, we can show that there are two Nash equilibria in Lemma 1. The first one is that both governments choose nationalization for any value of the shadow cost of excess burden, and the other is that both governments also choose privatization only when the shadow cost of excess burden is relatively large.

<Table 7: Privatization choice game before FTA>

Country *i*, *j*	Nationalization	Privatization
Nationalization	W_i^{NB}, W_j^{NB}	W_i^{MB}, W_j^{MB}
Privatization	W_j^{MB}, W_i^{MB}	W_i^{PB}, W_j^{PB}

Lemma 1: *In the privatization choice game before FTA, both nationalization is the unique Nash equilibrium when the shadow cost of excess burden is small. However, there exist two Nash equilibria when the shadow cost of excess burden is large: both nationalization and both privatization.*

Proof: Using the results in the MB model in Appendix, we can investigate the equilibrium and its resulting welfare under the asymmetric choices on privatization where home country chooses nationalization but foreign country chooses privatization before FTA. Then, using the welfare results in the previous section, we have the following relations: $W_i^{NB} = W_j^{NB} > W_j^{MB}$ when $0 \le \lambda \le 1$. However, $W_i^{PB} = W_j^{PB} < W_i^{MB}$ when $0 \le \lambda \le 0.007$, and $W_i^{PB} = W_j^{PB} > W_i^{MB}$ when $0.007 \le \lambda \le 1$ Hence, there exists a unique Nash equilibrium when $0 \le \lambda \le 0.007$, where both governments choose nationalization. When $0.007 \le \lambda \le 1$, there exist two Nash equilibria where both governments choose nationalization or privatization.

Lemma 2: *Both nationalization is the payoff-dominance equilibrium in the privatization choice game before FTA.*

Proof: Comparing social welfares in NB and PB models yields $W_i^{NB} > W_i^{PB}$.

5.2. Privatization choice game after FTA

We also consider a privatization choice game after FTA between two countries, which is described in Table 8. Then, we can show that there are also two Nash equilibria in Lemma 3. The first one is that both governments choose nationalization for any value of the shadow cost of excess burden, and the other is that both governments also choose privatization only when the shadow cost of excess burden is relatively large.

<Table 8: Privatization choice game after FTA>

Country *i, j*	Nationalization	Privatization
Nationalization	W_i^{NA}, W_j^{NA}	W_i^{MA}, W_j^{MA}
Privatization	W_j^{MA}, W_i^{MA}	W_i^{PA}, W_j^{PA}

Lemma 3: *In the privatization choice game after FTA, both nationalization is the unique Nash equilibrium when the shadow cost of excess burden is small. However, there exist two Nash equilibria when the shadow cost of excess burden is large, both nationalization and both privatization.*

Proof: Using the results in the MA model in Appendix, we can investigate the equilibrium and its resulting welfare under the asymmetric choices on privatization where home country chooses nationalization but foreign country chooses privatization after FTA. Then, using the welfare results in the previous section, we have the following relations: $W_i^{NA} = W_j^{NA} > W_j^{MA}$ when $0 \le \lambda \le 1$. However, $W_i^{PA} = W_j^{PA} < W_i^{MA}$ when $0 \le \lambda \le 0.185$, and $W_i^{PA} = W_j^{PA} > W_i^{MA}$ when $0.185 \le \lambda \le 1$. Hence, there exists a unique Nash equilibrium when $0 \le \lambda \le 0.185$, where both governments choose nationalization. When $0.185 \le \lambda \le 1$, there exist two Nash equilibria where both governments choose nationalization or privatization.

Lemma 4: *Both nationalization is the payoff-dominance equilibrium when the shadow cost of excess burden is small, but both privatization is when the shadow cost is large in the privatization choice game after FTA.*

Proof: Comparing social welfare in NA and PA models yields $W_i^{NA} < W_i^{PA}$ when $0.185 \le \lambda \le 1$.

5.3. FTA policy coordination game

Finally, we consider a FTA policy coordination game to examine whether or not both countries decide to sign on FTA.

Proposition 5: *Under the payoff-dominance equilibrium, FTA accompanied with privatization policy is the pure strategy Nash equilibrium when* $0.185 \le \lambda \le 0.321$. *Otherwise, nationalization policy without FTA is the pure strategy Nash equilibrium.*

Proof: Comparing the payoffs in the (payoff-dominance) Nash equilibrium before and after FTA, we have: (i) if $0 \le \lambda \le 0.185$, then $W_i^{NB} > W_i^{NA}$; (ii) if $0.185 \le \lambda \le 0.321$, then $W_i^{NB} < W_i^{PA}$; (iii) if $0.321 \le \lambda \le 1$, then $W_i^{NB} > W_i^{PA}$. Thus, when $0.185 \le \lambda \le 0.321$, PA model is Nash equilibrium. Otherwise, NB model is Nash equilibrium.

Using the welfare ranks in Proposition 4 and 5, we have obtained the following two results.

Proposition 6: *Under the payoff-dominance equilibrium, FTA accompanied with privatization policy yields the highest social welfare when* $0.185 \le \lambda \le 0.321$ *while nationalization without FTA yields the highest social welfare when* $0.321 \le \lambda \le 1$.

Proposition 7: *Under the payoff-dominance equilibrium, when the shadow cost of excess burden is very small,* $0 \le \lambda \le 0.185$*, nationalization without FTA yields lower social welfare.*

6. Conclusions

This paper introduced a model of international bilateral mixed markets where the SOEs compete with domestic and foreign private enterprises, and examined the strategic interaction of two countries' optimal choices on FTA and privatization policy with excess taxation burden. The main findings of our analysis are that: First, we showed that the welfare effect of privatization depends on the implementation of FTA. In particular, privatization will reduce the social welfare before FTA while it will improve after FTA. Second, we showed that the welfare effect of FTA depends on the shadow cost of excess burden. In particular, FTA will always reduce social welfare in the mixed market. However, in the private market FTA will improve welfare when the shadow cost of excess burden is small, but it will reduce welfare when it is large. Finally, we showed that FTA accompanied with privatization policy can be welfare-improving payoff-dominance equilibrium when shadow cost is small while nationalization policy without FTA can be also welfare-improving when shadow cost is large. However, the latter equilibrium can be welfare-distorting when shadow cost is very small.

One of important future studies requires more general functional forms with asymmetric demand and cost functions between the SOE and PE for confirming the robustness of the results. Also, the number of private firm within integrated market and different mode of competition will be challenging issue for the future study.

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Appendix: Analysis of asymmetric models

1. MB Model (Mixed choice Before free trade)

We analyze the asymmetric choice between nationalization and privatization policies before FTA. In particular, this model provides the case that home country keeps SOE while foreign country privatize SOE. Then, from the first-order conditions, we have the following equilibrium outputs of the SOE and PE of country *i* and *j*:

$$q_{hi}^{SOE} = \frac{60 - 4(5+18\lambda)s_i + 8s_j - 22t_i - 17t_j}{129}; \quad q_{ei}^{SOE} = 0$$

$$q_{hi}^{PE} = \frac{9 + 5(8+3\lambda)s_i - 16s_j + 44t_i + 34t_j}{129}; \quad q_{ei}^{PE} = \frac{24 + (35-3\lambda)s_i - 14s_j - 26t_i - 67t_j}{129}$$

$$q_{hj}^{SOE} = q_{hj}^{PE} = \frac{24-(8+3\lambda)s_i + 29s_j + 17t_i + 19t_j}{129}; \quad q_{ej}^{SOE} = q_{ej}^{PE} = \frac{3+(-1+5\lambda)s_i + 9s_j - 14t_i - 3t_j}{43}$$

Then, differentiations of W_i and W_j with respect to s_i, s_j, t_i and t_j yield the following three results.

1) If $0 \le \lambda \le 0.113$, then the optimal subsidy and tariff of country *i* and *j* are:

$$s_i^{MB} = \frac{23,094 - 2\lambda(48,118 + \lambda(401,324 + 3\lambda(229,232 + 5\lambda(23,401 + 270\lambda))))}{\Delta_1'}$$

$$s_j^{MB} = \frac{19,143 - \lambda(18,972 + \lambda(382,952 + 3\lambda(198,154 + \lambda(16,917 - 10\lambda(7,171 + 480\lambda)))))}{\Delta_1'}$$

$$t_i^{MB} = \frac{(1+\lambda)(19,009 + \lambda(95,901 + \lambda(97,189 - 3\lambda(28,739 + 33,390\lambda))))}{\Delta_1'}$$

$$t_j^{MB} = \frac{2(1+\lambda)(16,826 + \lambda(77,251 + \lambda(97,544 - 3\lambda(2,000 + \lambda(17,566 + 1,785\lambda)))))}{\Delta_1'}$$

where $\Delta_1' = 157,827 - \lambda(-1,032,904 + \lambda(-2,330,188 + \lambda(-1,899,388 + 3\lambda(12,151 + 2\lambda(87,166 + 6,735\lambda)))))$

Substituting the subsidy yields the following social welfare of country *i* and *j*:

$$W_i^{MB} = \frac{2(1+\lambda)^2}{(\Delta_1')^2}\begin{pmatrix} 4,098,255,341 + \lambda(43,957,351,790 + \lambda(193,768,067,497 + \lambda(447,990,434,814 + \lambda(565,176,459,002 \\ +\lambda(342,177,791,186 + 3\lambda(5,909,524,358 + \lambda(-27,480,092,354 + 3\lambda(-27,480,092,354 + 3\lambda \\ (-27,480,092,354 + 3\lambda(-3,216,883,439 + 15(2,180,408 + 1,234,515\lambda)))))))))) \end{pmatrix}$$

$$W_j^{MB} = \frac{2(1+\lambda)^2}{(\Delta_1')^2}\begin{pmatrix} 4,084,103,213 + \lambda(44,948,843,994 + \lambda(201,950,126,715 + \lambda(46,570,910,697 + 3\lambda \\ (183,042,894,746 + \lambda(74,533,408,232 + \lambda(-51,355,199,570 + \lambda(-54,068,869,798 \\ +\lambda(-2,083,757,786 + 9\lambda(967,453,106 + 5\lambda(25,860,349 + 915,495\lambda)))))))))) \end{pmatrix}$$

2) If $0.113 \le \lambda \le 0.181$, then the optimal subisdy of country *i* is zero. The optimal subsidy and tariff of country *i* and *j* are:

$$s_i^{MB} = 0$$

$$s_j^{MB} = \frac{41,373 - \lambda(121,058 + 524,157\lambda + 369,270\lambda^2)}{\Delta_2'}$$

$$t_i^{MB} = \frac{47,651 + \lambda(127,136 + 15\lambda(3,541 - 2,322\lambda))}{\Delta_2'}$$

$$t_j^{MB} = \frac{4(15,677 + 3\lambda(28,207 + \lambda(46,661 + 24,429\lambda)))}{\Delta_2'}$$

where $\Delta_2' = 3(116,357 + \lambda(526,836 + \lambda(767,309 + 358,626\lambda)))$

Substituting the subsidy yields the following social welfare of country *i* and *j*:

$$W_i^{MB} = \frac{2}{(\Delta_2')^2}\begin{pmatrix} 9,901,809,040 + \lambda(88,793,483,947 + \lambda(329,082,878,192 + \lambda(643,653,903,860 + \\ 3\lambda(233,173,921,486 + 9\lambda(14,821,734,055 + 6\lambda(582,274,019 + 1,219,050\lambda)))))) \end{pmatrix}$$

$$W_j^{MB} = \frac{8}{(\Delta_2')^2}\begin{pmatrix} 4,904,849,273 + \lambda(45,118,679,603 + \lambda(173,630,452,874 + \lambda(363,024,891,924 + \\ \lambda(446,050,991,599 + 3\lambda(107,512,476,224 + 27\lambda(1,571,081,668 + 261,265,207\lambda)))))) \end{pmatrix}$$

3) If $0.181 \le \lambda \le 1$, then the optimal subisdy of country *i* and *j* are zero, $s_i^{MB} = s_j^{MB} = 0$.

Hence, the opitimal tariff of both countries are: $t_i^{MB} = \frac{92,995 + 3\lambda(69,013 + 21,543\lambda))}{2\Delta_3'}$

and $t_j^{MB} = \frac{92,177 + 3\lambda(70,852 + 38,313\lambda)}{\Delta_3'}$.

where $\Delta_3' = 3(146,681 + 11\lambda(34,405 + 21,543\lambda))$

Substituting the subsidy yields the following social welfare of country *i* and *j*:

$$W_i^{MB} = \frac{1}{2(\Delta_3')^2}\begin{pmatrix} 124,318,025,138 + \lambda(644,090,457,304 + 3\lambda(414,179,933,225 \\ +9\lambda(39,292,750,166 + 33\lambda(385,693,391 + 5,959,500\lambda)))) \end{pmatrix}$$

$$W_j^{MB} = \frac{1}{8(\Delta_3')^2}\begin{pmatrix} 490,115,567,882 + \lambda(2,680,248,809,743 + \lambda(5,622,642,331,156 \\ +3\lambda(1,854,789,467,633 + 396\lambda(2,118,485,087 + 323,548,434\lambda)))) \end{pmatrix}$$

2. MA Model (Mixed choice After free trade)

We analyze the other asymmetric choice that home country keeps SOE while foreign country privatize SOE after FTA. Then, setting $t_i = t_j = 0$ into the equilibrium and welfare in the previous MB model; we can have the following optimal results:

1) If $0 \le \lambda \le 0.132$, then the optimal subsidy of both countries are:

$$s_i^{MB} = \frac{20,915 - 3\lambda(37,417 + 115,404\lambda)}{\Delta_4'}$$

$$s_j^{MB} = \frac{69,263 - 9\lambda(18,049 + 77,475\lambda - 42,957\lambda^2)}{\Delta_4'}$$

where $\Delta_4' = 106,646 + \lambda(434,839 + 3\lambda(113,033 - 67,380\lambda))$

Substituting the subsidy yields the following social welfare of country *i* and *j*

$$W_i^{MB} = \frac{(1+\lambda)^2}{2(\Delta_4')^2}\begin{pmatrix} 7,869,614,414 + 3\lambda(15,173,896,564 + 3\lambda \\ (8,555,090,369 + 3\lambda(789,767,614 + 890,431,383\lambda))) \end{pmatrix}$$

$$W_j^{MB} = \frac{(1+\lambda)^2}{8(\Delta_4')^2}\begin{pmatrix} 28,192,444,398 + \lambda(172,453,152,769 + 3\lambda(99,757,619,740 \\ +3\lambda(817,258,990 - 3\lambda(8,241,695,206 - 3,027,300,339\lambda)))) \end{pmatrix}$$

2) If $0.132 \le \lambda \le 0.247$, then the optimal subisdy of country *i* and *j* are: $s_i^{MB} = 0$ and $s_j^{MB} = \frac{1,053 - 4,257\lambda}{4(1,801 + 3,612\lambda)}$. Substituting the subsidy yields the following social welfare of country *i* and *j*: $W_i^{MB} = \frac{2,188,829 + 9\lambda(990,676 + 1,061,443\lambda)}{2(1,801 + 3,612\lambda)^2}$ and $W_j^{MB} = \frac{8,028,858 + 3\lambda(10,870,007 + 9\lambda(1,344,404 + 378,731\lambda)}{8(1,801 + 3,612\lambda)^2}$

3) If $0.247 \le \lambda \le 1$, then the optimal subisdy of country *i* and *j* are zero, $s_i^{MB} = s_j^{MB} = 0$. Substituting the subsidy yields the following social welfare of country *i* and *j*: $W_i^{MB} = \frac{634}{1,894}$ and $W_j^{MB} = \frac{3(370 + 89\lambda)}{3,698}$.