ACADEMIA ECONOMIC PAPERS
32 : 4 (December 2004), 605–630

Rivalry between Exporting Countries and an Importing Country under Incomplete Information

Pei-Cheng Liao *
Department of Accounting
National Taiwan University

Keywords: Export subsidies/Taxes, Tariffs, Incomplete information
JEL classification: D82, F12, F13

---

* Correspondence: Pei-Cheng Liao, Department of Accounting, National Taiwan University, Taipei 106, Taiwan. Tel: (02) 2363-0231 ext. 2999; Fax: (02) 2363-8038; E-mail: pcliao@ntu.edu.tw. I am grateful to Professor Kar-yiu Wong, Professor Ming-Chung Chang, and two anonymous referees for valuable comments and suggestions. The usual disclaimer applies.

ABSTRACT

This paper extends the Brander-Spencer (1985) framework to examine the non-cooperative Nash equilibrium of export subsidy policy under incomplete information when the firms' costs are unknown to the exporting and importing countries. With the assumptions of linear demand and two types of a firm's cost, the non-cooperative Nash equilibrium is that both exporting countries use a single pooling export subsidy (tax) under a uniform (discriminatory) tariff regime. Moreover, we find that the importing country would optimally choose a uniform tariff regime. However, both exporting countries prefer a discriminatory tariff regime as long as the expected cost differential between the two firms is small enough.

1. INTRODUCTION

Since the early 1980s, strategic trade theory has been widely investigated to highlight the impact of governments' interventions on producer surplus, consumer surplus, and national welfare. Brander and Spencer (1985) show that under Cournot competition, an export subsidy enables the domestic firm to be a Stackelberg leader, and thus increases the domestic welfare at the expense of the foreign firm. This paper has inspired a growing body of work on the proper use of export subsidies. The literature shows that the rationale for export subsidies is sensitive to modeling assumptions.[1] de Meza (1986) considers cost asymmetry between firms and shows that the countries with the lowest costs provide the highest export subsidies. Allowing a social cost of public funds that exceeds unity, Neary (1994) similarly finds that non-concavity of demand is a sufficient condition for the government to provide more subsidies to the more cost-competitive firm. Bandyopadhyay (1997) finds the conventional result in de Meza (1986) and Neary (1994) is reversed for inelastic demand.

Those results in the literature imply that governments should have relevant information in order to choose appropriate policies. Lacking any relevant information, a government may choose a policy which is actually harmful to its national welfare.[2] Thus, since the early 1990s, a number of economists have started to address this issue by incorporating incomplete information into the strategic trade policy models. Collie and Hviid (1993) extend the Brander-Spencer framework by considering the case in which the cost of the domestic firm is known to the domestic government but unknown to the foreign firm. Qiu (1994) assumes that the cost of the domestic firm is unknown to both the domestic government and the foreign firm. Collie and Hviid (1993) and Qiu (1994) both highlight the signaling effect of an export subsidy in the Brander-Spencer framework.[3] When the foreign firm is uncertain about the domestic

[1] For example, Eaton and Grossman (1986) argue that if the firms compete in a Bertrand way, the optimal domestic policy is an export tax. Horstmann and Markusen (1986) consider the case of integrated markets with free entry and find that an export subsidy is welfare-deteriorating. See, for example, Wong (1995) and Brander (1995) for recent discussion of the use of some of these strategic policies.

[2] See Wong (1991).

[3] There are some papers analyzing the signaling effect of tariffs. For example, Collie and Hviid (1994) show that the domestic government uses a tariff to signal the domestic demand to a foreign monopolist. Collie and Hviid (1999) show that the domestic government uses a tariff to signal the cost of its firm in a model in which a domestic and a foreign firms compete in the domestic market. Kolev and Prusa (1999)

firm's cost, the foreign firm makes its output decision based on its prior belief about the domestic firm's cost. Under Cournot competition, the domestic firm has an incentive to understate its cost, so a unilateral announcement of its cost is not credible. An export subsidy is then a strategic instrument used by the domestic government, not only to shift the profit of the foreign firm, but also to help the domestic firm signal its cost credibly. Thus, this signaling incentive justifies the use of export subsidies, and there exists a separating equilibrium in which the domestic government uses a higher export subsidy to signal the lower cost of the domestic firm as shown in Collie and Hviid (1993) and Qiu (1994).[4]

The models of both Collie and Hviid (1993) and Qiu (1994) are built on the assumption of a free trade policy adopted by the importing country. In fact, the importing country has an incentive to impose tariffs in order to extract rents from foreign suppliers. Gatsios (1990) and Hwang and Mai (1991) show that the optimal policy for the importing country is to impose a higher tariff on the imports from the more cost-efficient exporter. If the importing country cannot observe the firms' costs, the results in Gatsios (1990) and Hwang and Mai (1991) imply that each exporting firm has an incentive to overstate its cost in order to draw a lower tariff on its exports. Such a countervailing incentive to overstate costs is absent in Collie and Hviid (1993) and Qiu (1994), and it has not been addressed in the literature. Thus, in this paper we extend Qiu (1994) to examine the optimal export subsidy policy, but with the following main differences. First, we assume that the importing country is active in imposing tariffs in order to maximize its national welfare. Moreover, we consider two alternative tariff regimes: a uniform tariff regime, as required by the "Most-Favored-Nations" (MFN) clause of the GATT/WTO, and a discriminatory tariff regime. Under a uniform tariff regime, the importing country has to impose the same tariff rate on all imports, without discrimination. Under a discriminatory tariff regime, the importing country is able to set different tariffs against foreign exporters in different countries.[5] Second,

consider a signaling game in a different context. They analyze an optimal tariff in a model in which a foreign monopolist exports to the domestic market over an infinite number of periods, and the domestic government is unaware of the cost of the foreign monopolist.

[4] In Qiu (1994), the optimal separation-inducing menu requires that a higher export subsidy rate associated with a higher lump-sum tax be granted to the low-cost type of firm.

[5] Although the MFN clause prohibits discrimination among trading partners with respect to tariffs, the GATT/WTO rules do provide some permission and exceptions for preferential trading arrangements. For example, in June 1971, the GATT granted developed countries a waiver from the MFN clause to introduce a Generalised System of Preferences (GSP), according to the so-called "Enabling Clause". The European Community, Japan, and the United States have their own GSP schemes, providing tariff preferences to the imports from certain developing countries.

we examine the non-cooperative Nash export subsidy equilibrium, in which both exporting countries actively choose their optimal export subsidy policies simultaneously. Third, we assume that all the exporting and importing countries are uncertain about the firms' costs, while each firm knows its rival's cost. An export subsidy policy is then used to signal the firm's cost to the importing country, rather than to the rival firm as examined in Collie and Hviid (1993) and Qiu (1994). In the present model, it is expected that the aforementioned countervailing incentive to overstate costs will affect an exporting country's strategy to separate or pool the cost type of its firm. On the one hand, the exporting country would like to screen the cost type of its firm so that its export subsidy policy is tailor-made for the purpose of profit-shifting. On the other hand, the exporting country would like to send out a high-cost signal to the importing country in order to draw a lower tariff. Thus, a separating strategy as shown in Collie and Hviid (1993) and Qiu (1994) may no longer be optimal, because the benefit of separation may be mitigated by the possibility of having a high tariff imposed by the importing country.

We find that the dominant strategy for each exporting country is to use a single pooling export subsidy (tax) under a uniform (discriminatory) tariff regime. The non-cooperative Nash equilibrium is that both use pooling strategies to conceal their firms' types. Moreover, the importing country prefers a uniform tariff regime because it induces both exporting countries to use export subsidies. However, both exporting countries prefer a discriminatory tariff regime as long as the difference between the expected costs of the two firms is small enough.

The remainder of the paper is organized as follows: Section 2 provides the assumptions of the model and the features of the game. The non-cooperative Nash equilibria under discriminatory and uniform tariff regimes are analyzed in sections 3 and 4, respectively. Section 5 compares the two tariff regimes in terms of the welfare of each country. Section 6 provides a brief summary and some concluding remarks.

2. THE MODEL AND ASSUMPTIONS

We consider a one-product, two-firm, three-country model. Two of the countries, which are labeled 1 and 2, have a firm producing a homogeneous product to be exported to the third country, M. There is no other producer of this product in country M and there is no consumption of this product in countries 1 and 2. To keep the model tractable, we assume that the demand in country M is linear, given by $p = a - b(q_1 + q_2)$, where $a > 0$, $b > 0$, p is the market price, and q_i is the output of firm $i, i = 1, 2$. Firm i has a constant marginal cost, c_i, and a fixed cost, f_i. Fixed cost f_i is set to zero because it will not affect the equilibrium of the game. For simplicity, each firm is assumed to be one of two types, high cost, c_i^H, or low cost, c_i^L. The uncertainty of the cost realization can be interpreted as the demand shock, or input shock, for instance. The cost realizations are assumed to be privately known by the firms, and each firm knows its rival's cost. All the governments are uninformed about the firms' true costs. This assumption is reasonable because firms in the same industry usually have more information about their competitors' costs than do the governments. It is common knowledge that Prob $(c_1 = c_1^H) = \mu$ and Prob $(c_2 = c_2^H) = \rho$, where $0 \leq \mu \leq 1$ and $0 \leq \rho \leq 1$. μ and ρ could be the same when the two firms are affected by the same demand shock, or when they use a common input.

We consider the following three-stage, one-shot non-cooperative game. In the first stage, country M announces its tariff regime, either discriminatory or uniform. In the second stage, country i designs its export subsidy policy, either an incentive-compatible policy or a single pooling policy. Under an incentive-compatible policy, country i provides two different export subsidy rates associated with lump-sum transfers for firm i to choose, and such an incentive-compatible policy will induce firm i to tell its type truthfully. Firm i picks up the rate corresponding to its type, and at the same time reveals its type. Under a single pooling policy, country i provides one export subsidy rate for firm i, regardless of its type. Such a pooling policy thus provides no specific information about firm i's type. In the third stage, after observing the policy provided by country i (and the selection of firm i if an incentive-compatible policy is provided), country M updates its belief about firm i's type and imposes tariffs according to the tariff regime it announced in the first stage. If an incentive-compatible policy is used by country i in the second stage, country M sets tariffs based on the cost type revealed by firm i. If a single pooling policy is adopted by country i in the second stage, country M sets tariffs based on its prior belief about the cost of firm i, i.e., the expected value of firm i's marginal cost, $E(c_1) = \mu c_1^H + (1 - \mu)c_1^L$ and $E(c_2) = \rho c_2^H + (1 - \rho)c_2^L$, respectively. All government announcements are credible and cannot be reversed. Then the two firms compete in quantities in the market of country M, and the welfare of each country is realized.

To make our analysis interesting, we assume that the market in country M is big enough so that both firms produce a positive output under all policy parameters chosen by the governments. Note that the order of the moves played by the governments is exogenously given.[6] Country M is assumed to choose the tariff regime before, but the actual tariff rates after, the exporting countries' export subsidy policies. This reflects the fact that while it is easy for country M to set its tariff rates, the tariff regime, which represents the country's international commitment or its position in an international setting, e.g., whether it has to follow the MFN clause, cannot be changed so easily. Moreover, such an assumption is reasonable and compatible under incomplete information. First, the firms' costs are revealed reliably to country M through the export subsidy policies. Without the export subsidy policies, it is expected that no firm will truthfully announce its private information. Second, the present model captures the signaling effect of the export subsidy policy to country M, rather than to the rival firm as examined in Collie and Hviid (1993) and Qiu (1994).

In what follows, we analyze the two tariff regimes separately. The game is solved by backward induction. Given the export subsidies and tariffs chosen in the previous stages, the equilibrium in the market stage can be easily derived because there is no asymmetric information between firms. It is also straightforward to derive the equilibrium tariffs in the third stage.[7] In the second stage, countries 1 and 2 set their policies simultaneously. When taking the other's as given, if it is better to signal the firm's true type to country M, country i would design an incentive-compatible policy for firm i to truthfully reveal its type (we refer to the separating strategy). If it is better to conceal firm i's true type, country i would provide a single pooling rate (we refer to the pooling strategy). Each exporting country has two strategies, separating (S) or pooling (P) to choose between. We first derive the four possible outcomes and then determine the non-cooperative Nash equilibrium in the second stage.

[6] The issue on the order of the moves may be analyzed by endogenizing the timing of countries' policy decisions. However, this is beyond the scope of this paper. See Collie (1994), Wong and Chow (1997), Hayashibara (2002) for endogenous timing in trade policy games, though all three papers consider a two-country model, with one exporting and one importing country.

[7] See Choi (1995) for the equilibrium output and tariffs in a linear demand example on page 153, although there is no export subsidy in his model.

3. THE EQUILIBRIUM UNDER DISCRIMINATORY TARIFF REGIME

3.1 The separating strategy

We first derive the optimal incentive-compatible policy for country 1 when it plays the separating strategy.

Case A: Country 2 plays the separating strategy as well – (S, S).
Countries 1 and 2 use the incentive-compatible policies $[(s_1^H, \tau_1^H),\ (s_1^L, \tau_1^L)]$ and $[(s_2^H, \tau_2^H),\ (s_2^L, \tau_2^L)]$, respectively, to screen the types of their firms in the second stage. (s_i^H, τ_i^H) and (s_i^L, τ_i^L) are intended to provide for the high-cost and low-cost firm i, respectively, where s_i is a specific export subsidy rate and τ_i is a lump-sum transfer, and $i = 1, 2$. Since the costs of the firms are private information, we first have to derive the incentive compatibility (IC) constraints for $[(s_i^H, \tau_i^H),\ (s_i^L, \tau_i^L)]$ so that it can induce firm i to tell its type truthfully. Denote the true types of firms 1 and 2 as m and n, respectively, $m, n = H, L$. Denote $\pi_1^{mn}[(s_1^m, \tau_1^m), (s_2^n, \tau_2^n)]$ as the profit of firm 1 when both firms truthfully choose the policies corresponding to their types. Denote $\pi_1^{mn}[(s_1^k, \tau_1^k), (s_2^n, \tau_2^n)]$ as the profit of firm 1 when it chooses the policy (s_1^k, τ_1^k), which is inconsistent with its type m, and $m \neq k$. Denote $\Delta c_1 = c_1^H - c_1^L$ and $\Delta c_2 = c_2^H - c_2^L$. The IC constraints require that $\pi_1^{mn}[(s_1^m, \tau_1^m),\ (s_2^n, \tau_2^n)] \geq \pi_1^{mn}[(s_1^k, \tau_1^k), (s_2^n, \tau_2^n)]$, and we show in Appendix A that the IC constraints are $s_1^L - s_1^H \geq 7\Delta c_1/9$ and $\tau_1^L \geq \tau_1^H$. Similarly, the IC constraints for firm 2 are $s_2^L - s_2^H \geq 7\Delta c_2/9$ and $\tau_2^L \geq \tau_2^H$.[8]

Now the maximization problem of country i is

$$\max_{(s_i^H, \tau_i^H),\ (s_i^L, \tau_i^L)} E(W_i)$$

$$\begin{aligned} s.t. \quad & (1)\ s_i^L - s_i^H \geq 7\Delta c_i/9, \qquad i = 1, 2, \\ & (2)\ \tau_i^L \geq \tau_i^H \end{aligned}$$

[8] Country i has to make sure that its incentive-compatible policy still works even if firm j tells a lie. It can be shown that the IC constraints are also the same. The proof is available from the author upon request.

where $E(W_i)$ is the expected welfare of country i, which is the expected value of firm i's profit less any net subsidy payments. Solving the maximization problem, we find that the IC constraints are binding, i.e., $s_i^L - s_i^H = 7\Delta c_i/9$ and $\tau_i^L = \tau_i^H$.[9] Since the values of τ_i^H and τ_i^L do not affect country i's welfare, we can normalize them by setting $\tau_i^L = \tau_i^H = 0$. Forming the Lagrangian, country i's problem then becomes: $\max_{s_i^H, s_i^L} E(W_i) + \lambda[s_i^L - s_i^H - 7\Delta c_i/9]$.

The first-order conditions for countries 1 and 2 are given by:

$$\begin{cases} -\dfrac{\mu}{32b}\Big[2a + E(c_2) - 3c_1^H + 15s_1^H - \rho s_2^H - (1-\rho)s_2^L\Big] - \lambda = 0 \\ -\dfrac{(1-\mu)}{32b}\Big[2a + E(c_2) - 3c_1^L + 15s_1^L - \rho s_2^H - (1-\rho)s_2^L\Big] + \lambda = 0. \\ s_1^L - s_1^H - \dfrac{7}{9}\Delta c_1 = 0 \end{cases} \tag{1}$$

$$\begin{cases} -\dfrac{\rho}{32b}\Big[2a + E(c_1) - 3c_2^H + 15s_2^H - \mu s_1^H - (1-u)s_1^L\Big] - \lambda = 0 \\ -\dfrac{(1-\rho)}{32b}\Big[2a + E(c_1) - 3c_2^L + 15s_2^L - \mu s_1^H - (1-\mu)s_1^L\Big] + \lambda = 0. \\ s_2^L - s_2^H - \dfrac{7}{9}\Delta c_2 = 0 \end{cases} \tag{2}$$

Solving (1) and (2) simultaneously, we can get the following solutions:

$$s_1^H = -\frac{1}{56}\Big[8a + 3E(c_2) - 11E(c_1)\Big] - \frac{7}{9}(1-\mu)\Delta c_1, \tag{3a}$$

$$s_1^L = -\frac{1}{56}\Big[8a + 3E(c_2) - 11E(c_1)\Big] + \frac{7}{9}\mu\Delta c_1, \tag{3b}$$

$$s_2^H = -\frac{1}{56}\Big[8a + 3E(c_1) - 11E(c_2)\Big] - \frac{7}{9}(1-\rho)\Delta c_2, \tag{3c}$$

$$s_2^L = -\frac{1}{56}\Big[8a + 3E(c_1) - 11E(c_2)\Big] + \frac{7}{9}\rho\Delta c_2. \tag{3d}$$

Equations (3) show that $s_i^H < s_i^L < 0$, implying that country i has to impose a higher export tax on the high-cost type of its firm. However, under full information, it can be shown that country i would impose a lower export tax on the high-cost type of its firm. As we mentioned before, when the firms' costs are not observed by country M, the low-cost type has an incentive to claim to be the high-cost type so that the tariff

[9] When the IC constraints are binding, the firms are actually indifferent to claiming either type. In this case, we assume that the firms will choose to claim their true types.

imposed would be lower. If country i imposed a lower export tax on the high-cost type as if there were full information, both types would choose s_i^H, and country i would never separate the type of firm i. Thus, country i has to provide an incentive for the low-cost type to tell the truth. That is, it has to impose a lower export tax on the low-cost type and a higher export tax on the high-cost type.

Case B: Country 2 plays the pooling strategy – (S, P).
In this case, country 1 uses the incentive-compatible policy $[(s_1^H, \tau_1^H), (s_1^L, \tau_1^L)]$ to screen the type of firm 1, while country 2 provides a single pooling export subsidy rate $\overline{s}_2$ for firm 2. Firm 1's cost is revealed through its policy choice, while firm 2's cost stays unknown to country M. Denote $\pi_1^{mn}[(s_1^m, \tau_1^m), \overline{s}_2]$ as firm 1's profit when it truthfully chooses the policy (s_1^m, τ_1^m). Denote $\pi_1^{mn}[(s_1^k, \tau_1^k), \overline{s}_2]$ as firm 1's profit when it chooses the policy (s_1^k, τ_1^k), which is inconsistent with its type m, $m \neq k$. It is shown in Appendix B that the IC constraints to make $\pi_1^m[(s_1^m, \tau_1^m), \overline{s}_2] \geq \pi_1^m[(s_1^k, \tau_1^k), \overline{s}_2]$ are $s_1^L - s_1^H \geq 7\Delta c_1/9$ and $\tau_1^L \geq \tau_1^H$. Solving the maximization problem for country 1 subject to the IC constraints, we find that the IC constraints are binding, i.e., $s_1^L - s_1^H = 7\Delta c_1/9$ and $\tau_1^L = \tau_1^H$. Again, we can set $\tau_1^L = \tau_1^H = 0$ for simplicity, without affecting the welfare of country 1. Solving the first-order conditions for maximization of countries 1 and 2 simultaneously, we get

$$s_1^H = -\frac{1}{56}\Big[8a + 3E(c_2) - 11E(c_1)\Big] - \frac{7}{9}(1-\mu)\Delta c_1, \tag{4a}$$

$$s_1^L = -\frac{1}{56}\Big[8a + 3E(c_2) - 11E(c_1)\Big] + \frac{7}{9}\mu\Delta c_1, \tag{4b}$$

$$\overline{s}_2 = -\frac{1}{56}\Big[8a + 3E(c_1) - 11E(c_2)\Big]. \tag{4c}$$

Comparing (3a), (3b) and (4a), (4b), we find that country 1's separating strategy, $[(s_1^H, 0), (s_1^L, 0)]$, is the same regardless of country 2's strategy.

3.2 The pooling strategy

We now derive the optimal single pooling rate $\overline{s}_1$ for country 1 when it plays the pooling strategy.

Case C: Country 2 plays the separating strategy – (P, S).
This case is just symmetric to Case B in which country 1 plays separating while coun-

try 2 plays pooling. Thus, from equations (4), we know that

$$\begin{aligned}
\overline{s}_1 &= -\frac{1}{56}\Big[8a + 3E(c_2) - 11E(c_1)\Big],\\
s_2^H &= -\frac{1}{56}\Big[8a + 3E(c_1) - 11E(c_2)\Big] - \frac{7}{9}(1-\rho)\Delta c_2,\\
s_2^L &= -\frac{1}{56}\Big[8a + 3E(c_1) - 11E(c_2)\Big] + \frac{7}{9}\rho\Delta c_2.
\end{aligned}$$

Case D: Country 2 plays the pooling strategy as well – (P, P).
Countries 1 and 2 provide $\overline{s}_1$ and $\overline{s}_2$ for firms 1 and 2, respectively, regardless of their types. Solving the maximization problems of countries 1 and 2 simultaneously, we find that $\overline{s}_1 = -[8a + 3E(c_2) - 11E(c_1)]/56$ and $\overline{s}_2 = -[8a + 3E(c_1) - 11E(c_2)]/56$. Thus, the single pooling export tax rate $\overline{s}_1$ is the same regardless of the policy strategy of country 2.

The analysis above is symmetric to country 2. Thus we have the following lemma:

Lemma 1 Under a discriminatory tariff regime, each exporting country imposes an export tax on its firm. No matter what strategy country j uses, the optimal incentive-compatible policy for country i is always $s_i^H = -[8a + 3E(c_j) - 11E(c_i)]/56 - 7(1-\theta_i)\Delta c_i/9$ and $s_i^L = -[8a + 3E(c_j) - 11E(c_i)]/56 + 7\theta_i\Delta c_i/9$, where θ_i is the probability that firm i is the high-cost type and $\Delta c_i = c_i^H - c_i^L$, $i, j = 1, 2$. The optimal pooling rate for country i is always $\overline{s}_i = -[8a + 3E(c_j) - 11E(c_i)]/56$, $i, j = 1, 2$.

The intuition of Lemma 1 is the following. Countries 1 and 2 are unaware of the firms' costs, and they determine their policies simultaneously. No matter what policy country j uses, it does not change the information set that country i has when country i is choosing its policy. That is, country i always chooses its policy based on its prior belief that $c_1 = E(c_1)$ and $c_2 = E(c_2)$. Thus, regardless of country j's strategy, the incentive-compatible policy or the pooling policy that country i chooses is always the same.

We now have $[(s_i^H, 0), (s_i^L, 0)]$ and $\overline{s}_i$, so we are able to derive the payoffs of country i in each case. Table 1 is the 2×2 matrix summarizing the expected welfare of countries 1 and 2 in each case under a discriminatory tariff regime. The payoffs can be ranked as $E(W_i^D)|_{(P,P)} > E(W_i^D)|_{(P,S)} > E(W_i^D)|_{(S,S)}$ and $E(W_i^D)|_{(P,P)} > E(W_i^D)|_{(S,P)} > E(W_i^D)|_{(S,S)}$, where superscript D stands for the discriminatory tar-

Table 1 Export Subsidy Policy Game under Discriminatory Tariff Regime

		Country 2: Separating	Country 2: Pooling
Country 1	Separating	$\left(\frac{15}{12544b}A - \frac{2}{27b}C + \frac{4}{81b}D,\ \frac{15}{12544b}B + \frac{4}{81b}C - \frac{2}{27b}D\right)$	$\left(\frac{15}{12544b}A - \frac{2}{27b}C + \frac{1}{9b}D,\ \frac{15}{12544b}B + \frac{4}{81b}C + \frac{4}{9b}D\right)$
	Pooling	$\left(\frac{15}{12544b}A + \frac{4}{9b}C + \frac{4}{81b}D,\ \frac{15}{12544b}B + \frac{1}{9b}C - \frac{2}{27b}D\right)$	$\left(\frac{15}{12544b}A + \frac{4}{9b}C + \frac{1}{9b}D,\ \frac{15}{12544b}B + \frac{1}{9b}C + \frac{4}{9b}D\right)^*$

where $A = \left[8a + 3E(c_2) - 11E(c_1)\right]^2,\ B = \left[8a + 3E(c_1) - 11E(c_2)\right]^2,$

$C = \mu(1-\mu)(c_1^H - c_1^L)^2,\ D = \rho(1-\rho)(c_2^H - c_2^L)^2.$

*: Nash Equilibrium.

iff regime. It is easy to find that the dominant strategy for country i is pooling, so (P, P) is the Nash equilibrium under a discriminatory tariff regime.

Proposition 1 In the sequential game with linear demand and incomplete information about the firms' costs, the non-cooperative Nash equilibrium under a discriminatory tariff regime is that each exporting country imposes a single pooling export tax on its firm.

Proposition 1 is different from the results in Collie and Hviid (1993) and Qiu (1994), showing the signaling effect of an export subsidy in the absence of tariffs. Under discriminatory tariffs, we find that each exporting country is better off concealing the type of its firm by providing a pooling export tax rate. Although the exporting country still has an incentive to screen the type of its firm in order to choose appropriate export tax rates for different types, the incentive-compatible policy, which requires that it impose a higher (lower) export tax on the high (low)-cost type, is actually contrary to what it would do under full information. Thus, pooling is the dominant strategy for each exporting country even though its firm may be the high-cost type.

4. THE EQUILIBRIUM UNDER UNIFORM TARIFF REGIME

We now examine the Nash equilibrium when country M announces adoption of a uniform tariff regime in the first stage. The analysis here is similar to that in section 3, except that country M has to set a uniform tariff rather than two different ones.

4.1 The separating strategy

We first derive the optimal incentive-compatible policy $[(s_1^H, \tau_1^H), (s_1^L, \tau_1^L)]$ for country 1 when it plays the separating strategy.

Case A: Country 2 plays the separating strategy as well – (S, S).
Using the same techniques as in section 3, we are able to derive the IC constraints: $s_i^L - s_i^H \geq \Delta c_i/15$ and $\tau_i^L \geq \tau_i^H$, $i = 1, 2$.[10] The maximization problem of country i is

$$\begin{aligned} &\max_{(s_i^H, \tau_i^H),\ (s_i^L, \tau_i^L)} E(W_i) \\ &s.t. \quad (1)\ s_i^L - s_i^H \geq \Delta c_i/15, \qquad i = 1, 2. \\ &\qquad\quad (2)\ \tau_i^L \geq \tau_i^H \end{aligned}$$

Solving the maximization problem, we find that the IC constraints are not binding, i.e., $s_i^L - s_i^H > \Delta c_i/15$ and $\tau_i^L > \tau_i^H$, $i = 1, 2$. Solving the first-order conditions for maximization of countries 1 and 2 simultaneously yields

$$s_1^m = \frac{1}{18}\Big[2a + 5E(c_2) - E(c_1) - 6c_1^m\Big], \ \ m = H, L, \tag{5a}$$

$$s_2^n = \frac{1}{18}\Big[2a + 5E(c_1) - E(c_2) - 6c_2^n\Big], \ \ n = H, L. \tag{5b}$$

Since the values of τ_1^H and τ_1^L do not affect the welfare of country 1, we set $\tau_1^H = 0$, for simplicity. τ_1^L can be set to satisfy $\pi_1^{mn}[(s_1^m, \tau_1^m), (s_2^n, \tau_2^n)] \geq \pi_1^{mn}[(s_1^k, \tau_1^k), (s_2^n, \tau_2^n)]$.

[10] The deviation for the IC constraints is available from the author upon request.

Thus, we can get

$$\frac{1}{108b}(\Delta c_1)\Big[10a + 7E(c_2) - 5E(c_1) + 18c_2^n - 3c_1^H - 27c_1^L\Big] \\ \geq \tau_1^L \geq \frac{1}{108b}(\Delta c_1)\Big[10a + 7E(c_2) - 5E(c_1) + 18c_2^n - 27c_1^H - 3c_1^L\Big]. \quad (6)$$

$[(s_1^H, 0), (s_1^L, \tau_1^L)]$ defined in (5a) and (6) will induce firm 1 to tell its type truthfully, and $s_1^L > s_1^H > 0$, $\tau_1^L > \tau_1^H = 0$. That is, country 1 has to offer a higher export subsidy on the low-cost type, and at the same time impose a higher lump-sum tax on it. Since the low-cost type tends to lie in order to avoid a higher tariff, a higher export subsidy prevents it from lying. On the other hand, the high-cost type tends to lie in order to get a higher export subsidy, so a higher lump-sum tax imposed on the low-cost type prevents the former from lying.

Case B: Country 2 plays the pooling strategy – (S, P).
In this case, the IC constraints for $[(s_1^H, \tau_1^H), (s_1^L, \tau_1^L)]$, which again can be shown to be $s_1^L - s_1^H \geq \Delta c_1/15$ and $\tau_1^L \geq \tau_1^H$. Solving the maximization problems of countries 1 and 2 simultaneously, we get

$$s_1^m = \frac{1}{18}\Big[2a + 5E(c_2) - E(c_1) - 6c_1^m\Big], \ \ m = H, L, \quad (7a)$$

$$\overline{s}_2 = \frac{1}{18}\Big[2a + 5E(c_1) - 7E(c_2)\Big]. \quad (7b)$$

Again, the IC constraints are not binding. For simplicity, we set $\tau_1^H = 0$, and τ_1^L can be set to satisfy $\pi_1^{mn}[(s_1^m, \tau_1^m), \overline{s}_2] \geq \pi_1^{mn}[(s_1^k, \tau_1^k), \overline{s}_2]$. Thus, we can get

$$\frac{1}{108b}(\Delta c_1)\Big[10a + 13E(c_2) - 5E(c_1) + 12c_2^n - 3c_1^H - 27c_1^L\Big] \\ \geq \tau_1^L \geq \frac{1}{108b}(\Delta c_1)\Big[10a + 13E(c_2) - 5E(c_1) + 12c_2^n - 27c_1^H - 3c_1^L\Big]. \quad (8)$$

Comparing (5a) with (7a), we find that (s_1^H, s_1^L) is the same no matter what strategy country 2 is playing. However, comparing conditions (6) and (8), we find that the range for τ_1^L is different because the profit of firm 1 varies with country 2's strategy and c_2^n. In conditions (6) and (8), the lower bound of τ_1^L is the one to extract all the information rent from the high-cost type of firm 1, so that it is indifferent to claiming either type. Although country 1 knows neither country 2's strategy nor c_2^n when it chooses $[(s_1^H, 0), (s_1^L, \tau_1^L)]$, τ_1^L can be announced at a level which equals the information rent of the high-cost type. We assume that such an announcement is credible and cannot be reversed, so τ_1^L can be calculated and collected at the end of the game when everything turns into full information.

4.2 The pooling strategy

We now derive the pooling rate $\overline{s}_1$ for country 1 when it plays the pooling strategy.

Case C: Country 2 plays the separating strategy – (P, S).
This case is symmetric to Case B. Thus, from equations (7), we know that $\overline{s}_1 = [2a + 5E(c_2) - 7E(c_1)]/18$ and $s_2^n = [2a + 5E(c_1) - E(c_2) - 6c_2^n]/18$, $n = H, L$.

Case D: Country 2 plays the pooling strategy as well – (P, P).
Solving the maximization problems of countries 1 and 2 simultaneously, we can get $\overline{s}_1 = [2a + 5E(c_2) - 7E(c_1)]/18$ and $\overline{s}_2 = [2a + 5E(c_1) - 7E(c_2)]/18$.

The analysis above is symmetric to country 2. Thus we have the following lemma:

Lemma 2 Under a uniform tariff regime, each exporting country provides an export subsidy on its firm. No matter what strategy country j uses, the optimal incentive-compatible policy for country i is always $s_i^m = [2a + 5E(c_j) - E(c_i) - 6c_i^m]/18$, $m = H, L$ and $i, j = 1, 2$. The optimal pooling rate for country i is always $\overline{s}_i = [2a + 5E(c_j) - 7E(c_i)]/18$, $i, j = 1, 2$.

Table 2 is the 2×2 matrix summarizing the expected welfare of countries 1 and 2 in each case under a uniform tariff regime. The payoffs can be ranked as $E(W_1^U)|_{(P,S)} > E(W_1^U)|_{(P,P)} > E(W_1^U)|_{(S,P)}$ and $E(W_1^U)|_{(P,S)} > E(W_1^U)|_{(S,S)} > E(W_1^U)|_{(S,P)}$, where superscript U stands for the uniform tariff regime. The analysis is symmetric to country 2. It is easy to find that the dominant strategy for country i is pooling, so (P, P) is the Nash equilibrium under a uniform tariff regime. However, we can find that (S, S) is the jointly optimal outcome for countries 1 and 2.

Table 2 Export Subsidy Policy Game under Uniform Tariff Regime

		Country 2: Separating	Country 2: Pooling
Country 1	Separating	$\left(\frac{5}{432b}A' + \frac{5}{12b}C + \frac{1}{4b}D,\ \frac{5}{432b}B' + \frac{1}{4b}C + \frac{5}{12b}D\right)$	$\left(\frac{5}{432b}A' + \frac{5}{12b}C + \frac{1}{9b}D,\ \frac{5}{432b}B' + \frac{1}{4b}C + \frac{4}{9b}D\right)$
	Pooling	$\left(\frac{5}{432b}A' + \frac{4}{9b}C + \frac{1}{4b}D,\ \frac{5}{432b}B' + \frac{1}{9b}C + \frac{5}{12b}D\right)$	$\left(\frac{5}{432b}A' + \frac{4}{9b}C + \frac{1}{9b}D,\ \frac{5}{432b}B' + \frac{1}{9b}C + \frac{4}{9b}D\right)^{**}$

where $A' = \Big[2a + 5E(c_2) - 7E(c_1)\Big]^2,\ B' = \Big[2a + 5E(c_1) - 7E(c_2)\Big]^2,$

$$C = \mu(1-\mu)(c_1^H - c_1^L)^2,\ D = \rho(1-\rho)(c_2^H - c_2^L)^2.$$

**: Nash Equilibrium.

Proposition 2 In the sequential game with linear demand and incomplete information about the firms' costs, the non-cooperative Nash equilibrium under a uniform tariff regime is that each exporting country provides a pooling export subsidy. However, the joint welfare of the exporting countries would rise if both provide the incentive-compatible policies to separate the types of their firms.

To see why a prisoner's dilemma problem implied by Proposition 2 arises, let us compare the cases of (S, S) and (P, P). In these two cases, the total outputs produced by the two firms are the same, so the market price as well. Under (S, S), the low (high)-cost type gets more (less) subsidy, and the low (high)-cost type produces more (less) than that under (P, P). Thus, the expected total production costs are lower under (S, S) than (P, P), because separation makes production more efficient. However, under (S, S), each firm's type is revealed to country M, so the expected total tariff payments by countries 1 and 2 are higher than that under (P, P). The cost saving from production efficiency outweighs the loss in the tariff payments, so the joint welfare of countries 1 and 2 is higher under (S, S) than (P, P). Since countries 1 and 2 determine their policies simultaneously and $E(W_1^U)|_{(P,S)} > E(W_1^U)|_{(S,S)}$, $E(W_2^U)|_{(S,P)} > E(W_2^U)|_{(S,S)}$, each country has an incentive to deviate by using a single pooling policy to get higher welfare. A prisoner's dilemma problem is inevitable unless they are able to reach an agreement to collude. Otherwise, the non-cooperative Nash equilibrium is sustained, and each country provides a single pooling export subsidy to its firm.

5. Welfare Considerations

Based on the results we got in sections 3 and 4, we are able to determine the optimal tariff regime for country M in the first stage. If country M announces adoption of a discriminatory tariff regime in the first stage, the Nash equilibrium is (P, P), Case D in section 3. Thus, we can get the expected welfare of country M in this case:

$$E(W_M^D)\Big|_{(P,P)} = \frac{9}{196b}\Big[2a - E(c_1) - E(c_2)\Big]^2 + \frac{9}{128b}\Big[E(c_1) - E(c_2)\Big]^2 + \frac{1}{18b}\Big[\mu(1-\mu)(\Delta c_1)^2 + \rho(1-\rho)(\Delta c_2)^2\Big],$$

where superscript D stands for the discriminatory tariff regime. If, on the other hand, country M announces a uniform tariff regime in the first stage, the Nash equilibrium is (P, P), Case D in section 4. The expected welfare of country M in this case is

$$E(W_M^U)\Big|_{(P,P)} = \frac{25}{324b}\Big[2a - E(c_1) - E(c_2)\Big]^2 + \frac{1}{18b}\Big[\mu(1-\mu)(\Delta c_1)^2 + \rho(1-\rho)(\Delta c_2)^2\Big],$$

where superscript U stands for the uniform tariff regime. Using the condition $2a - E(c_1) - E(c_2) > 6|E(c_1) - E(c_2)|$[11] yields $E(W_M^U)|_{(P,P)} > E(W_M^D)|_{(P,P)}$. Thus, the expected welfare of country M is higher under a uniform tariff regime, implying that it would optimally choose a uniform tariff regime in the first stage.

Now we consider the welfare effect of these two tariff regimes on countries 1 and 2. Suppose that $E(c_i) \geq E(c_j)$. We find that $E(W_i^D)|_{(P,P)} > E(W_i^U)|_{(P,P)}$ always holds. Therefore, if the firms have the same expected cost, both exporting countries prefer a discriminatory tariff regime. If the firms have different expected costs, the country with a higher expected cost always prefers a discriminatory tariff regime. The country with a lower expected cost would prefer a discriminatory tariff regime as well

[11] We assume that both firms produce a positive output under all policy parameters, so $8a + 3E(c_i) - 11E(c_j) > 0$ under a discriminatory tariff regime, and $2a + 5E(c_i) - 7E(c_j) > 0$ under a uniform tariff regime, $i, j = 1, 2$. Thus, we have the condition $2a - E(c_1) - E(c_2) > 6|E(c_1) - E(c_2)|$.

if and only if the expected cost differential, $\left|E(c_1) - E(c_2)\right|$, is small enough. We have the following proposition:

Proposition 3 In the sequential game with linear demand and incomplete information about the firms' costs, the importing country will optimally choose a uniform tariff regime. However, both exporting countries prefer a discriminatory tariff regime if and only if $\left|E(c_1) - E(c_2)\right| < 16\{a - \max[E(c_1), E(c_2)]\}/97$. Otherwise, the country with a higher expected cost prefers a discriminatory tariff regime while the one with a lower expected cost prefers a uniform tariff regime.

Proof. See Appendix C.

Gatsios (1990) and Hwang and Mai (1991) show that the importing country is better off under a discriminatory tariff regime, unless the two firms are equally cost-efficient. However, in the present model with incomplete information, regardless of the cost competitiveness of the firms, Proposition 3 shows that the importing country optimally prefers a uniform tariff regime in the beginning of the game. The intuition is that a uniform tariff regime makes the exporting countries subsequently use export subsidies rather than export taxes, and the importing country thus benefits with a lower market price, greater consumer surplus, and higher tariff revenue.[12]

Moreover, Gatsios (1990) and Hwang and Mai (1991) show that the more cost-efficient exporting country prefers a uniform tariff regime while the less cost-efficient exporting country prefers a discriminatory tariff regime. With identical costs, the two exporting countries are indifferent to either tariff regime. However, in the present model, as long as the expected cost differential is small enough, both exporting countries prefer a discriminatory tariff regime, even though the country with a lower expected cost would be discriminated against with a higher tariff imposed. An intuitive explanation can be provided by Brander and Spencer (1985) and Hwang and Mai (1991). Brander and Spencer (1985) show that an export tax is jointly optimal for both exporting countries, because the non-cooperative game leads to too much export subsidy provided, which in turn intensifies the competition between the firms. As we showed in Proposition 1, even though the two exporting countries play the game non-cooperatively, they impose export taxes under a discriminatory tariff regime. Such an equilibrium outcome is jointly better than that under a uniform tariff regime. Further-

[12] The result here is analogous to Choi (1995), showing that the importing country prefers a uniform tariff regime because it would induce the firms to choose a lower marginal cost technology. The importing country thus benefits with a lower market price and greater quantities.

more, Hwang and Mai (1991)'s 50 percent rule states that the difference between the discriminatory tariffs is half of the cost difference between the firms. Thus, as long as $\left|E(c_1) - E(c_2)\right|$ is small enough, the tariff differential is even smaller so that the tariff disadvantage of the country with a lower expected cost would be outweighed by the benefit in the mitigation of the market competition due to the export taxes adopted by the exporting countries. Therefore, the country with a lower expected cost would prefer a discriminatory tariff regime as well.

6. CONCLUDING REMARKS

This paper examines the non-cooperative Nash export subsidy equilibrium under incomplete information when the firms' costs are known only to themselves but not to their governments and the importing country. We find that with linear demand and two types of a firm's cost, the dominant strategy for each exporting country is pooling. The non-cooperative Nash equilibrium is that both countries use a single pooling export subsidy (tax) under over a uniform (discriminatory) tariff regime. Despite the fact that, under a uniform tariff regime, the joint expected welfare of the exporting countries is higher when both use separating strategies, a prisoner's dilemma problem is inevitable unless they reach an agreement to collude.

We also compare the two tariff regimes in terms of the welfare of each country. We find that the importing country would optimally choose a uniform tariff regime. This result is contrary to the general belief that a discriminatory tariff regime should dominate over a uniform tariff regime because under the former the country can also choose the same tariffs. We suggest that this preconception does not hold in the present model because the exporting countries react with export subsidies under a uniform tariff regime but with export taxes under a discriminatory tariff regime. Moreover, it is generally believed that the more cost-efficient firm prefers a uniform tariff regime because the tariff imposed would be lower. However, we show that both exporting countries would prefer a discriminatory tariff regime as long as the expected cost differential is small enough. This is because, under a uniform tariff regime, both countries provide too much export subsidy, which in turn intensifies the competition between the firms. A discriminatory tariff regime makes them impose export taxes instead, leading to a higher product price and greater profits.

The analysis of this paper relies on the assumption that the order of the moves played by the three countries is exogenously given. Our primary purpose is to examine the strategic incentives of the exporting countries to use the export subsidy or tax policies to signal their firms' costs to the importing country, so the exporting countries simultaneously choose export subsidy policies before the importing country sets tariffs. Moreover, we focus on the non-cooperative Nash equilibrium of the export subsidy policies, so the sequential move of the exporting countries is not considered. The analysis on endogenizing the timing of all three countries' policy decisions may be left for future research.

Appendix A: Derivation of IC Constraints in (S, S) Case with Discriminatory Tariffs

First, we have to derive $\pi_1^{mn}[(s_1^m, \tau_1^m), (s_2^n, \tau_2^n)]$. Given (s_1^m, τ_1^m) and (s_2^n, τ_2^n), country M updates its posterior belief that $c_1 = c_1^m$ and $c_2 = c_2^n$. Country M then chooses discriminatory tariffs (t_1^m, t_2^n) as if there were full information. Now we solve the game by backward induction. In the market stage, the optimal quantities are $q_1^m = (a + c_2^n - 2c_1^m + 2s_1^m - s_2^n + t_2^n - 2t_1^m)/(3b)$ and $q_2^n = (a + c_1^m - 2c_2^n + 2s_2^n - s_1^m + t_1^m - 2t_2^n)/(3b)$. In the third stage, country M chooses tariffs to maximize its welfare. The welfare of country M is defined as the sum of consumer surplus and tariff revenue, i.e., $W_M = b(q_1^m + q_2^n)^2/2 + t_1^m q_1^m + t_2^n q_2^n$. Thus, country M optimally sets $t_1^m = (2a + c_2^n - 3c_1^m + 3s_1^m - s_2^n)/8$ and $t_2^n = (2a + c_1^m - 3c_2^n + 3s_2^n - s_1^m)/8$. Substituting t_1^m and t_2^n back into q_1^m and q_2^n, we are able to derive firm 1's profit $\pi_1^{mn}[(s_1^m, \tau_1^m), (s_2^n, \tau_2^n)] = (2a + c_2^n - 3c_1^m + 3s_1^m - s_2^n)^2/(64b) - \tau_1^m$.

Second, we have to derive $\pi_1^{mn}[(s_1^k, \tau_1^k), (s_2^n, \tau_2^n)]$. Given (s_1^k, τ_1^k) and (s_2^n, τ_2^n), country M updates its posterior belief that $c_1 = c_1^k$ and $c_2 = c_2^n$, and chooses tariffs (t_1^k, t_2^n). Now we solve the game by backward induction. In the market stage, the optimal quantities are $q_1^m = (a + c_2^n - 2c_1^m + 2s_1^k - s_2^n + t_2^n - 2t_1^k)/(3b)$ and $q_2^n = (a + c_1^m - 2c_2^n + 2s_2^n - s_1^k + t_1^k - 2t_2^n)/(3b)$. In the third stage, country M optimally sets $t_1^k = (2a + c_2^n - 3c_1^k + 3s_1^k - s_2^n)/8$ and $t_2^n = (2a + c_1^k - 3c_2^n + 3s_2^n - s_1^k)/8$. Thus, we can get $\pi_1^{mn}[(s_1^k, \tau_1^k), (s_2^n, \tau_2^n)] = (6a + 3c_2^n - 16c_1^m + 7c_1^k + 9s_1^k - 3s_2^n)^2/(576b) - \tau_1^k$.

The IC constraints require that $\pi_1^{mn}[(s_1^m, \tau_1^m), (s_2^n, \tau_2^n)] \geq \pi_1^{mn}[(s_1^k, \tau_1^k), (s_2^n, \tau_2^n)]$. When firm 1's true cost is c_1^H, we have $(2a + c_2^n - 3c_1^H + 3s_1^H - s_2^n)^2/(64b) - \tau_1^H \geq (6a + 3c_2^n - 16c_1^H + 7c_1^L + 9s_1^L - 3s_2^n)^2/(576b) - \tau_1^L$. When firm 1's true cost is c_1^L, we have $(2a + c_2^n - 3c_1^L + 3s_1^L - s_2^n)^2/(64b) - \tau_1^L \geq (6a + 3c_2^n - 16c_1^L + 7c_1^H + 9s_1^H - 3s_2^n)^2/(576b) - \tau_1^H$. Therefore,

$$
\begin{aligned}
&\frac{1}{576b}(12a + 6c_2^n - 25c_1^L + 7c_1^H + 9s_1^L + 9s_1^H - 6s_2^n)(9s_1^L - 9s_1^H - 7\Delta c_1) \\
&\quad \geq \tau_1^L - \tau_1^H \\
&\quad \geq \frac{1}{576b}(12a + 6c_2^n - 25c_1^H + 7c_1^L + 9s_1^L + 9s_1^H - 6s_2^n)(9s_1^L - 9s_1^H - 7\Delta c_1).
\end{aligned}
$$

Since $12a+6c_2^n-25c_1^L+7c_1^H+9s_1^L+9s_1^H-6s_2^n > 12a+6c_2^n-25c_1^H+7c_1^L+9s_1^L+9s_1^H-6s_2^n > 0$, we have $9s_1^L-9s_1^H-7\Delta c_1 \geq 0$ and $\tau_1^L-\tau_1^H \geq 0$.

Appendix B: Derivation of IC Constraints in (S, P) Case with Discriminatory Tariffs

First, derive $\pi_1^{mn}[(s_1^m, \tau_1^m), \overline{s}_2]$. Given (s_1^m, τ_1^m) and $\overline{s}_2$, country M chooses tariffs based on its posterior belief that $c_1 = c_1^m$ and $c_2 = E(c_2)$. The game is solved by backward induction in the same way as Appendix A. Solving the equilibrium in the market stage and the third stage, we can get $\pi_1^{mn}[(s_1^m, \tau_1^m), \overline{s}_2] = [6a+8c_2^n-5E(c_2)-9c_1^m+9s_1^m-3\overline{s}_2]^2/(576b)-\tau_1^m$.

Second, derive $\pi_1^{mn}[(s_1^k, \tau_1^k), \overline{s}_2]$. Given (s_1^k, τ_1^k) and $\overline{s}_2$, country M chooses tariffs based on its posterior belief that $c_1 = c_1^k$ and $c_2 = E(c_2)$. Solving the equilibrium in the market stage and the third stage, we can get $\pi_1^{mn}[(s_1^k, \tau_1^k), \overline{s}_2] = [6a+8c_2^n-5E(c_2)-16c_1^m+7c_1^k+9s_1^k-3\overline{s}_2]^2/(576b)-\tau_1^k$.

The IC constraints require that $\pi_1^{mn}[(s_1^m, \tau_1^m), \overline{s}_2] \geq \pi_1^{mn}[(s_1^k, \tau_1^k), \overline{s}_2]$, and it can be shown that they are $s_1^L - s_1^H \geq 7\Delta c_1/9$ and $\tau_1^L \geq \tau_1^H$.

Appendix C: Proof of Proposition 3

$$
\begin{aligned}
&E(W_1^D)\Big|_{(P,P)} - E(W_1^U)\Big|_{(P,P)} \\
&\quad = \frac{15}{12544b}\Big[8a+3E(c_2)-11E(c_1)\Big]^2 - \frac{5}{432b}\Big[2a+5E(c_2)-7E(c_1)\Big]^2 \\
&\quad = \frac{5}{338688b}\bigg\{81\Big[8a+3E(c_2)-11E(c_1)\Big]^2 - 784\Big[2a+5E(c_2)-7E(c_1)\Big]^2\bigg\}.
\end{aligned}
$$

The sign of $E(W_1^D)|_{(P,P)} - E(W_1^U)|_{(P,P)}$ is the same as that of $9[8a+3E(c_2)-11E(c_1)]-28[2a+5E(c_2)-7E(c_1)]$. Thus, we can get $E(W_1^D)|_{(P,P)} > E(W_1^U)|_{(P,P)}$ if and only if $E(c_2)-E(c_1) < 16[a-E(c_2)]/97$. The analysis is symmetric to country 2. Therefore, if and only if $|E(c_1)-E(c_2)| < 16\{a-\max[E(c_1), E(c_2)]\}/97$, both exporting countries prefer a discriminatory tariff regime.

REFERENCES

Bandyopadhyay, S. (1997), "Demand Elasticities, Asymmetry and Strategic Trade Policy," *Journal of International Economics*, 42, 167–177.

Brander, J. A. (1995), "Strategic Trade Policy," in G. Grossman and K. Rogoff (eds), *Handbook of International Economics*, Volume 3, 1395–1455, Amsterdam, New York and Oxford: Elsevier, North-Holland.

Brander J. A. and B. J. Spencer (1985), "Export Subsidies and International Market Share Rivalry," *Journal of International Economics*, 18, 83–100.

Choi, J. P. (1995), "Optimal Tariffs and the Choice of Technology: Discriminatory Tariffs vs. the 'Most Favored Nation' Clause," *Journal of International Economics*, 38, 143–160.

Collie, D. (1994), "Endogenous Timing in Trade Policy Games: Should Governments Use Countervailing Duties?" *Weltwirtschaftliches Archiv*, 130, 191–209.

Collie, D. and M. Hviid (1993), "Export Subsidies as Signals of Competitiveness," *Scandinavian Journal of Economics*, 95, 327–339.

Collie, D. and M. Hviid (1994), "Tariffs for a Foreign Monopolist under Incomplete Information," *Journal of International Economics*, 37, 249–264.

Collie, D. and M. Hviid (1999), "Tariffs as Signals of Uncompetitiveness," *Review of International Economics*, 7, 571–579.

de Meza, D. (1986), "Export Subsidies and High Productivity: Cause or Effect?" *Canadian Journal of Economics*, 19, 347–350.

Eaton, J. and G. Grossman (1986), "Optimal Trade and Industrial Policy under Oligopoly," *Quarterly Journal of Economics*, 101, 383–406.

Gatsios, K. (1990), "Preferential Tariffs and the 'Most Favoured Nation' Principle: A Note," *Journal of International Economics*, 28, 365–373.

Hayashibara, M. (2002), "Industrial Concentration Reverses the Timing in a Trade Policy Game," *Open Economies Review*, 13, 73–86.

Horstmann, I. and J. R. Markusen (1986), "Up the Average Cost Curve: Inefficient Entry and the New Protectionism," *Journal of International Economics*, 20, 225–247.

Hwang, H. and C. Mai (1991), "Optimum Discriminatory Tariffs under Oligopolistic Competition," *Canadian Journal of Economics*, 24, 693–702.

Kolev, D. R. and T. J. Prusa (1999), "Tariff Policy for a Monopolist in a Signaling Game," *Journal of International Economics*, 49, 51–76.

Neary, J. P. (1994), "Cost Asymmetries in International Subsidy Games: Should Governments Help Winners or Losers?"*Journal of International Economics*, 37, 197–218.

Qiu, L. D. (1994), "Optimal Strategic Trade Policy under Asymmetric Information," *Journal of International Economics*, 36, 333–354.

Wong, K. (1991), "Incentive Incompatible, Immiserizing Export Subsidies," Mimeo, University of Washington, Seattle.

Wong, K. (1995), *International Trade in Goods and Factor Mobility*, Cambridge, Massachusetts: MIT press.

Wong, K. P. and K. W. Chow (1997), "Endogenous Sequencing in Strategic Trade Policy Games under Uncertainty," *Open Economies Review*, 8, 353–369.

不完全資訊下出口國與進口國的貿易政策競爭

廖珮真 *
國立台灣大學會計學系

關鍵詞: 出口補貼／出口稅、關稅、不完全資訊
JEL 分類代號: D82, F12, F13

---

* 聯繫作者: 廖珮真, 國立台灣大學會計學系, 台北市 106 大安區羅斯福路四段 1 號。電話: (02) 2363-0231 分機 2999; 傳真: (02) 2363-8038; E-mail: pcliao@ntu.edu.tw。作者感謝王家驤教授、年會論文評論人張明宗教授, 以及兩位匿名評審的寶貴意見。文中若有任何錯誤, 當屬作者之責。

摘　要

本文採用 Brander-Spencer (1985) 兩出口國與一進口國的基本模型, 來探討當此三國政府皆不知道兩出口廠商的成本時, 在進口國採行不同的關稅制度下, 兩出口國出口補貼政策的 Nash 均衡。在線性市場需求及高低兩種成本類型的假設下, 本文發現當進口國採行單一關稅制度, 兩出口國均提供單一出口補貼, 而當進口國採行歧視性關稅制度, 兩出口國均課徵單一出口稅。本文亦發現進口國的最適關稅制度為單一關稅制度, 但只要兩出口廠商的預期成本差距夠小, 兩出口國均偏好歧視性關稅制度。