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Wei Fang
Graduate School of Economics
Waseda University

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1-6-1, Nishiwaseda, Shinjuku-ku, Tokyo
169-8050 JAPAN

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Fang Wei †

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Abstract

This paper reexamines the implication of the separation of ownership and management based on a strategic export promotion policy under Cournot competition in a third-market model. Without government intervention, both firms' managerial delegations induce the firms to act as though they were subsidized by the owners with a subsidy *à* la Brander-Spencer. However, when the governments are involved, the strategic subsidy competition between them strengthens both the owners' subsidization incentives in the symmetric cost conditions and results in the oversubsidization to the firms. Consequently, each exporting country's welfare worsens while world welfare improves.

Keywords: Strategic Trade Policy, Managerial Incentives, Cournot Competition
JEL Classification: C72, F13, L22

1 Introduction

Over 70 years ago, Berle and Means (1932) first argued that large corporations are characterized by the separation of ownership and management. They criticized that firms' own profit-maximization behavior is oversimplified in traditional economic and industrial organization theories. Based on Berle and Means (1932)'s argument, Baumol (1958) suggested that firm managers may have certain objectives other than pure profit maximization and assumed a sales maximization hypothesis. His work emphasized the behavioral theory of the firm, and a number of economists examined different managerial objectives to analyze firms' optimal behavior (See Simon (1964), Williamson (1964), etc.).

However, the above studies focused on the internal organization of the firm and regarded the firm as a simple monopolist. When a greater number of firms compete in the market, each

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†‡)Graduate School of Economics, Waseda University. E-mail address: fwei@suou.waseda.jp. Corresponding address: 1-6-1 Nishi-Waseda, Tokyo, Japan, 169-8050.

firm's managerial objectives are determined by taking into consideration the rival firms' behavior. A strategic managerial decision analysis in the oligopolistic market was first conducted by Vickers (1985) and stylized by Fershtman and Judd (1987) and Sklivas (1987) (hereafter the FJS model). They considered a two-stage model where, in the first stage, profit-maximizing owners offer compensation schemes to their managers and in the next stage, managers compete in quantities or prices under precommitted compensation schemes. The FJS model clarified managers' nonprofit-maximizing behavior from the game-theoretical point of view, indicating that delegating a manager with distorted objective functions affects the strategic performance of the firms and induces the firm to act as a Stackelberg-leader in the quantity (or price) competition.

The theory of a strategic trade policy also progressed remarkably in terms of the game-theoretical approach in the 1980s. A representative model – Brander and Spencer (1985) (hereafter the BS model) – adopted a two-stage game and revealed that strategic export subsidization may enhance the exporting country's welfare; in the first stage, the governments determine the specific subsidies, and in the consecutive stage, the firms compete in a Cournot fashion in the third market.[1] The rent-shifting effect of the strategic subsidy, as shown in the BS model, can be explained by the firms' distorted objective functions as well. Government subsidization induces the firms to maximize the subsidy-inclusive profits and win a Stackelberg-leader position in the quantity competition, thus improving their own welfare.

Although Fershtman and Judd (1987) have pointed out the similarity between the BS and FJS models, few studies have considered this view seriously. Recently, a number of papers analyzed strategic managerial delegation involving international trade in a duopoly market. Das (1997) applied an FJS-style delegation in both quantity and price settings to the standard strategic trade policy models and reexamined the governments' strategic trade policy. Miller and Pazgal (2005), which is distinguished from the analyses in Brander and Spencer (1985) and Eaton and Grossman (1986), introduced the so-called – "Relative Performance" contract – a linear combination of own profit and competitor's profit. Collie (1997) examined the domestic government's incentive to delegate the trade policy to a policy-maker when two firms compete in the domestic market and revealed that the domestic government should choose to delegate in order to improve both countries' welfares. However, the above research did not discuss the nature of the equivalent strategic behavior between government trade policy and managerial delegation under oligopolistic competition. In addition, they considered the two policies as independent instruments and did not explore their total effect on the behavior of the firms.

Our paper combines the BS model and FJS models and discusses their equivalence results. Although Das (1997) has already investigated such a strategic export subsidy model coupled with managerial delegation, our study is explicitly different from Das (1997). First, we focus on the owner's subsidization incentives by designing a managerial incentive contract. Although Das (1997) has indicated that the owner's delegation itself is a profit-shifting mechanism, he did not clearly explain this mechanism. In our paper, we show the equivalence result that the owner's delegation behavior has the same effect as government subsidization on the own firm in the duopoly market. Second, we discuss how government intervention affects the owner's profit-shifting performance. Das (1997) simply compared the magnitude of government subsidy in equilibrium with the BS model and disregarded the role of the owner's rent-shifting performance in a strategic export subsidy competition. We clarify that each owner's strategic subsidization incentive is strengthened with government intervention if their own subsidy-inclusive marginal cost is lower than the rival firm's marginal cost. Third, we examine the total subsidy effect summing up both government subsidization and owner's delegation behavior. In symmetric cost conditions, each exporting firm is over-subsidized in equilibrium and the Cournot competition between the firms becomes more fierce. Each exporting country's welfare worsens and world welfare improves.

The remaining paper proceeds as follows. In section 2, we describe a three-stage government-owner-manager game and examine the effects of both owners' and governments' subsidization incentives. In section 3, we solve the model concentrating on the owners' subsidization incentives. In section 4, we discuss the equilibrium value of the contract terms dependent on the marginal cost conditions. Section 5 summarizes a discussion on the extensions of this study and the concluding remarks.

2 Model Setup

Following the framework of the BS model, we consider two exporting countries, each with a firm producing a homogeneous product and selling it to a third country, an importing country. Let $q_i (i = 1, 2)$ denote the output produced by firm i, and $Q = q_1 + q_2$ the total output. Throughout our paper, we assume a linear inverse demand function in the third market, as follows:

$$p = P(Q) = 1 - q_1 - q_2.$$

Let c_i denotes the marginal production cost of firm i and s_i^G, the unit production (= export) subsidy provided by country i's government. Firm i's profit function is given by

$$\Pi_i = \pi_i(\mathbf{q}, s_i^G) = \left(P(Q) - c_i + s_i^G\right) q_i,$$

where $\mathbf{q} = (q_i, q_j)$ denotes the output profile.

Each exporting firm has one owner and one manager. Each owner designs an incentive contract to compensate its manager, which is expressed as a linear combination of the firm's profit and revenue as in the FJS model:

$$\begin{aligned} M_i = m_i(\mathbf{q}, \beta_i, s_i^G) &= \beta_i \, \pi_i(\mathbf{q}, s_i^G) + (1 - \beta_i) P(Q) q_i \\ &= \left[P(Q) - \beta_i(c_i - s_i^G)\right] q_i, \end{aligned} \tag{1}$$

where β_i denotes the contract term of firm i and is the weight on the firm's profit in the contract. If $\beta_i = 1$, (1) is simply firm i's pure profit function.

Note that M_i does not represent a manager's rewards in general. In fact, the manager is paid $A_i + B_i M_i$ for some constants A_i and B_i with $B_i > 0$. The owner must offer his manager a contract under which the participation constraint is satisfied, i.e., $A_i + B_i M_i = \bar{K}$ such that $\bar{K}$ equals the manager's reservation income or opportunity cost and is a constant.[2] Without loss of generality, we normalize $\bar{K}$ to 0, i.e., $A_i + B_i M_i = 0$.

We explore a three-stage government-owner-manager game as in Das (1997). In the first stage, each exporting country's government simultaneously determines the country-specific subsidy rate to the own firm. In the second stage, given both the countries' subsidy rates, each owner delegates a manager and designs an incentive contract that is publicly observable. In the third stage, each manager – being aware of his incentive scheme and that of the rival – decides the production quantity to export to the third country competing *à* la Cournot.

Considering the weighed-average combination of profit and sales in (1), the manager is able to determine a more (or less) aggressive output, since unlike in the pure profit maximization case, the manager faces the marginal cost of $\beta_i(c_i - s_i^G)$ in the incentive contract. We term $\beta_i(c_i - s_i^G)$ as firm i's managerial marginal cost. Each firm acts as though it were subsidized (or taxed) by an amount equivalent to the cost difference between the actual marginal cost c_i and the managerial marginal cost $\beta_i(c_i - s_i^G)$. We define this cost difference as total subsidy (or tax) of firm i, s_i^T: [3]

$$s_i^T := c_i - \beta_i(c_i - s_i^G).$$

Total subsidy (or tax) can be divided into two parts. One is government subsidy s_i^G set at the first stage, which is the cost difference between government intervention and nonintervention behavior. The other is nonpecuniary subsidy caused by the owner's manipulated incentive contracts designed in the second stage, which is the cost difference between the owner's delegation and non-delegation behavior given a precommitted government subsidization.[4] We term this nonpecuniary subsidy as *owner's subsidy (or tax) equivalent* of firm i, s_i^O: [5]

$$s_i^O := s_i^T - s_i^G = (1 - \beta_i)(c_i - s_i^G).$$

Owner's subsidy (or tax) equivalent appears to be a debatable concept since the owner cannot subsidize (or tax) the firm itself. However, by manipulating an incentive contract, the owner can divert the manager's objective from strict profit maximization to attain the subsidization (or taxation) objective. Owing to the separation of ownership and management, the firm faces a marginal cost that is reduced by s_i^O (or increased by $-s_i^O$) comparing to the pure profit-maximization behavior. Hence, the owner's behavior of delegating a manager with contract term β_i is equivalent to subsidizing the firm with a unit production subsidy s_i^O (or taxing the firm with unit production tax $-s_i^O$).

In our paper, unlike Das (1997), we let each owner decide his/her owner subsidy (or tax) equivalent s_i^O instead of contract term β_i in the second stage. Given that s_i^G is determined in the first stage, s_i^O is a monotonic function of β_i if $c_i - s_i^G \neq 0$.[6] Therefore, our owner's subsidy equivalent approach results in the same equilibrium values as those in the contract term approach in Das (1997). We can rewrite (1) as follows:

$$M_i = \widetilde{m}_i(\mathbf{q}, s_i^T) = \left[P(Q) - c_i + s_i^T\right] q_i, \tag{2}$$

where $s_i^T = s_i^O + s_i^G$. We solve the game by backward induction from the third stage.

3 Model Solution

3.1 Output Stage Equilibrium

After observing each country's government subsidy rate and each firm's incentive contract, the managers decide their optimal outputs under the precommitted contract in (2). Given that the second-order condition (SOC) is satisfied,[7] the first-order condition (FOC) for maximizing (2) with respect to its own output yields

$$0 = \frac{\partial \widetilde{m}_i(\mathbf{q}, s_i^T)}{\partial q_i} = MR_i - (c_i - s_i^T), \tag{3}$$

where $MR_i = P(Q) + q_i P'(Q)$ denotes the marginal revenue of firm i. Given its rival's output, each firm's manager ascertains the best response obtained by equating the marginal revenue with the marginal cost net of total subsidy, i.e., $MR_i = c_i - s_i^T$.

Define $R^i(q_j, s_i^T)$ as manager i's reaction function:

$$R^i(q_j, s_i^T) = \arg\max_{q_i} \ \widetilde{m}_i(\mathbf{q}, s_i^T) = \frac{1}{2}(1 - q_j - c_i + s_i^T).$$

Thus, $R_q^i \stackrel{\text{def}}{=} \frac{\partial R^i(q_j, s_i^T)}{\partial q_j} = -\frac{1}{2} < 0$ shows that each firm's optimal output is a strategic substitute to the other's. Solving for each firm's optimal output at the third-stage equilibrium yields

$$q_i^*(\mathbf{s^T}) = \frac{1}{3}[1 - 2(c_i - s_i^T) + (c_j - s_j^T)], \tag{4}$$

where $\mathbf{s^T} = (s_i^T, s_j^T)$ represents the total subsidy profile. Note that each firm's equilibrium output depends on the total subsidies of both firms. Differentiating (4) with s_i^O yields:

$$\frac{\partial q_i^*(\mathbf{s^T})}{\partial s_i^O} = \frac{\partial q_i^*(\mathbf{s^T})}{\partial s_i^T} = \frac{2}{3} > 0 \qquad , \qquad \frac{\partial q_j^*(\mathbf{s^T})}{\partial s_i^O} = \frac{\partial q_j^*(\mathbf{s^T})}{\partial s_i^T} = R_q^j \frac{\partial q_i^*(\mathbf{s^T})}{\partial s_i^T} = -\frac{1}{3} < 0. \tag{5}$$

An increase in the domestic owner's subsidy reduces the domestic marginal cost and induces the domestic manager to act more aggressively under Cournot competition. Hence, the domestic firm's output increases and foreign firm's output decreases as a strategic substitute.

3.2 Contract Stage Equilibrium

In the second stage, each firm's owner decides s_i^O in the incentive contract to maximize its own profit. Since we assume that the cost of delegating a manager is zero, i.e., $A_i + B_i M_i = 0$, the owner acts as a pure profit maximizer. Evaluating the equilibrium output in (4) yields the following expression for each firm's profit function:

$$\begin{aligned} \pi_i^*(\mathbf{s^O}, \mathbf{s^G}) &= \pi_i\left(q_i^*(\mathbf{s^O} + \mathbf{s^G}), q_j^*(\mathbf{s^O} + \mathbf{s^G}), s_i^G\right) \\ &= \frac{1}{9}\left[1 - 2(c_i - s_i^T) + (c_j - s_j^T) - 3s_i^O\right]\left[1 - 2(c_i - s_i^T) + (c_j - s_j^T)\right]. \end{aligned}$$

Given the SOC is satisfied,[8] the FOC for maximizing the profit function is given by

$$\begin{aligned} 0 = \frac{\partial \pi_i^*(\mathbf{s^O}, \mathbf{s^G})}{\partial s_i^O} &= \frac{\partial \pi_i}{\partial q_i}\frac{\partial q_i^*}{\partial s_i^O} + \frac{\partial \pi_i}{\partial q_j}\frac{\partial q_j^*}{\partial s_i^O} \\ &= \left(MR_i - c_i + s_i^G\right)\frac{\partial q_i^*}{\partial s_i^O} + q_i P' \frac{\partial q_j^*}{\partial s_i^O}. \end{aligned} \tag{6}$$

Using the comparative static results in (5) and noting that $\frac{\partial q_i^*}{\partial s_i^O} \neq 0$ yields

$$MR_i = c_i - s_i^G - q_i P' R_q^j. \tag{7}$$

The above equation coincides with the FOC in the Stackelberg equilibrium under profit maximization when firm i is a leader. Managerial delegation provides the own firm an opportunity to act as a Stackelberg leader under Cournot quantity competition.

Substituting (7) into (3), we obtain the optimal owner's subsidy (or tax) equivalent as below:

$$s_i^O = q_i P' R_q^j > 0. \tag{8}$$

Since s_i^O is positive, we regard s_i^O as the owner's subsidy equivalent of firm i.[9]

BS Subsidy Equivalence Result

Without government intervention, the nonintervention two-staged owner-manager model is the FJS model. We find that the optimal owner's subsidy equivalent in the FJS model is identical to *à* la Brander-Spencer government subsidy, i.e.,

$$s_i^{OFJ} = \frac{1 - 3c_i + 2c_j}{5} = s_i^B,$$

where the superscripts FJ and B denote the equilibrium values in the FJS and BS models, respectively.

The resulting equilibrium output and national welfare also yield the equivalence results.

$$q_i^{FJ} = \frac{2}{5}(1 - 3c_i + 2c_j) = q_i^B \tag{9}$$

$$W_i^{FJ} = \frac{2}{25}(1 - 3c_i + 2c_j)^2 = W_i^B \tag{10}$$

Proposition 1 *In the absence of government intervention, strategic managerial delegation induces each firm to act as though it were subsidized with an optimal government subsidy in the BS model, i.e.,* $s_i^{OFJ} = s_i^B$ *and* $q_i^{FJ} = q_i^B (i = 1, 2)$.

The above result also holds under a general demand function when each firm's product is a strategic substitute to that of the other. The BS and FJS models can be regarded as being similar principal-agent models, in which agents play Nash against all others, and principals play

Stackelberg against agents and Nash against all other principals. In the BS model, the governments' precommitments to pay an export subsidy distort firms' incentives to advance the own national welfare. Similarly, in the FJS model, owners' strategic managerial delegation also distorts managers' incentives to achieve higher profits. Note that the objective functions in both the models are the same, i.e., since principals maximize the own firm's subsidy-exclusive profit functions and agents maximize the own firm's subsidy-inclusive profit functions. Thus, under the same duopolistic market performance, owner's optimal subsidy equivalent in the FJS model is equivalent to the government's optimal subsidy in the BS model.

Equilibrium Owner's Subsidy Equivalent

Denote $\gamma^i(s_j^O, \mathbf{s^G})$ as owner i's reaction function to maximize its own profit:

$$\gamma^i(s_j^O, \mathbf{s^G}) := \arg\max_{s_i^O} \pi_i^*(\mathbf{s^O}, \mathbf{s^G}) = \frac{1}{4}(1 - 2c_i + c_j + 2s_i^G - s_j^O - s_j^G).$$

Although the properties of the above reaction function can be easily derived in the linear demand function, we provide an intuitive explanation in view of (6). The first term in (6) represents the marginal profit-loss through the excess competition effect. It shows that an increase in the domestic firm's production results in a further decrease in the marginal revenue as compared to the subsidy-inclusive marginal cost in view of (3) and (8). Hence, the own output expansion leads to a domestic profit loss. The second term in (6) represents the marginal profit gain through the rent-shifting effect, which shows that a decrease in the foreign firm's output improves the terms of trade and thus shifts the rent from the foreign firm to the domestic firm.

We depict owner i's reaction curve as $\gamma^i\gamma^{i\prime}(i = 1, 2)$ in Figure 1. Each firm's reaction curve is downward sloping, which is given by

$$\begin{aligned}\frac{\partial \gamma^i(s_j^O, \mathbf{s^G})}{\partial s_j^O} \propto \frac{\partial^2 \pi_i^*(\mathbf{s^O}, \mathbf{s^G})}{\partial s_j^O \partial s_i^O} &= \frac{\partial MR_i}{\partial s_j^O}\frac{\partial q_i^*}{\partial s_i^O} + \frac{\partial (q_i P')}{\partial s_j^O}\frac{\partial q_j^*}{\partial s_i^O} \\ &= 0 - \frac{\partial q_i^*}{\partial s_j^T}\frac{\partial q_j^*}{\partial s_i^O} < 0.\end{aligned}$$

In view of (6), an increase in the rival firm's owner's subsidy equivalent does not affect the excess competition effect since the manager always equates its marginal revenue to the marginal cost exclusive of the total subsidy. However, its terms of trade deteriorates due to an increase in the rival firm's output, and the rent-shifting effect becomes weaker. Hence, each firm's owner's subsidy equivalent is a strategic substitute to that of the rival. The above result also clarifies that an increase in the rival country's government subsidy shifts the reaction curve inward as below:

$$\frac{\partial \gamma^i(s_j^O, \mathbf{s^G})}{\partial s_j^G} = \frac{\partial \gamma^i(s_j^O, \mathbf{s^G})}{\partial s_j^O} < 0.$$

Meanwhile, an increase in the own government's subsidy shifts the reaction curve outward:

$$\frac{\partial \gamma^i(s_j^O, \mathbf{s^G})}{\partial s_i^G} \propto \frac{\partial^2 \pi_i^*(\mathbf{s^O}, \mathbf{s^G})}{\partial s_i^G \partial s_i^O} = \left(\frac{\partial MR_i}{\partial s_i^G} - 1\right)\frac{\partial q_i^*}{\partial s_i^T} + \frac{\partial (q_i P')}{\partial s_i^G}\frac{\partial q_j^*}{\partial s_i^T}$$
$$= 0 - \frac{\partial q_i^*}{\partial s_i^T}\frac{\partial q_j^*}{\partial s_i^T} > 0.$$

An increase in the own government subsidy does not affect the excess competition effect. However, it strengthens the rent-shifting effect; this is because the rival firm's output contracts further and improves the terms of trade, thus shifting the reaction curve outward shown in Figure 1.

The intersection of the two reaction curves labeled N in Figure 1 represents the optimal owner's subsidy equivalent of firm i in the second-stage equilibrium, $s_i^{ON}(\mathbf{s^G})$ which is given by

$$s_i^{ON}(\mathbf{s^G}) = \frac{1 - 3(c_i - s_i^G) + 2(c_j - s_j^G)}{5}.$$

The comparative static results yield:

$$\frac{\partial s_i^{ON}(\mathbf{s^G})}{\partial s_i^G} = \frac{3}{5} > 0 \qquad , \qquad \frac{\partial s_j^{ON}(\mathbf{s^G})}{\partial s_i^G} = -\frac{2}{5} < 0.$$

An increase in the domestic government subsidy makes the domestic firm more efficient than the rival firm due to the reduction in marginal cost. Thus, the domestic owner has a stronger subsidization incentive as indicated by de Meza (1986). Meanwhile, the rival firm becomes less efficient and its owner's subsidization incentive weakens. The resulting equilibrium is represented by Point G in Figure 1.

Equilibrium Output Change

The resulting second-stage equilibrium output is given by

$$q_i^N(\mathbf{s^G}) := q_i^*\left(s_i^{ON}(\mathbf{s^G}) + s_i^G, s_j^{ON}(\mathbf{s^G}) + s_j^G\right) \qquad (i, j = 1, 2;\, j \neq i). \tag{11}$$

Differentiating firm i's equilibrium output $q_i^N(\mathbf{s^G})$ with respect to s_i^G yields

$$0 < \frac{\partial q_i^N}{\partial s_i^G} = \frac{\partial q_i^*}{\partial s_i^T} + \frac{\partial q_i^*}{\partial s_i^T}\frac{\partial s_i^{ON}}{\partial s_i^G} + \frac{\partial q_i^*}{\partial s_j^T}\frac{\partial s_j^{ON}}{\partial s_i^G}. \tag{12}$$

An increase in the domestic government subsidy affects the domestic equilibrium output in three ways: (1) it reduces the domestic marginal cost; (2) strengthens the domestic owner's subsidization incentive; and (3) weakens the foreign owner's subsidization incentive. Since the three effects work in the same direction, the overall effect is reinforced, and the domestic firm acts more aggressively than it does without government intervention.

Likewise, the foreign firm's equilibrium output is affected in the same three ways.

$$
\begin{aligned}
0 > \frac{\partial q_j^N}{\partial s_i^G} &= \frac{\partial q_j^*}{\partial s_i^T} + \frac{\partial q_j^*}{\partial s_i^T}\frac{\partial s_i^{ON}}{\partial s_i^G} + \frac{\partial q_j^*}{\partial s_j^T}\frac{\partial s_j^{ON}}{\partial s_i^G} \\
&= R_q^j \frac{\partial q_i^N}{\partial s_i^G} + \delta \frac{\partial q_j^*}{\partial s_j^T}\frac{\partial s_j^{ON}}{\partial s_i^G} < 0. \qquad (13)
\end{aligned}
$$

Using (5), (12) and $\delta = 1 - R_q^i R_q^j > 0$, we can rewrite foreign output change into two parts as shown in (13). The first part represents the foreign firm's output decrease as a strategic substitute to the domestic output, and the second part represents the foreign firm's excess output decrease due to strategic managerial delegation competition between the owners. Note that the second part does not hold true when the foreign owner does not compete to delegate a manager.

3.3 Subsidy Stage Equilibrium

Evaluating at the equilibrium output in (11), each country's welfare function is expressed by the product surplus less the subsidy payment.

$$
\begin{aligned}
W_i = w_i(\mathbf{s^G}) &= \pi_i\left(q_i^N(\mathbf{s^G}), q_j^N(\mathbf{s^G}), s_i^G\right) - s_i^G q_i^N(\mathbf{s^G}) \\
&= \frac{2}{25}\left(1 - 3c_i + 2c_j - 2s_i^G - 2s_j^G\right)\left(1 - 3c_i + 2c_j + 3s_i^G - 2s_j^G\right).
\end{aligned}
$$

Given that the SOC is satisfied,[10] we solve the FOC for welfare maximization as follows.

$$
\begin{aligned}
0 = \frac{\partial w_i(\mathbf{s^G})}{\partial s_i^G} &= \frac{\partial \pi_i}{\partial q_i}\frac{\partial q_i^N}{\partial s_i^G} + \frac{\partial \pi_i}{\partial q_j}\frac{\partial q_j^N}{\partial s_i^G} - s_i^G \frac{\partial q_i^N}{\partial s_i^G} \\
&= -q_i P' R_q^j \frac{\partial q_i^N}{\partial s_i^G} + q_i P' \frac{\partial q_j^N}{\partial s_i^G} - s_i^G \frac{\partial q_i^N}{\partial s_i^G} \qquad (14) \\
&= -q_i P' \left(\delta \frac{\partial q_j^*}{\partial s_j^T}\frac{\partial s_j^{ON}}{\partial s_i^G}\right) - s_i^G \frac{\partial q_i^N}{\partial s_i^G} \qquad (15)
\end{aligned}
$$

where (7) and (13) were used. The parenthetical term in (15) represents the foreign firm's excess output decreases due to the strategic managerial delegation competition shown by the second part in (13). This term times $(-P')$ represents the price rise and times domestic output q_i represents the domestic marginal revenue increase caused by the improved terms of trade. Given any s_j, a small subsidy benefits the own country as shown by

$$
\left.\frac{\partial w_i(\mathbf{s^G})}{\partial s_i^G}\right|_{s_i^G=0} = q_i P' \left(-\delta \frac{\partial q_j^*}{\partial s_j^T}\frac{\partial s_j^{ON}}{\partial s_i^G}\right) > 0.
$$

Lemma 1 *When both exporting firms strategically delegate a manager, the governments of both exporting countries' governments have positive incentives to subsidize the own firms.*

Denote s_i^{GE} as the equilibrium government's subsidy of country i, given by

$$s_i^{GE} = \delta\, q_i P' \frac{\partial q_j^*}{\partial s_j^T} \frac{\partial s_j^{ON}}{\partial s_i^G} \Big/ \frac{\partial q_i^N}{\partial s_i^G} = \frac{1 - 4c_i + 3c_j}{14} > 0. \tag{16}$$

The positive value is assured by the duopolistic output in the equilibrium, i.e.,

$$q_i^E = q_i^N(\mathbf{s^G}) = \frac{3}{7}(1 - 4c_i + 3c_j) > 0. \tag{17}$$

Since the firms are subsidized by the owners in the second-stage equilibrium, there may be a doubt as to why the governments do not tax the firms to reduce welfare distortion in the first-stage equilibrium. The seemingly paradoxical result suggests that only the rent-shifting effect induces a shift in each owner's reaction curve shown in the previous subsection. Taxation increases the marginal cost, owing to which domestic owner has less incentive to subsidize the firm. The profit of the domestic firm decreases and the rent shifts to the foreign firms, thus deteriorating the domestic country's welfare. Although each firm's owner subsidizes the firm through manipulating the separation of ownership and management, each country's government still has a positive incentive to subsidize the own firm to prevent rent outflow.

3.4 Intuition for Subsidy Incentives

In view of (16), it is shown that the optimal government subsidy is definitely lower than the subsidy *à* la Brander-Spencer under the asymmetric cost conditions, i.e.,[11]

$$\begin{aligned} s_i^{GE} - s_i^B &= \frac{1 - 4c_i + 3c_j}{14} - \frac{1 - 3c_i + 2c_j}{5} \\ &= -\frac{9 - 22c_i + 13c_j}{70} \\ &= -\frac{2(1 - 3c_i + 2c_j) + 4(1 - 4c_i + 3c_j) + 3(1 - c_j)}{70} < 0, \end{aligned}$$

where (9) and (17) were used.

Lemma 2 *Strategic managerial delegation competition supresses both governments' subsidization incentives, i.e.,* $s_i^{GE} < s_i^B (i = 1, 2)$.

The intuition behind this can be explained as below. In the absence of government intervention, each owner manipulates the incentive scheme to grant the firm a subsidy à la Brander-Spencer. However, when the governments are involved, each country's government subsidization strengthens the domestic owner's subsidization incentive and weakens that of the foreign owner. The quantity competition between the exporting firms becomes more fierce, which deteriorates the terms of trade and worsens the welfare of the exporting countries. Therefore, each country's government has a weaker incentive to subsidize the own firm.

The owner's subsidy equivalent in equilibrium can be rewritten as:

$$s_i^{OE} = s_i^{ON}(\mathbf{s^G}) = \frac{3(1-4c_i+3c_j)}{14}.$$

Comparing the owner's subsidy equivalent s_i^{OE} to the subsidy *à* la Brander-Spencer s_i^B yields

$$s_i^{OE} - s_i^B = \frac{1-18c_i+17c_j}{70}.$$

Evidently, $s_i^{OE} > s_i^B$ under the symmetric cost function. However, under the asymmetric cost function, we find that

$$s_i^{OE} \gtreqqless s_i^B \qquad \Longleftrightarrow \qquad s_i^{GE} \gtreqqless c_i - c_j.$$

Note that if the foreign firm is not as efficient as the domestic firm, i.e., $c_i \leq c_j$, s_i^{OE} is always larger than s_i^B due to the positive value of s_i^{GE} shown in (16). Then, consider the case wherein the foreign firm is more efficient than the domestic firm, i.e., $c_i > c_j$. The above condition can be rewritten as follows:

$$s_i^{OE} \gtreqqless s_i^B \qquad \Longleftrightarrow \qquad c_i - s_i^{GE} \lesseqqgtr c_j.$$

It is shown that if the domestic firm's subsidy-inclusive marginal cost is lower than the foreign firm's marginal cost, the domestic owner's subsidy equivalent in equilibrium is higher than the subsidy *à* la Brander-Spencer and vice versa. The intuition can be shown by the result in de Meza (1986). When the strategic government subsidization makes the domestic firm more efficient than the foreign firm, the domestic owner has a stronger subsidization incentive than it does without government intervention.

Proposition 2 *Each firm's equilibrium owner's subsidy equivalent is higher than the subsidy à la Brander-Spencer if and only if its government-subsidy-inclusive marginal cost is lower than the rival firm's marginal cost.*

Using (8), we can rewrite (14) as below.

$$\begin{aligned} 0 = \frac{\partial w_i(\mathbf{s^G})}{\partial s_i^G} &= \left(-q_i P' R_q^j - s_i^G\right) \frac{\partial q_i^N}{\partial s_i^G} + q_i P' \frac{\partial q_j^N}{\partial s_i^G} \\ &= -s_i^T \frac{\partial q_i^N}{\partial s_i^G} + q_i P' \frac{\partial q_j^N}{\partial s_i^G} \end{aligned}$$

Solving for total subsidy in the above equation, we obtain:

$$s_i^{TE} = q_i P' \frac{\partial q_j^N}{\partial s_i^G} \Big/ \frac{\partial q_i^N}{\partial s_i^G} = \frac{2(1-4c_i+3c_j)}{7} > 0.$$

Comparing total subsidy with the subsidy *à* la Brander-Spencer yields[12]

$$s_i^{TE} \gtreqless s_i^B \qquad \Longleftrightarrow \qquad s_i^{GE} \gtreqless \frac{1}{6}(c_i - c_j).$$

Note that only if the domestic firm is not considerably less efficient than the foreign firm does $s_i^{TE} > s_i^B$ hold. However, if we confine our analysis under the symmetric cost conditions, each firm owner's subsidy and total subsidy in equilibrium is higher than the subsidy *à* la Brander-Spencer. In other words, strategic subsidy competition between the exporting countries strengthens both firms' owner's subsidization incentives and leads to oversubsidization to the firms.

Country i's welfare in equilibrium is given by:

$$W_i^E = w_i(\mathbf{s^{GE}}) = \frac{3}{49}(1 - 4c_i + 3c_j)^2,$$

which is lower than the welfare in the BS model shown in (10) when the cost conditions are symmetric, i.e., $W_i^E < W_i^B$. However, the third country is at an advantage due to an improvement in the importing country's terms of trade. Further, world welfare improves as well, i.e., $\sum_{i=1}^3 W_i^E > \sum_{i=1}^3 W_i^B$.

Proposition 3 *Under strategic managerial delegation and export subsidy competition, each exporting country's welfare worsens in comparison to the BS model due to excess subsidization in the symmetric cost conditions. However, the third country benefits from an improvement in the terms of trade and world welfare improves.*

3.5 Stackelberg Solution

Positive government subsidization in equilibrium also benefits the home firm with a Stackelberg-leader advantage in the owners' subsidy competition. To verify this result, we first show owner i's Stackelberg-leader subsidy and owner j's Stackelberg-follower subsidy as below.

$$\begin{aligned} s_i^{OL} &= \arg\max_{s_i^O} \widetilde{\pi}_i(s_i^O, \gamma^j(s_i^O), \mathbf{0}) = \frac{1 - 3c_i + 2c_j}{3} \\ s_j^{OF} &= \gamma^j(s_i^{OL}, \mathbf{0}) = \frac{1 - 4c_j + 3c_i}{6}. \end{aligned}$$

In Figure 1, Point L represents the Stackelberg equilibrium. Substituting the above values into (4) yields the Stackelberg leader and follower's output in the absence of government intervention:

$$q_i^{NL} = q_i^*(s_i^{OL}, s_j^{OF}) = \frac{1 - 3c_i + 2c_j}{2} \quad , \quad q_j^{NF} = q_j^*(s_j^{OF}, s_i^{OL}) = \frac{1 - 4c_j + 3c_i}{3}. \tag{18}$$

On the other hand, if only country i subsidizes its firm, its optimal subsidy rate is derived as below:

$$s_i^{GU} = \arg\max_{s_i^G} w_i(s_i^G, 0) = \frac{1 - 3c_i + 2c_j}{12}. \tag{19}$$

With country i's unilateral government subsidization, the total subsidies of firm i and j are equivalent to the Stackelberg leader and follower owner's subsidy, respectively, which are given by

$$\begin{aligned} s_i^{TU} &= s_i^{ON}(s_i^{GU}, 0) + s_i^{GU} = \frac{1 - 3c_i + 2c_j}{3} = s_i^{OL}, \\ s_j^{TU} &= s_j^{ON}(s_i^{GU}, 0) = \frac{1 - 4c_j + 3c_i}{6} = s_i^{OF}. \end{aligned}$$

— Figure 1 around here —

Since the equilibrium outputs are dependent on the total subsidies of both firms, the equilibrium outputs with unilateral government subsidy also yield equivalent results under the Stackelberg equilibrium:

$$q_i^U = q_i^*(\mathbf{s^{TU}}) = q_i^{NL} \qquad , \qquad q_j^U = q_j^*(\mathbf{s^{TU}}) = q_j^{NF}.$$

Unilateral government subsidization makes the domestic firm achieve the Stackelberg-leader output in determining the incentive contracts in the absence of government intervention, Therefore, each country's government has a positive incentive to subsidize its own exports.

4 Values of β_i in Equilibrium

The owner's subsidy equivalent is defined as $s_i^O := (1 - \beta_i)(c_i - s_i^G)$. Since s_i^O is always positive in view of (8), we obtain:

$$\beta_i^E \lesseqqgtr 1 \qquad \Longleftrightarrow \qquad c_i - s_i^{GE} \gtreqqless 0.$$

Therefore, whether β_i^E is larger or smaller than unity is dependent on the subsidy-inclusive marginal cost. When government's subsidy rate exceeds the firm's marginal cost, i.e., $s_i^{GE} > c_i$, the owner adds greater weight on the firm's profit in the manager's incentive contract, i.e., $\beta_i^E > 1$. Oversubsidization by the government makes the firms compete more fiercely and leads to overproduction. This lowers the market price and reduces the firm's profit. Hence, the owner should design a profit-oriented incentive contract to induce the firm to act less aggressively and ease the competition between the firms. To the best of our knowledge, literatures on the FJS-style managerial incentives always resulted in β_i in equilibrium being smaller than unity. Our paper presents a counter example where β_i is possibly larger than unity if the government subsidizes the own firm, outweighing its marginal cost. Note that if $c_i = s_i^{GE}$, the firm's profit is equivalent to the revenue; thus $\beta_i^E = 1$.

Using the equilibrium value of s_i^{GE} in (16), it follows that

$$c_i - s_i^{GE} = -\frac{1 - 18c_i + 3c_j}{14}.$$

Thus, the values of β_i^E are dependent on the marginal cost conditions as below.

$$\beta_i^E \lesseqqgtr 1 \qquad \Longleftrightarrow \qquad c_j \lesseqqgtr -\frac{1}{3} + 6c_i$$
$$\beta_j^E \lesseqqgtr 1 \qquad \Longleftrightarrow \qquad c_j \gtreqqless \frac{1}{18} + \frac{1}{6}c_i$$

We summarize the above results into Figure 2. In view of (17), constrained in a duopolistic market performance that both firms produce a strictly positive output at the equilibrium that $1 - 4c_i + 3c_j > 0$ ($i, j = 1, 2; j \neq i$), the figure is divided into four parts that summarize all the equilibrium values of β_i^E.

— Figure 2 around here —

5 Discussion and Concluding Remarks

This paper reexamines the strategic export subsidy competition with the separation of ownership and management in a third market model. We explore the owners' subsidization incentives in designing a managerial incentive contract and reveal the total subsidy effect on the firms' performance in the market. Although Das (1997) indicated that both the firms are subsidized with a smaller government subsidy as compared to the case without delegation, we show a contradictory fact that the firms are subsidized in a larger total subsidy in equilibrium. Under symmetric cost conditions, the firms are over-subsidized and both the exporting countries' welfare deteriorates. The nature of strategic managerial delegation in the export subsidy competition lies in that it intensifies the competition between the exporting firms and reduces the distortions in oligopoly pricing, thus improving world welfare. This is the main point in our paper different from Das (1997).

We further consider our study to be extended in the following three direction.[13] First, the same analytical approach can be applied in price competition. When two firms engage in price competition, each firm's owner has the incentive to tax the firm equivalent to a government tax *à* la Eaton-Grossman. When the governments are involved, each country's government still has an incentive to tax the firm. The strategic government tax competition strengthens both the firms' taxation incentives and the total taxation are larger than in the case without managerial delegation. Thus, both the firms result in a higher equilibrium price. The exporting countries' welfare improves and world welfare deteriorates.

Recently, many papers attempt to endogenize the owners' managerial hiring decisions. Basu (1995) discussed that a Stackelberg equilibrium may be realized in the framework of the FJS model. White (2001) examined a mixed oligopoly with one public firm and a number of private firms. Constantine, Evangelos, and Emmanuel (2006) endogenizes the owner's choice between the two types of managerial incentive contracts: Profit-Revenues contract (introduced in the FJS model) and Relative-Performance contracts (introduced in Miller and Pazgal (2001, 2002)). The above study showed that prisoner's dilemma that result in the FJS model may not occur if the firm is able to arrive at the managerial delegation decision. However, while applying the endogenization in our model and letting the firm decide whether or not to delegate a manager in the first stage, we find that both the firms' owners have no incentive to delegate a manager and a Pareto-efficient result is realized.

This paper examined the three stage game in which the governments move as Stackelberg leaders to the firms. We find that the results are largely dependent on the order of the moves. If we let the firms move first in the first stage and the governments subsequently, the total subsidy in equilibrium is a subsidy *à* la Brander-Spencer. This is because the governments always determine the optimal subsidy rates to maximize the total subsidy exclusive profit of the national firm. Irrelevant of firm owner's subsidization in the first stage, the governments always decide the total subsidy rate to *à* la Brander-Spencer subsidy. Bearing in mind this subsidization behavior, the firm owners greatly tax the firms to induce higher government subsidy. The analysis that the owners move as leaders against governments is somewhat difficult and is left for future research.

REFERENCE

Basu, K. (1993): *Lectures in Industrial Organization Theory*. Blackwell, Oxford.

——— (1995): "Stackelberg Equilibrium in Oligopoly: An Explanation Based on Managerial Incentives," *Economic Letters*, 49, 459–464.

Baumol, W. (1958): "On the Theory of Oligopoly," *Economica*, 25, 187–198.

Berle, A., and G. Means (1932): *The Modern Corporation and Private Property*. New York MacMillan.

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

Collie, D. R. (1997): "Delegation and Strategic Trade Policy," *International Economic Journal*, 11(3), 35–46.

Constantine, M., M. Evangelos, and P. Emmanuel (2006): "Endogenous Strategic Managerial Incentive Contracts," mimeo, http://wwwapp.iese.edu/JEI/upload/mmp-delegation.pdf.

Das, S. P. (1997): "Strategic Managerial Delegation and Trade Policy," *Journal of International Economics*, 43, 173–188.

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

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

Fershtman, C., and K. L. Judd (1987): "Equilibrium Incentives in Oligopoly," *The American Economic Review*, 77(5), 927–940.

Miller, N. H., and A. Pazgal (2001): "The Equivalence of Price and Quantity Competition with Delegation," *The Rand Journal of Economics*, 32, 284–301.

——— (2002): "Relative Performance as a Strategic Commitment Mechanism," *Managerial and Decision Economics*, 23, 51–68.

——— (2005): "Strategic Trade and Delegated Competition," *Journal of International Economics*, 66, 215–231.

Simon, H. (1964): "On the Concept of Organizational Goal," *Administrative Science Quarterly*, 9, 1–21.

Sklivas, S. D. (1987): "The Strategic Choice of Managerial Incentives," *The Rand Journal of Economics*, 18(3), 452–458.

Vickers, J. (1985): "Delegation and the Theory of the Firm," *Economic Journal*, 95, 138–147.

White, M. D. (2001): "Managerial Incentives and the Decision to Hire Managers in Markets with Public and Private Firms," *European Journal of Political Economy*, 17, 877–896.

Williamson, O. E. (1964): *The Economics of Discretionary Behavior: Managerial Objectives in a Theory of the Firm*. Englewood Cliffs, Prentice-Hall.

Notes

[1]Eaton and Grossman (1986) reported that strategic export taxation is optimal when the firms compete in a Bertrand fashion with zero conjectural variations.

[2]See Chapter 14 in Basu (1993).

[3]If $s_i^T < 0$, the firm is taxed in total.

[4]With government subsidy commitment at the first stage, the marginal cost is $c_i - s_i^G$ without managerial delegation and $(1-\beta_i)(c_i - s_i^G)$ with managerial delegation. We define its difference as owner's subsidy (tax) equivalent.

[5]We regard s_i^O as the owner's subsidy equivalent if $s_i^O > 0$ or the owner's tax equivalent if $s_i^O < 0$.

[6]We will discuss the case where $s_i^G = c_i$ in section 4.

[7]It is easily verified that:

$$\frac{\partial^2 \widetilde{m}_i(\mathbf{q}, s_i^T)}{\partial q_i^2} = -2 < 0.$$

[8]The SOC can be derived as follows:

$$\frac{\partial^2 \pi_i^*(\mathbf{s^O}, \mathbf{s^G})}{(\partial s_i^O)^2} = \frac{\partial^2 \pi_i^*(\mathbf{s^O}, \mathbf{s^G})}{(\partial s_i^O)^2} = -\frac{4}{9} < 0.$$

[9]In price competition, s_i^O is always negative and we regard it as the owner's tax equivalent of firm i (See the author's working paper).

[10]Again, the SOC is easily verified:

$$\frac{\partial^2 w_i(\mathbf{s^G})}{(\partial s_i^G)^2} = -\frac{24}{25} < 0.$$

[11]Das (1997) does not show this result explicitly.

[12]It is given by

$$\begin{aligned} s_i^{TE} - s_i^B &= \frac{3 - 19c_i + 16c_j}{35} \\ &= \frac{3(1 - 4c_i + 3c_j) - 7(c_i - c_j)}{35} \\ &= \frac{6}{5}\left[s_i^G - \frac{1}{6}(c_i - c_j)\right]. \end{aligned}$$

[13]See details provided in the author's working paper.

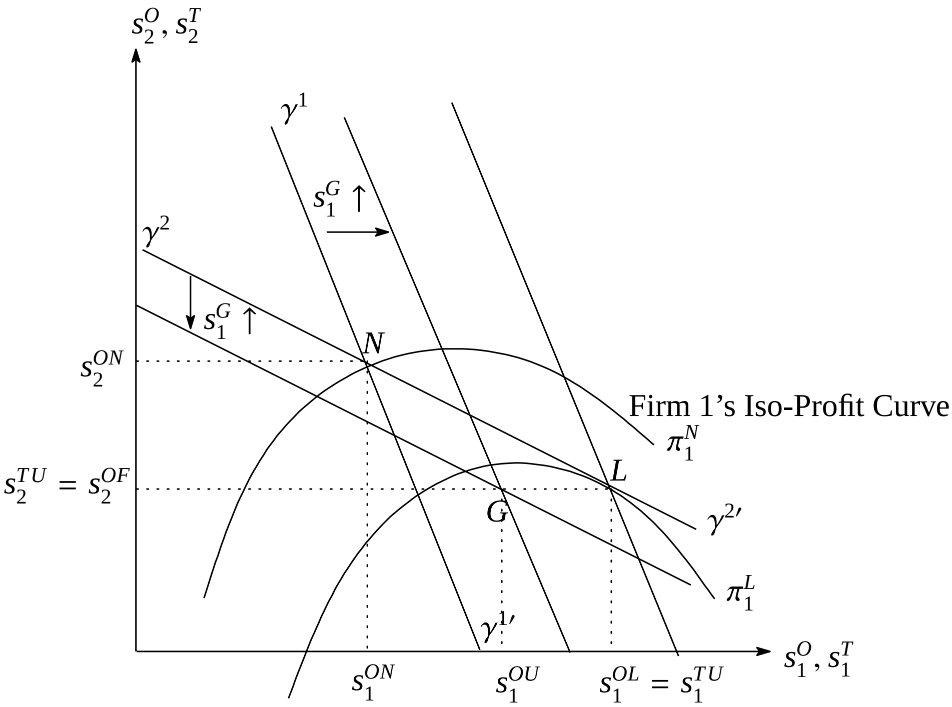

Figure 1: Government Subsidization and Stackelberg Equilibrium in the Contract Stage

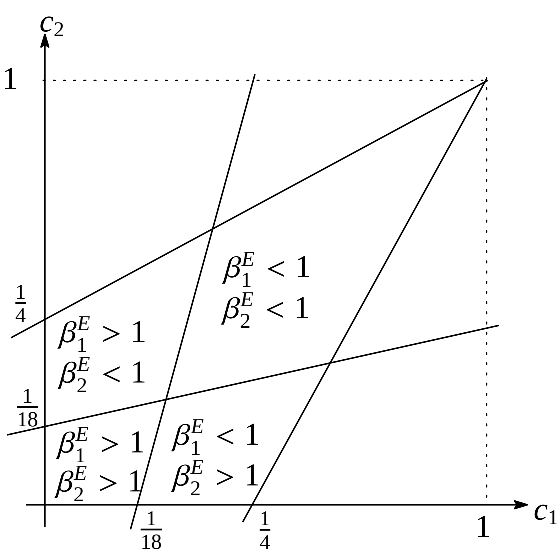

Figure 2: Values of β_i in Equilibrium