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Strategic Trade Policies and Managerial Incentives under International Cross Ownership[1]

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Abstract: This paper examines the implications of the separation of ownership and management based on a strategic export promotion policy when the shares of exporting firms are internationally owned by the residents of both countries in an international duopolistic market. Although the presence of either cross ownership or managerial delegation weakens the exporting countries' subsidization incentives, their combined presence does not always have an additive effect. We find that the cross-ownership structure always weakens the governments' subsidization incentives irrespective of the presence of managerial delegation. However, managerial delegation may raise or lower the optimal subsidy (or tax) rate, depending on the presence of a cross-ownership structure. Furthermore, we compare the equilibrium subsidy rates in four different cases to show the correlation between ownership structure and managerial delegation. This paper clarifies how combined presence of managerial decision process and international mutual shareholding alter strategic export promotion policies when firms compete a la Cournot.

Keywords: Strategic trade policy, Managerial delegation, Cross ownership, International duopoly, Cournot competition

JEL Classifications: C72, F13, L22

1. Introduction

Early research on strategic trade policy, such as the work of Brander and Spencer (1985) (hereafter, the BS model) built a standard rent-shifting model and presented a well-known argument for welfare-improving export subsidy. Brander and Spencer (1985)'s paper is based on a single nationality of the firms involved, that is, any firm located in a country is assumed to be completely owned by its own nationals. However, the accelerated globalization of economic activities and foreign investment liberalization make the ownership of firms more complicated. Any firm financing through equities may create ownership not only by domestic investors, but also by foreign investors in other nations. The presence of foreign ownership has been shown to weaken governments' subsidization or taxation incentives, since trade policies are implemented in consideration of foreign firms' profits.[2]

In addition to foreign ownership structure, modern enterprises are characterized by a separation of ownership and management, which was first indicated by Berle and Means (1932).

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[2] See Dick (1993), Welzel (1995), Lee (1990), Miyagiwa (1992), and Wei and Kiyono (2005).

Works analyzing the separation of ownership and management in imperfect competition began with Vickers (1985) and were stylized by Fershtman and Judd (1987) and Sklivas (1987) (hereafter, the FJS model). These authors showed that delegating a manager with distorted objective functions affects the strategic performance of the firm and induces the firm to act as a Stackelberg leader in quantity (or price) competition.

These previous works showed that the presence of either foreign ownership or managerial delegation weakens exporting countries' subsidization incentives. However, to the best of our knowledge, no paper has examined their combined presence.[3] To fill in this blank, this paper discusses how strategic subsidization incentives are affected by managerial delegation when shares of the firms are internationally owned by the residents of two exporting countries. We found that the cross-ownership structure always weakens countries' subsidization incentives irrespective of managerial delegation. However, managerial delegation may raise or lower the optimal subsidy (or tax) rate, depending on the cross-shareholding ratio. Furthermore, we compare the optimal subsidy rates in four different cases to show the correlation between cross ownership and managerial delegation. This paper elucidates how the combined presence of foreign ownership and managerial decision affects the implication of strategic export promotion policies in the framework of a BS model.

The rest of the paper is organized as follows. Section 2 introduces the model setup. Section 3 investigates the full-game equilibria in the combined presence of cross ownership and separation of ownership and management. Sections 4 and 5 discuss the effects of these two phenomena, respectively. Section 6 compares the equilibrium results in the four cases concerning cross ownership and managerial delegation. The concluding remarks are summarized in section 7.

2. Model

Following Brander and Spencer (1985), we consider two exporting countries, each with a firm producing a homogeneous product and competing a la Cournot in a third country. Let $\mathrm{q_i}$ denote the output produced by firm i (i=1,2) and $\mathrm{Q} = \mathrm{q_1} + q_2$ the total output. Throughout our paper, we assume a linear demand function in the third market.

$$\mathrm{p} = \mathrm{P(Q)} = \mathrm{a} - \mathrm{q_1} - q_2.$$

Let $\mathrm{c_i}$ denote the unit cost of firm i and $\mathrm{s_i}$ the unit production (i.e.,= export) subsidy provided by country i's government. Firm i's subsidy-inclusive profit function is given by

$$\pi_{\mathrm{i}}(\boldsymbol{q}, s_i) = (P(Q) - c_i + s_i)q_i \tag{1}$$

where $\mathbf{q} = (\mathrm{q_1}, \mathrm{q_2})$ 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 weighted-average combination of the firm's profit and sales as in the FJS model.

$$\begin{aligned} \mathrm{M_i}(\boldsymbol{q}, \beta_i, s_i) &= \beta_i \pi_i(\boldsymbol{q}, s_i) + (1 - \beta_i)P(Q)q_i \\ &= [\mathrm{P(Q)} - \beta_{\mathrm{i}}(c_i - s_i)]q_i \end{aligned} \tag{2}$$

where β_{i} is defined as the contract term, which is the weight on the firm's profit in the contract. If $\beta_{\mathrm{i}} = 1$, equation (2) is simply firm i's pure profit function of (1).

[3] Das (1997), Collie (1997), Miller and Pazgal (2005), and Wei (2010) examined strategic managerial delegation involving trade policies, but not considering foreign ownership.

Without loss of generality, we assume that each firm offers his manager a contract under which the participation constraint is satisfied, that is, $A_i + B_i M_i = 0$ for some constants A_i and B_i with $B_i > 0$.

In view of (2), the firm faces a managerial subsidy-inclusive cost of $\beta_i(c_i - s_i)$. Each firm acts as though it were subsidized by an amount equivalent to the cost difference between the actual cost c_i and the managerial subsidy-inclusive cost $\beta_i(c_i - s_i)$. Wei (2010) defined this cost difference as the *total subsidy (or tax)* of firm i, S_i, as below.

$$S_i \coloneqq c_i - \beta_i(c_i - s_i).$$

Total subsidy can be divided into two parts. One is government subsidy s_i. The other is nonpecuniary subsidy caused by the owner's manipulated incentive contracts. Wei (2010) termed the latter the *owner's subsidy (or tax) equivalent* d_i:

$$d_i \coloneqq S_i - s_i = (1 - \beta_i)(c_i - s_i).$$

Owner's subsidy equivalent d_i shows the cost difference between the owner's delegation and non-delegation behavior. Owing to the separation of ownership and management, the owner can divert the manager's objective from strict profit maximization to attain the subsidization objective.

We adopt Wei's (2010) owner's subsidy equivalent approach throughout the whole paper. Our model is described as a three-staged government-owner-manager game as in Das (1997). In the first stage, each exporting country's government determines its country-specific subsidy (s_1, s_2). In the second stage, each firm's owner delegates a manager and decides the owner's subsidy equivalent (d_1, d_2) in the incentive contract. In the third stage, each manager decides the production quantity (q_1, q_2) competing a la Cournot in the third market.

3. Model Solution

3.1 Output Stage Equilibrium

In view of the definition of d_i, (2) can be rewritten as follows.

$$\widetilde{M_i}(\boldsymbol{q}, S_i) = [P(Q) - c_i + S_i]q_i \tag{3}$$

where $S_i = d_i + s_i$.

We solve the game by backward induction. In the third stage, after observing each country's subsidy rate and each firm's incentive contract, the managers determine their optimal outputs as below.

$$q_i^*(\boldsymbol{S}) = \frac{1}{3}[a - 2(c_i - S_i) + (c_j - S_j)] \tag{4}$$

where $\boldsymbol{S} = (S_1, S_2)$ denotes total subsidy profile. Each firm's equilibrium output depends on the total subsidies of both firms. In the international duopoly market, the presence of managerial delegation pushes the domestic firm's reaction curve outward, which increases the best response output of the domestic firm and reduces that of the foreign firm, that is, $\frac{\partial q_i^*(.)}{\partial d_i} > 0, \frac{\partial q_i^*(.)}{\partial d_j} < 0$.

3.2 Contract Stage Equilibrium

At the second stage, the owners design the optimal contracts to maximize their own profits. Since the cost of hiring a manager is zero, each owner acts as a pure profit-maximizer. The optimal owner's subsidy equivalent of firm i in the second-stage equilibrium, $d_i^N(\boldsymbol{s})$ can be derived as

$$d_i^N(\boldsymbol{s}) = \frac{a - 3(c_i - s_i) + 2(c_j - s_j)}{5} \tag{5}$$

where $\boldsymbol{s} = (s_1, s_2)$ and the superscript N represents the equilibrium results in the second-stage.

Note that $d_i^N(0,0)$ is a la Brander and Spencer export subsidy. In the absence of government intervention, the two-staged owner-manager subgame is the FJS model. Strategic managerial delegation induces the firms to act as though they were subsidized with the same rent-shifting device as in the BS model. This equivalence result holds under a general demand function when each firm's product is a strategic substitute to the rival firm.

Each firm's profit function can be rewritten as $\pi_i^N(\boldsymbol{s}) = \pi_i(q_i^N(\boldsymbol{s}), q_j^N(\boldsymbol{s}), s_i)$. Differentiating $\pi_i^N(\boldsymbol{s})$ with s_i yields $\frac{\partial \pi_i^N(\boldsymbol{s})}{\partial s_i} > 0, \frac{\partial \pi_j^N(\boldsymbol{s})}{\partial s_i} < 0 \ (i, j = 1,2; j \neq i)$. With managerial delegation, government subsidization increases the domestic firm's profit and reduces the rival firm's profit. The rent-shifting effect of strategic subsidization is not dampened in the presence of separation of ownership and management.

3.3 Subsidy Stage Equilibrium

We assume that the shares of both firms are internationally owned by the residents of both countries. Although shareholders are from different nations, shareholder unanimity on managerial delegation to maximize its holding firm's profit is assumed to be satisfied. Let σ_i denote the percentage share of firm i's (i =1, 2) equities owned by its domestic residents. The values of σ_i (i =1, 2) are assumed to be exogenously given. Evaluating at the equilibrium in the second stage, country i's welfare function is given as follows:

$$W_i(\boldsymbol{s}; \boldsymbol{\sigma}) = \sigma_i\, \pi_i^N(\boldsymbol{s}) + (1 - \sigma_j)\pi_j^N(\boldsymbol{s}) - s_i q_i^N(\boldsymbol{s}),$$

where $\boldsymbol{\sigma} = (\sigma_1, \sigma_2)$ represents the *bilateral ownership structure* of the firms.

Assumption 1. $\sigma_i \in \left(\frac{1}{2}, 1\right)$ for i=1,2.

Without Assumption 1, there is no essential meaning to referring to the home firm as the "home" firm.

Each government maximizes its national welfare by choosing the optimal export subsidy, taking into account the responses of both firms. Under the symmetric cost conditions $c_i = c_j = c$, the full-game Nash equilibrium subsidy denoted as $s_i^E(\boldsymbol{\sigma})$ is dependent on the cross-ownership structure as below:

$$s_i^E(\boldsymbol{\sigma}) = \frac{(16\sigma_i + 13\sigma_j - 10\sigma_i\sigma_j - 18)(a - c)}{2[24 - 11(\sigma_i + \sigma_j) + 5\sigma_i\sigma_j]} \tag{6}$$

where the superscript E represents the full-game equilibrium results. From Assumption 1, the denominator in (6) is positive, that is, $24 - 11(\sigma_i + \sigma_j) + 5\sigma_i\sigma_j > 0$, and hence $s_i^E(\boldsymbol{\sigma})$ is positive if and only if $\sigma_j > \frac{18 - 16\sigma_i}{13 - 10\sigma_i}$. Figure 1 illustrates the pairs of (σ_1, σ_2) for which country 1's government finds zero subsidy optimal with origin (0.5, 0.5). As shown in Figure 1, when the domestic residents' shares are large enough, each country's government subsidizes the firm; otherwise, export tax is the optimal trade policy because the government has to consider the flight of rents to the foreign country.

4. Effects of Cross Ownership

4.1 Government Subsidy

We first examine how the cross-ownership structure (σ_i, σ_j) affects the equilibrium results in the presence of managerial delegation. Without cross ownership, Das (1997) showed that

$s_i^E(1,1) = \frac{1}{14}(a-c)$, and each government always has a positive incentive to subsidize its own exports. Under cross ownership, (6) shows that $\frac{\partial s_i^E(\sigma_i,\sigma_j)}{\partial \sigma_k} > 0$ $(k = i, j)$, which yields

$$s_i^E(\sigma_i,\sigma_j) < s_i^E(1,1)$$

Proposition 1. *Under managerial delegation, cross ownership weakens both countries' subsidization incentives, that is.,* $s_i^E(\sigma_i,\sigma_j) < s_i^E(1,1)$, $\forall \sigma_i, \sigma_j$.

Compared to Das (1997), the combined presence with cross ownership weakens the governments' subsidy incentives. We show the welfare effect specific to cross ownership in the Appendix. This negative effect can be divided into three parts, representing the cross-ownership augmented subsidy incentives effect through managerial delegation.[4]

4.2 Owner's Subsidy Equivalent

Solving for the owner's subsidy equivalent in the full-game equilibrium yields

$$d_i^E(\boldsymbol{\sigma}) = d_i^N(s_i^E(\boldsymbol{\sigma}), s_j^E(\boldsymbol{\sigma})) = \frac{3(2-\sigma_j)(a-c)}{2[24-11(\sigma_i+\sigma_j)+5\sigma_i\sigma_j]} \tag{7}$$

The owner's subsidy equivalent is always positive irrespective of cross ownership. It is easy to show that $\frac{\partial d_i^E(\boldsymbol{\sigma})}{\partial \sigma_i} > 0$. Increasing domestic ownership strengthens the domestic owner's subsidy incentives. Differentiating (7) with σ_j yields

$$\frac{\partial d_i^E(\boldsymbol{\sigma})}{\partial \sigma_j} = \frac{-3(2-\sigma_i)(a-c)}{2[24-11(\sigma_i+\sigma_j)+5\sigma_i\sigma_j]^2} < 0.$$

The above equation is equivalent to $\frac{\partial d_i^E(\boldsymbol{\sigma})}{\partial(1-\sigma_j)} > 0$. Increasing the shares of foreign equities owned by domestic residents also increases the domestic owner's subsidy equivalent.

Comparing $d_i^E(\sigma_i,\sigma_j)$ with $d_i^E(1,1)$ yields

$$\begin{aligned} d_i^E(\sigma_i,\sigma_j) - d_i^E(1,1) &= \frac{3(2-\sigma_j)(a-c)}{2[24-11(\sigma_i+\sigma_j)+5\sigma_i\sigma_j]} - \frac{3(a-c)}{14} \\ &= -\frac{3[10-11\sigma_i-4\sigma_j+5\sigma_i\sigma_j]}{14[24-11(\sigma_i+\sigma_j)+5\sigma_i\sigma_j]}(a-c). \end{aligned}$$

We can derive that $d_i^E(\sigma_i,\sigma_j) > d_i^E(1,1)$ if and only if $\sigma_i > \frac{10-4\sigma_j}{11-5\sigma_j}$, or equivalently, $\Delta\sigma_i = \sigma_i - \sigma_j > \frac{5(1-\sigma_j)(2-\sigma_j)}{11-5\sigma_j}$. The owner's subsidy equivalent may become larger in the presence of cross ownership if the two firms' domestic share difference is large enough.

4.3 Firm's Output

Solving for the equilibrium output yields

$$q_i^E(\boldsymbol{\sigma}) = 2d_i^E(\boldsymbol{\sigma}) = \frac{3(2-\sigma_i)(a-c)}{24-11(\sigma_i+\sigma_j)+5\sigma_i\sigma_j}.$$

The same result holds for the equilibrium output, that is, $q_i^E(\sigma_i,\sigma_j) > q_i^E(1,1)$ if and only if

[4] See the Appendix for details.

$\sigma_i > \frac{10-4\sigma_j}{11-5\sigma_j}$, as in the previous subsection.

Proposition 2. *Given managerial delegation, the presence of cross ownership may increase firm i's equilibrium output if firm i's domestic shareholding* σ_i *is large enough:*

$$d_i^E(\sigma_i,\sigma_j) \gtreqless d_i^E(1,1) \;\Leftrightarrow\; q_i^E(\sigma_i,\sigma_j) \gtreqless q_i^E(1,1) \;\Leftrightarrow\; \sigma_i \gtreqless \frac{10-4\sigma_j}{11-5\sigma_j}.$$

4.4 Total Subsidy

Solving for total subsidy in equilibrium, we obtain

$$S_i^E(\boldsymbol{\sigma}) = s_i^E(\boldsymbol{\sigma}) + d_i^E(\boldsymbol{\sigma}) = \frac{(8\sigma_i + 5\sigma_j - 5\sigma_i\sigma_j - 6)(a-c)}{24 - 11(\sigma_i+\sigma_j) + 5\sigma_i\sigma_j}.$$

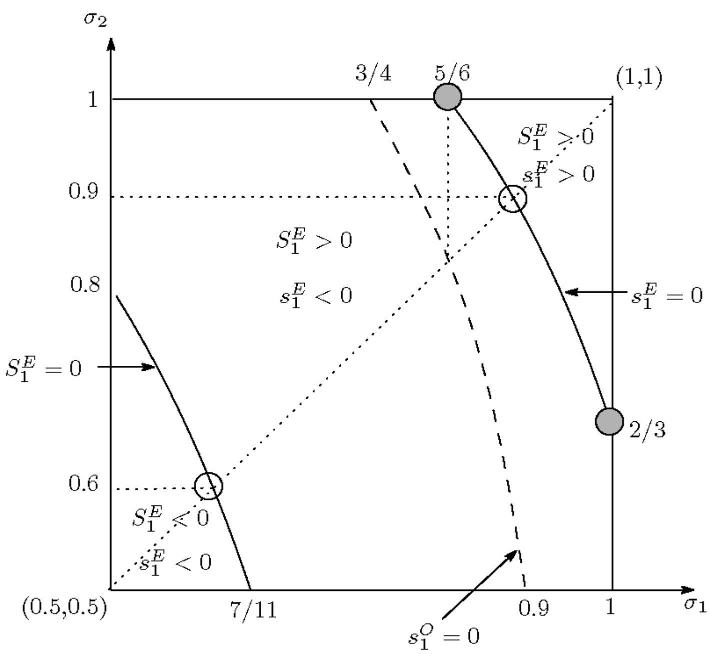

Figure 1 s_1^E, s_1^O, and S_1^E

$S_i^E(\boldsymbol{\sigma})$ is positive if and only if $\sigma_j > \frac{2(3-4\sigma_i)}{5(1-\sigma_i)}$. The conditions for (σ_1,σ_2) when $S_1^E(\boldsymbol{\sigma}) = 0$ are depicted in Figure 1. Although the owner's subsidy equivalent is always positive, total subsidy may become negative when the domestic residents hold large shares of foreign equities. That is, the government's optimal tax rate outweighs the owner's optimal subsidy rate.

Since $\frac{\partial S_i^E(\sigma)}{\partial \sigma_k} > 0 (k = i,j)$, $S_i^E(\sigma_i,\sigma_j) < S_i^E(1,1)$ holds. Cross-ownership structure always weakens total subsidy incentives.

5. Effects of Managerial Delegation

Next, we examine the effects of managerial delegation under a cross-ownership structure (σ_i,σ_j). Denote $s_i^O(\boldsymbol{\sigma})$ as country i's equilibrium subsidy rate without managerial delegation, i.e., $d_1 = d_2 = 0$. The superscript O represents the equilibrium results in the presence of cross ownership only. The optimal subsidy (see Dick (1993), Welzel (1995)) yields

$$s_i^O(\boldsymbol{\sigma}) = \frac{(16\sigma_i + 12\sigma_j - 12\sigma_i\sigma_j - 15)(a-c)}{33 - 20(\sigma_i+\sigma_j) + 12\sigma_i\sigma_j}.$$

$s_i^O(\boldsymbol{\sigma})$ is positive if and only if $\sigma_j > \frac{15-16\sigma_i}{12(1-\sigma_i)}$. The conditions for (σ_1,σ_2) when $s_1^O(\boldsymbol{\sigma}) = 0$ are shown by the dashed line in Figure 1, which lies between the lines for $s_1^E(\boldsymbol{\sigma}) = 0$ and

$S_1^{E}(\boldsymbol{\sigma}) = 0$. Figure 1 shows that without managerial delegation, country 1's government is more likely to subsidize its own firm than in the case of managerial delegation.

5.1 Government Subsidy

Comparing $s_i^{E}(\boldsymbol{\sigma})$ with $s_i^{O}(\boldsymbol{\sigma})$ yields

$$s_i^{E}(\boldsymbol{\sigma}) - s_i^{O}(\boldsymbol{\sigma}) = \frac{(16\sigma_i + 13\sigma_j - 10\sigma_i\sigma_j - 18)(a-c)}{2[24 - 11(\sigma_i + \sigma_j) + 5\sigma_i\sigma_j]} - \frac{(16\sigma_i + 12\sigma_j - 12\sigma_i\sigma_j - 15)(a-c)}{33 - 20(\sigma_i + \sigma_j) + 12\sigma_i\sigma_j}$$
$$= \frac{4(1-7\sigma_i)\sigma_j^2 - (117 - 216\sigma_i + 32\sigma_i^2)\sigma_j + 126 - 210\sigma_i + 32\sigma_i^2}{2(24 - 11(\sigma_i+\sigma_j) + 5\sigma_i\sigma_j)(33 - 20(\sigma_i+\sigma_j) + 12\sigma_i\sigma_j)}(a-c) \tag{8}$$

Since the denominator in (8) is positive, the sign of $s_i^{E}(\sigma) - s_i^{O}(\sigma)$ is determined by the numerator. We define

$$f(\boldsymbol{\sigma}) \coloneqq 4(1-7\sigma_i)\sigma_j^2 - (117 - 216\sigma_i + 32\sigma_i^2)\sigma_j + 126 - 210\sigma_i + 32\sigma_i^2 \tag{9}$$

which is a quadric function of σ_j. The discriminant for $f(\boldsymbol{\sigma})$ is given by $\Delta(\sigma_i) := (117 - 216\sigma i$*+32σi22−161−7σi126−210σi+32σi2*. There are four solutions for $\Delta\sigma i$*=0*, but in view of Assumption 1, we only consider the range around $\sigma_i \in (0.5,1)$. Since $\Delta(0.5) > 0$ and $\Delta(1) < 0$, at least one solution satisfies $\Delta(\sigma_i) = 0,\ \forall\sigma_i \in (0.5,1)$ owing to the intermediate-value theorem.

Lemma 1. $\forall\, \sigma_i \in (0.5,1)$, *there exists a unique* $\sigma_i = \hat{\sigma}$ *satisfying* $\Delta(\hat{\sigma}) = 0$.

Proof. See the Appendix.

In view of Lemma 1, we get the following result.

$$\Delta(\sigma_i) \gtreqqless 0 \quad \Leftrightarrow \quad \sigma_i \lesseqqgtr \hat{\sigma} \quad \forall\sigma_i \in (0.5,1) \tag{10}$$

Given Assumption 1, $1 - 7\sigma_i < 0$ in (9). Using the result in (10), $s_i^{E}(\sigma)$ vs. $s_i^{O}(\sigma)$ can be shown in the following three cases.

(I)When $\sigma_i > \hat{\sigma},\ \Delta(\sigma_i) < 0$ *holds.*

$$f(\boldsymbol{\sigma}) < 0 \quad \Leftrightarrow \quad s_i^{E}(\boldsymbol{\sigma}) < s_i^{O}(\boldsymbol{\sigma}).$$

(II)When $\sigma_i < \hat{\sigma},\ \Delta(\sigma_i) > 0$ *holds.* Two real roots $\underline{\sigma_j}(\sigma_i)$ and $\overline{\sigma}_j(\sigma_i)$ satisfying $f(\sigma_i,, \underline{\sigma_j}) = f(\sigma_i, \overline{\sigma}_j)$=0.

$$\begin{cases} f(\boldsymbol{\sigma}) > 0 \quad \Leftrightarrow \quad s_i^{E}(\boldsymbol{\sigma}) > s_i^{O}(\boldsymbol{\sigma}) \qquad when\ \underline{\sigma_j}(\sigma_i) < \sigma_j < \overline{\sigma}_j(\sigma_i) \\ f(\boldsymbol{\sigma}) = 0 \quad \Leftrightarrow \quad s_i^{E}(\boldsymbol{\sigma}) = s_i^{O}(\boldsymbol{\sigma}) \qquad when\ \sigma_j = \underline{\sigma_j}(\sigma_i)\ or\ \overline{\sigma}_j(\sigma_i) \\ f(\boldsymbol{\sigma}) < 0 \quad \Leftrightarrow \quad s_i^{E}(\boldsymbol{\sigma}) < s_i^{O}(\boldsymbol{\sigma}) \qquad when\ \sigma_j(\sigma_i) < \underline{\sigma_j}(\sigma_i)\ or\ \sigma_j > \overline{\sigma}_j(\sigma_i) \end{cases}$$

where $\underline{\sigma_j}(\sigma_i) = \frac{117 - 216\sigma_i + 32\sigma_i^2 + \sqrt{\Delta(\sigma_i)}}{8(1-7\sigma_i)}$ and $\overline{\sigma}_j(\sigma_i) = \frac{117 - 216\sigma_i + 32\sigma_i^2 - \sqrt{\Delta(\sigma_i)}}{8(1-7\sigma_i)}$.

(III)When $\sigma_i = \hat{\sigma},\ \Delta(\sigma_i) = 0$ *and* $\underline{\sigma_j}(\hat{\sigma}) = \overline{\sigma}_j(\hat{\sigma})$ *holds.*

$$\begin{cases} f(\boldsymbol{\sigma}) < 0 \quad \Leftrightarrow \quad s_i^{E}(\boldsymbol{\sigma}) > s_i^{O}(\boldsymbol{\sigma}) \qquad when\ \sigma_j \neq \underline{\sigma_j}(\hat{\sigma}) \\ f(\boldsymbol{\sigma}) = 0 \quad \Leftrightarrow \quad s_i^{E}(\boldsymbol{\sigma}) = s_i^{O}(\boldsymbol{\sigma}) \qquad when\ \sigma_j = \underline{\sigma_j}(\hat{\sigma}) \end{cases}.$$

The values of the two roots $\underline{\sigma_j}(\sigma_i)$ and $\overline{\sigma}_j(\sigma_i)$ for $\Delta(\sigma_i) = 0$ yield the following Lemma.

Lemma 2. $\forall \sigma_i \in (0.5, \hat{\sigma})$, $\underline{\sigma_j}(\sigma_i)$ *and* $\overline{\sigma}_j(\sigma_i)$ *satisfy:*

(1). $\underline{\sigma_j}'(\sigma_i) > 0$, $\overline{\sigma}_j'(\sigma_i) < 0$.

(2). $\overline{\sigma}_j(\sigma_i) \gtreqless 1 \quad \Leftrightarrow \quad \sigma_i \lesseqgtr \sigma_m$.

(3). $\underline{\sigma_j}(\sigma_i) \gtreqless 0.5 \quad \Leftrightarrow \quad \sigma_i \gtreqless \sigma_n$

where $0.5 < \sigma_m < \sigma_n < \hat{\sigma} < 1$.

Proof. See the Appendix.

The curves for $\overline{\sigma}_2(\sigma_1)$ and $\underline{\sigma_2}(\sigma_1)$ obtained from Lemma 2 are depicted in Figure 2. The two curves intersect at $\sigma_1 = \hat{\sigma}$, in which $\overline{\sigma}_2(\hat{\sigma}) = \underline{\sigma_2}(\hat{\sigma})$. Figure 2 is largely divided into two areas by the curves of $\overline{\sigma}_2(\sigma_1)$ and $\underline{\sigma_2}(\sigma_1)$. To the left of the curves, $s_1^E(\boldsymbol{\sigma}) > s_1^O(\boldsymbol{\sigma})$, and to the right, the relationship is reversed; the curves represent $s_1^E(\boldsymbol{\sigma}) = s_1^O(\boldsymbol{\sigma})$. Note that regardless of the value of σ_2, if $\sigma_1 > \hat{\sigma}$, $s_1^E(\boldsymbol{\sigma}) < s_1^O(\boldsymbol{\sigma})$ always holds; and if $\sigma_1 < \sigma_m$, $s_1^E(\boldsymbol{\sigma}) > s_1^O(\boldsymbol{\sigma})$ always holds.

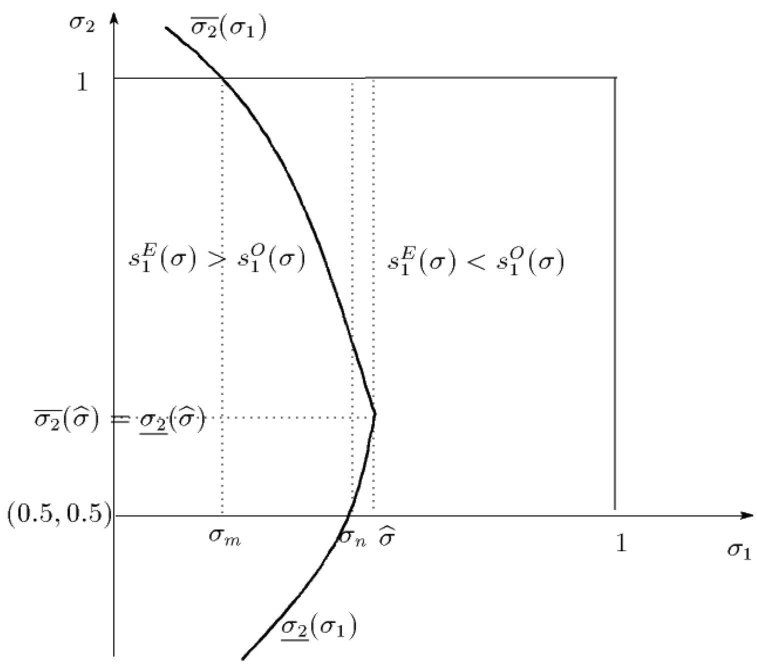

Figure 2 Values of $s_1^E(\boldsymbol{\sigma})$ *vs.* $s_1^O(\boldsymbol{\sigma})$

Proposition 3. *Given* (σ_i, σ_j), *managerial delegation may raise or lower the governments' optimal subsidy rates depending on the presence of a cross ownership structure* (σ_i, σ_j) *when* $\sigma_m < \sigma_i < \hat{\sigma}$. *Furthermore, if the domestic shareholding ratio is small enough that* $\sigma_i < \sigma_m$, *managerial delegation always strengthens the government's subsidization incentive (more concisely, lowers the government's tax incentive), that is,* $s_i^E(\boldsymbol{\sigma}) > s_i^O(\boldsymbol{\sigma})$. *Further, if the domestic shareholding ratio is large enough that* $\sigma_i > \hat{\sigma}$, *the government's subsidization incentive is always weakened under managerial delegation, that is,* $s_i^E(\boldsymbol{\sigma}) < s_i^O(\boldsymbol{\sigma})$.

In the absence of cross ownership as shown in Wei (2010), managerial delegation always weakens the government's subsidization incentive. This is because managerial delegation itself already acts as a profit-shifting device, and further subsidization will lead to even more fierce competition between the firms and lower their profits. When allowing international cross ownership, a large fraction of domestic shareholding does not change this result. However, when the domestic shareholding is small enough, as in nearly half, the government is likely to tax the exports. Holding both firms' shareholding weakens the government's tax incentive.

5.2 Firm's Output

Setting $d_1 = d_2 = 0$, the equilibrium output $q_i^O(\boldsymbol{\sigma})$ yields

$$q_i^O(\boldsymbol{\sigma}) = \frac{2(3-2\sigma_j)(a-c)}{33-20(\sigma_i+\sigma_j)+12\sigma_i\sigma_j}.$$

Comparing $q_i^E(\boldsymbol{\sigma})$ with $q_i^O(\boldsymbol{\sigma})$ yields

$$q_i^E(\boldsymbol{\sigma}) - q_i^O(\boldsymbol{\sigma}) = \frac{2(1-\sigma_i)(27-29\sigma_j+8\sigma_j^2)+\sigma_j}{[24-11(\sigma_i+\sigma_j)+5\sigma_i\sigma_j][33-20(\sigma_i+\sigma_j)+12\sigma_i\sigma_j]} > 0.$$

In view of Assumption 1, $q_i^E(\boldsymbol{\sigma}) > q_i^O(\boldsymbol{\sigma})$ holds. Managerial delegation increases the equilibrium output irrespective of the presence of a cross-ownership structure.

Proposition 4. *Given (σ_i, σ_j), managerial delegation always increases each firm's equilibrium output, that is,* $q_i^E(\boldsymbol{\sigma}) > q_i^O(\boldsymbol{\sigma})$.

6. Equilibrium Results in the Four Cases

In this section, we summarize the equilibrium results, analyzing the implication of a cross-ownership structure and managerial delegation on the governments' subsidy incentives in the following four cases.

- Case N: without managerial delegation and cross ownership,
- Case O: with only cross ownership,
- Case D: with only managerial delegation,
- Case E: with both managerial delegation and cross ownership.

Related papers analyzing the implication of a cross-ownership structure and managerial delegation on the governments' subsidy incentives are shown in the following table 1.

Table 1 Related papers

	Cross Ownership	**Full Ownership**
Delegation	This paper	Das(1997), Wei(2010)
Non-Delegation	Dick(1993), Wei and Kiyono (2005)	Brander and Spencer(1985)

6.1 Government Subsidy

First, the government's optimal subsidy rates in the four cases are summarized in Table 2.

As shown in Proposition 1, cross ownership always lowers the governments' optimal subsidy rates irrespective of managerial delegation, that is, $s_i^E(\boldsymbol{\sigma}) < s_i^D$ and $s_i^O(\boldsymbol{\sigma}) < s_i^N$.

Managerial delegation always lowers the government's optimal subsidy rate in the absence of cross ownership, that is, $s_i^D < s_i^N$. However when allowing cross ownership, the effects of managerial delegation on the optimal subsidy, that is, $s_i^E(\boldsymbol{\sigma})\ vs.\ s_i^O(\boldsymbol{\sigma})$, are dependent on the cross-ownership structure (σ_1, σ_2), as shown in Figure 2 on page 85.

Table 2 Optimal subsidy rates of government

s_i	Cross Ownership	Full Ownership
Delegation	$s_i^E(\boldsymbol{\sigma}) = \frac{16\sigma_i + 13\sigma_j - 10\sigma_i\sigma_j - 18}{2[24 - 11(\sigma_i + \sigma_j) + 5\sigma_i\sigma_j]}(a-c)$	$s_i^D = \frac{1}{14}(a-c)$
Non-Delegation	$s_i^O(\boldsymbol{\sigma}) = \frac{16\sigma_i + 12\sigma_j - 12\sigma_i\sigma_j - 15}{33 - 20(\sigma_i + \sigma_j) + 12\sigma_i\sigma_j}(a-c)$	$s_i^N = \frac{1}{5}(a-c)$

Furthermore, we can show

$$s_i^O(\boldsymbol{\sigma}) - s_i^D = \frac{244\sigma_i + 188\sigma_j - 180\sigma_i\sigma_j - 243}{14(33 - 20(\sigma_i + \sigma_j) + 12\sigma_i\sigma_j)}(a-c),$$

which yields $s_i^O(\boldsymbol{\sigma}) > s_i^D$ if and only if $\sigma_j > \frac{243-244\sigma_i}{188-180\sigma_i}$. The conditions for (σ_1, σ_2) satisfying $s_1^O(\sigma) = s_1^D$ combined with the results in Figure 2 are shown in Figure 3 below.

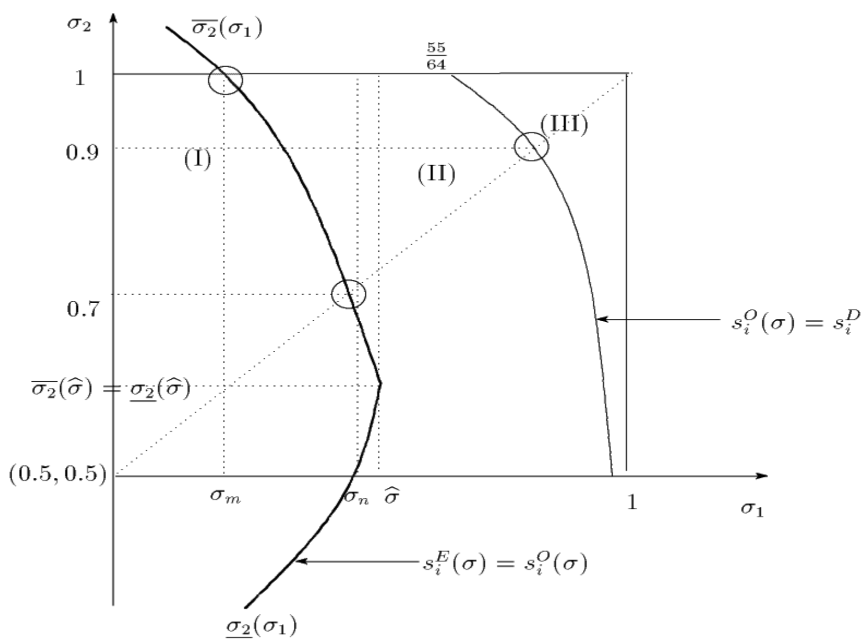

Figure 3 Optimal subsidy rates

Summarizing the above results, the ranking of optimal government subsidy rates in the four cases shown in Figure 3 is as below.

- $(\sigma_i, \sigma_j) \in Region(I)$: $s_i^O(\boldsymbol{\sigma}) < s_i^E(\boldsymbol{\sigma}) < s_i^D < s_i^N$
- $(\sigma_i, \sigma_j) \in Region(II)$: $s_i^E(\boldsymbol{\sigma}) < s_i^O(\boldsymbol{\sigma}) < s_i^D < s_i^N$
- $(\sigma_i, \sigma_j) \in Region(III)$: $s_i^E(\boldsymbol{\sigma}) < s_i^D < s_i^O(\boldsymbol{\sigma}) < s_i^N$

Note that the government's equilibrium subsidy rate is always the highest in the BS model, the case without managerial delegation and cross ownership. The presence of either managerial delegation or cross ownership weakens the government's subsidization incentive. The lower the domestic shareholding ratio, the stronger the effect of cross ownership and the weaker the effect of managerial delegation. The combined two effects are strengthened only in Regions (II) and (III), where $s_i^E(\boldsymbol{\sigma})$ is the lowest among the four cases. However, when domestic shareholding is small as in Region (I), the combined presence does not have an additive effect. Managerial delegation leads to higher subsidization (or lower taxation) in the presence of cross ownership.

6.2 Equilibrium Output

The following Table 3 summarizes the individual firm's equilibrium output under the four cases.

Table 3 Equilibrium outputs of individual firm

$\mathbf{q_i}$	Cross Ownership	Full Ownership
Delegation	$q_i^E(\boldsymbol{\sigma}) = \frac{3(2-\sigma_j)}{24-11(\sigma_i+\sigma_j)+5\sigma_i\sigma_j}(a-c)$	$q_i^D = \frac{3}{7}(a-c)$
Non-Delegation	$q_i^O(\boldsymbol{\sigma}) = \frac{2(3-3\sigma_j)}{33-20(\sigma_i+\sigma_j)+12\sigma_i\sigma_j}(a-c)$	$q_i^N = \frac{2}{5}(a-c)$

In view of Proposition 4 and Table 3, managerial delegation always increases the firms' equilibrium outputs irrespective of the presence of a cross-ownership structure, that is, $q_i^D > q_i^N$ and $q_i^E(\boldsymbol{\sigma}) > q_i^O(\boldsymbol{\sigma})$.

Meanwhile, Proposition 2 shows that cross ownership may increase the firms' equilibrium outputs if the domestic shareholding is large enough under managerial delegation. That is, $q_i^E(\boldsymbol{\sigma}) > q_i^D(\boldsymbol{\sigma})$ if and only if $\sigma_i > \frac{10-4\sigma_j}{11-5\sigma_j}$.

The ranking of the equilibrium outputs in the four cases is shown in Figure 4.

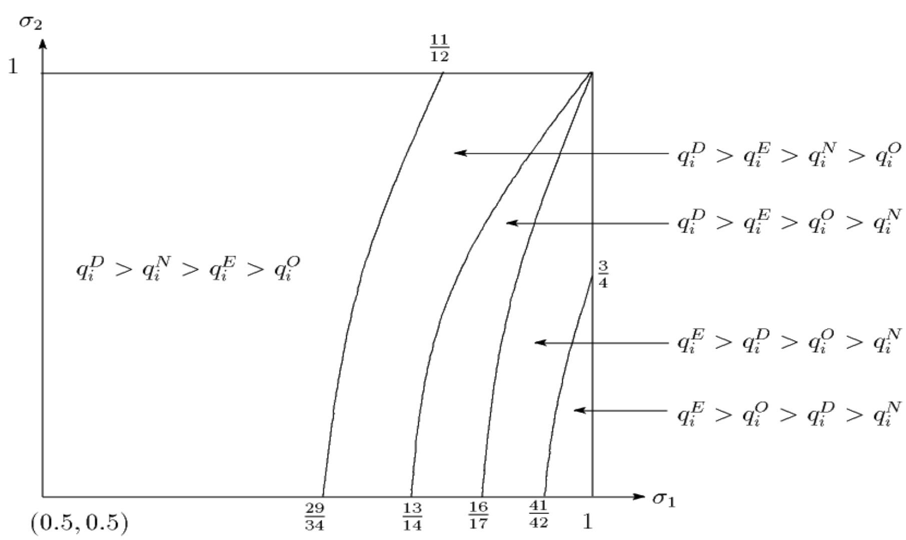

Figure 4 Equilibrium outputs

Note that the equilibrium output is always higher in the presence of managerial delegation. However, cross ownership increases (reduces) the equilibrium output when the domestic shareholding ratio is high (low). The lower the domestic shareholding ratio, the stronger the effect of cross ownership on reducing the equilibrium output.

7. Conclusions

Using a familiar third market model, this paper focuses on separation of the firm's structure: separation of ownership and management, and separation of stocks among different nationals. The separation of ownership and management makes firms behave more aggressively; however, the separation of stocks among the rival firm's shareholding makes the governments consider the flight of rents going abroad. As for the government's subsidy policy decision, either separation effects weaken the government's subsidization incentives. The strength of the combined two separation effects is dependent on the presence of a cross-ownership structure. The lower the domestic shareholding ratio, the larger the effect of cross ownership

In addition to separation, mergers are also often found in modern enterprises. In contrast to the analyses in this paper, it would be interesting to examine integration in the firm's structure: integration of management and integration of stocks (merger). A study to examine the integration effect on firms' behavior and governments' policy decisions would complement the research in this paper and provide some new implications for the analyses of trade policy dealing with firm's structure. This is left for the future.

Appendices

A.1 Subsidy Incentives Specific to Cross Ownership

The FOC for welfare maximization in the first stage in Section 3.3 should satisfy:[5]

$$
\begin{aligned}
0 = \frac{\partial \mathrm{W_i}(\boldsymbol{s};\boldsymbol{\sigma})}{\partial s_i} &= \sigma_i \frac{\partial \pi_i^N(\boldsymbol{s})}{\partial s_i} + (1-\sigma_j)\frac{\partial \pi_j^N(\boldsymbol{s})}{\partial s_i} - q_i - s_i \frac{\partial q_i^N}{\partial s_i} \\
&= \sigma_\mathrm{i}\left(q_i P'(Q) R_S^j \frac{\partial S_j^N}{\partial s_i} + q_i\right) + (1-\sigma_j)\left(q_j P'(Q) R_S^i \frac{\partial S_i^N}{\partial s_i}\right) - q_i - s_i \frac{\partial q_i^N}{\partial s_i} \\
&= \mathrm{q_i} P'(Q) R_S^j \frac{\partial S_j^N}{\partial s_i} - s_i \frac{\partial q_i^N}{\partial s_i} \qquad \text{(a1)} \\
&\quad -(1-\sigma_\mathrm{i})\mathrm{q_i P'(Q) R_S^j} \frac{\partial S_j^N}{\partial s_i} - (1-\sigma_i) q_i + (1-\sigma_j) q_j P'(Q) R_S^i \frac{\partial S_i^N}{\partial s_i} \qquad \text{(a2)}
\end{aligned}
$$

where $\mathrm{q_i^N(s) = R^i(q_j^N(s), S_i^N(s))}$ denotes the equilibrium output in the second stage. Comparing the subsidy incentives above with the case sans cross ownership, we can show that the terms in (a1) represent the subsidy incentive under managerial delegation without cross ownership as in Das(1997), and the terms in (a2) show the subsidy incentives specific to cross ownership.[6] Furthermore, (a2) can be decomposed into the following three parts.

The first part $-(1-\sigma_\mathrm{i})\mathrm{q_i} P'(Q) R_S^j \partial S_j^N / \partial s_i$ shows the ***cross rent-shifting effect through managerial delegation***. Export subsidy to the home firm, through the standard rent-shifting effect, increases its profit, but leads to an increase in the dividend given to the foreign firm. Note that $\left|R_S^j \frac{\partial S_j^N}{\partial s_i}\right| < \left|\frac{\partial q_j^N}{\partial s_i}\right|$, and hence export subsidy increases the domestic owner's subsidy and leads to fiercer competition in the output market. The domestic firm's profit gain shrinks, and the dividend given to the foreign firm is also reduced.

---

[5] The second-order condition for welfare maximization is satisfied:

$$\frac{\partial^2 W_i(s;\sigma)}{\partial s_i^2} = -\frac{4}{25}(11 - 9\sigma_i + 4\sigma_j) < 0.$$

[6] Without cross ownership, i.e., $\sigma_1 = \sigma_2 = 1$, the terms in (a2) disappear.

The second part $-(1-\sigma_i)q_i$ shows ***the subsidy outflow effect***, as it is the portion of the subsidy expense going abroad as an increased dividend to the foreign residents.

The third part $-(1-\sigma_j)q_j P'(Q) R_S^i \partial S_i^N/\partial s_i$ shows the ***dividend suppression effect through managerial delegation***. Further, note that $\left|R_S^i \frac{\partial S_i^N}{\partial s_i}\right| < \left|\frac{\partial q_i^N}{\partial s_i}\right|$, and hence managerial delegation scales down the decrease in the dividend from the shared foreign firm.

The above three negative parts weaken the governments' subsidy incentives under cross ownership, which we call the ***cross-ownership augmented subsidy incentives effect through managerial delegation.***

A.2 Proof for Lemma 1

(Reduction to absurdity) If there are two solutions $\sigma_a, \sigma_b (0.5 < \sigma_a < \sigma_b < 1)$ satisfying $\Delta(\sigma_a) = \Delta(\sigma_b) = 0$, based on the mean-value theorem, there must exist $\sigma_c \in (\sigma_a, \sigma_b)$ satisfying $\Delta'(\sigma_c) = 0$. Owing to $\Delta''(\sigma_i) = 64(941 - 960\sigma_i + 192\sigma_i^2) > 0\ \forall \sigma \in (0.5, 1)$, $\Delta'(\sigma_i) > 0\ \forall \sigma_i > \sigma_c$ holds. This leads to $\Delta(\sigma_i) > 0\ \forall \sigma_i > \sigma_b$, which contradicts the result that $\Delta(1) < 0$.

A.3 Proof for Lemma 2

(1) Differentiating $\underline{\sigma_j}'(\boldsymbol{\sigma})$ and $\overline{\sigma_j}(\boldsymbol{\sigma})$ with σ_i yields

$$\underline{\sigma_j}'(\sigma_i) = \frac{A(\sigma_i) + B(\sigma_i)}{8\sqrt{\Delta(\sigma_i)}(1-7\sigma_i)^2}, \qquad \overline{\sigma_j}'(\sigma_i) = \frac{A(\sigma_i) - B(\sigma_i)}{8\sqrt{\Delta(\sigma_i)}(1-7\sigma_i)^2},$$

where $A(\sigma_i) \coloneqq (603 + 64\sigma_i - 224\sigma_i^2)\sqrt{\Delta(\sigma_i)}$ and $B(\sigma_i) \coloneqq \frac{1}{2}(1-7\sigma_i)\Delta'(\sigma_i) + 7\Delta(\sigma_i)$. Given Assumption 1, $A(\sigma_i) > 0$ and $B(\sigma_i) > 0$, since $\Delta(\sigma_i) > 0$, $\Delta'(\sigma_i) < 0\ \forall \sigma_i \in (0.5, \hat{\sigma})$. Thus, it is evident that $\underline{\sigma_j}'(\sigma_i) > 0$.

This sign for $\underline{\sigma_j}'(\sigma_i)$ is dependent on the difference between $A(\sigma_i)$ and $B(\sigma_i)$. Since $A(\sigma_i) + B(\sigma_i) > 0$, we take the difference of their squares as below.

$$\begin{aligned}
&A(\sigma_i)^2 - B(\sigma_i)^2 \\
&= -32(1-7\sigma_i)^2(105399 + 261024\sigma_i - 221248\sigma_i^2 - 115712\sigma_i^3 + 78848\sigma_i^4) \\
&= -32(1-7\sigma_i)^2\big[105399(1-\sigma_i^3) + 221248\sigma_i^2(1-\sigma_i) + 10313\sigma_i^2(1-\sigma_i) + 29464\sigma_i^2 \\
&\qquad + 78848\sigma_i^4\big] < 0
\end{aligned}$$

Thus, $A(\sigma_i) < B(\sigma_i)$, which yields $\overline{\sigma_j}'(\sigma_i) < 0$.

(2) Comparing $\overline{\sigma_j}(\sigma_i)$ with 1 yields

$$\overline{\sigma_j}(\sigma_i) - 1 = \frac{109 - 160\sigma_i + 32\sigma_i^2 - \sqrt{\Delta(\sigma_i)}}{8(1-7\sigma_i)},$$

where the sign is determined by the numerator. Define $\{\sigma_m : 109 - 160\sigma_m + 32\sigma_m^2 - \sqrt{\Delta(\sigma_m)} = 0\}$. Under the constraint in Assumption 1, we get one solution $\sigma_m = \frac{13}{22}$. Simple computation shows $\Delta(\sigma_m) > 0$, so $\sigma_m < \hat{\sigma}$ holds. In view of $\overline{\sigma_j}'(\sigma_i) < 0$, we can derive $\overline{\sigma_j}(\sigma_i) \gtreqless 1$ if and only if $\sigma_i \lesseqgtr \frac{13}{22}\ \forall \sigma_i \in (0.5, \hat{\sigma})$.

(3) Comparing $\underline{\sigma_j}(\sigma_i)$ with 0.5 yields

$$\underline{\sigma_j}(\sigma_i) - 0.5 = \frac{113 - 188\sigma_i + 32\sigma_i^2 + \sqrt{\Delta(\sigma_i)}}{8(1 - 7\sigma_i)}$$

where the sign is also determined by the numerator. Define $\{\sigma_n: 113 - 188\sigma_n + 32\sigma_n^2 - \sqrt{\Delta(\sigma_n)} = 0\}$. We get one solution $\sigma_n = \frac{109-21\sqrt{17}}{32}$ under the constraint in Assumption 1. Simple computation shows $\Delta(\sigma_n) > 0$, so $\sigma_n < \sigma_m < \hat{\sigma}$ holds. In view of $\underline{\sigma_j}'(\sigma_i) > 0$, we can derive $\overline{\sigma_j}(\sigma_i) \gtreqless 0.5$ if and only if $\sigma_i \gtreqless \frac{109-21\sqrt{17}}{32}$ $\forall\ \sigma_i \in (0.5, \hat{\sigma})$.

$$\underline{\sigma_j}(\sigma_i) \gtreqless 0.5 \quad \Leftrightarrow \quad \sigma_i \gtreqless \sigma_n = \frac{109 - 21\sqrt{17}}{32} \quad \forall\ \sigma_i \in (0.5, \hat{\sigma})$$

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