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THE CHOICE OF OPTIMAL PROTECTION AND OLIGOPOLY：IMPORT TARIFFS VS PRODUCTION SUBSIDIES

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THE CHOICE OF OPTIMAL PROTECTION AND OLIGOPOLY: IMPORT TARIFFS VS PRODUCTION SUBSIDIES

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Abstract

This paper analyzes the choice of import tariffs and production subsidies to provide optimal protection of domestic industry in the presence of oligopolistic competition, provided that there is a difference in costs between domestic and foreign firms. We show that the choice of optimal protection depends both on the difference in firms' costs and the relative number of firms across countries. First, in the case that the number of foreign firms is larger, an optimal protection is a production subsidy, regardless of the difference in costs. Second, in the case that the number of foreign firms is equal to, or less than that of domestic firms, an import tariff provides optimal protection if the difference in costs is large, while a production subsidy provides optimal protection if the differece in costs is small.

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1. INTRODUCTION

There is a large body of research analysing optimal *trade policies*. It has been shown that import tariffs and import quotas are equivalent in the case of perfect competition. But, if there is distortion, e.g., imperfect competition, then the equivalence does not necessarily hold. For example, Helpman and Krugman (1989) state that an import tariff policy is superior to an import quota policy as a means to protect domestic industry in the presence of international oligopoly. As to the choice of optimal export policies, i.e., export taxes or export subsidies, extending the model of Brander and Spencer (1985) to cases of more than two firms, Dixit (1984) shows that an export subsidy in a Cournot oligopoly equilibrium is the optimal choice so long as the number of domestic firms is not too large. Eaton and Grossman (1992) prove that the choice of optimal export policies depends on the form of oligopolistic competition. That is, an export subsidy policy is an optimal under Cournot duopoly, while an export tax policy is an optimal under Bertrand duopoly.

Under the GATT-WTO system, import tariffs are allowed, while import quotas are basically banned. A production subsidy policy to protect a domestic industry is not generally banned, however, an export subsidy policy is not allowed, and likely leads to retaliation, i.e., a countervailing duty policy.

Although there are many works discussing the optimal choice of *trade policies*, there are few analysing the choice between a trade policy, like an import tariff, and an industrial policy, like a production subsidy, to protect a domestic industry. For example, Corden (1957) shows that the optimal protection is an import tariff, rather than a production subsidy in the case of a large country under perfect competition. That is, the domestic economy is better off because of the effect of the terms of trade. On the other hand, Bhagwati and Ramaswami (1963), and Bhagwati, et. al. (1969) show the benefits of a production subsidy in the case of a small country with domestic distortion, such as a domestic monopoly. In that case, the domestic economy is better off because a production subsidy directly affects the domestic distortion, while the terms of trade resulting from an import tariff policy do not effect the international market.

If there is a distortion in the international market as well as domestic distortion, however, which should the government choose, an import tariff or a production subsidy ? In this paper we will discuss the optimal policy to protect a domestic industry in terms of social welfare in cases of oligopolistic competition. Dixit (1984), closely related to our paper, discusses optimal trade and industrial policies for oligopolistic industries. Although he analyzes optimal import tariffs and export subsidies in an intra-industry trade model, he does not discuss the choice of optimal protection.

We will show that the choice of optimal protection depends on the differences in firms' costs and the relative number of firms across countries. That is, in the case that the number of foreign firms is larger than that of domestic firms, a production subsidy provides optimal protection, regardless of the differences in their costs. In the case that the number of foreign firms is less than that of domestic firms, if cost differences are large, an import tariff provides optimal protection, but if they are small, a production subsidy provides optimal protection.

The next section presents our simple model. We will derive an optimal import tariff (hereafter, ITP) and an optimal production subsidy (hereafter, PSP). In section 3, comparing these policies, we will show the conditions of optimal protection for a domestic industry in terms of social welfare. Finally, section 4 summarizes our results and presents remaining issues.

2. THE MODEL

We suppose that there are a number of domestic and foreign (*) firms, which compete in a homogeneous product market of the domestic country. Since we will mainly discuss the choice of optimal protection by the domestic government, we omit the foreign market. This assumption implies that a domestic firm's costs are so high that it cannot export to the foreign market. Even if we consider the foreign market, our main results cannot be revised.

Let us assume that the inverse demand function of the domestic market is given by

$$P = a - bX, \quad X = \sum_{i=1}^{n} x_i + \sum_{j=1}^{n^*} x^*_j, \tag{1}$$

where P is the market price in the domestic market, X is total output, x_i (x^*_j) is the output of the domestic (foreign) firm i (j) in the domestic market.

We assume that the production cost functions of firms in both countries are as follows:

$$C_i = cx_i, \quad i = 1, \ldots, n, \tag{2}$$

$$C^*_j = \overline{c^*} x_j^*, \quad j = 1, \ldots, n^*, \tag{2*}$$

where

$$a > c > c^* (> \overline{c^*}), \text{ and } c > a^* > \overline{c^*} > 0, \tag{3}$$

$\delta = c - c^* > 0.$

Note that δ represents the cost difference between domestic and foreign firms, and that c^* includes transfer costs τ, i.e., $c^* = \overline{c^*} + \tau$. Below we will use δ as a parameter, given α.

The profit functions of the firms in both countries under free trade are given by

$$\Pi_i = (P - c)x_i - K,\ i = 1, \ldots, n, \tag{4}$$

$$\Pi^*_j = (P - c^*)x^*_j - K^*,\ j = 1, \ldots, n^*, \tag{4*}$$

where K (K^*) is a fixed cost of a domestic (foreign) firm.

Taking into account (1), the first conditions of are given by

$$\frac{\partial \Pi_i}{\partial x_i} = P - c + \frac{\partial P}{\partial x_i} x_i$$

$$= P - c - bx_i = 0,\ i = 1, \ldots, n, \tag{4´}$$

$$\frac{\partial \Pi^*_j}{\partial x^*_j} = P - c^* + \frac{\partial P}{\partial x^*_j} x^*_j$$

$$= P - c^* - bx^*_j = 0,\ j = 1, \ldots, n^*. \tag{4*´}$$

The firms exhibit Cournot-type behavior in the market. Hence, at free trade equilibrium, from (1), (4´), and (4*´), the output of each firm is given by

$$x^F = \frac{\alpha - n^*\delta}{b(N + 1)}, \tag{5}$$

$$x^{*F} = \frac{\alpha + (n+1)\delta}{b(N + 1)}, \tag{5*}$$

where $\alpha = a - c > 0$, and $N = n + n^*$.

We assume that the output of a domestic firm under free trade is positive, i.e.,

$$\alpha/n^* > \delta\ (> 0). \tag{6}$$

The total output in the domestic market is given by

$$X^F = \frac{N\alpha + n^* \delta}{b(N + 1)}, \tag{7}$$

The welfare of the domestic country under free trade is given by

$$W^F = \int_0^{X^F} P(X)dX - P(X^F)X^F + n\Pi(x^F). \tag{8}$$

From (4′), it holds that $P - c = bx^F$. Thus, we have

$$\Pi(x^F) = (P - c)x^F - K = bx^{F\,2} - K.$$

Taking into account (1), (4), (5), (7), and the above equation, (8) can be rewritten as

$$\begin{aligned} W^F &= (b/2)X^{F\,2} + n\{bx^{F\,2} - K\} \\ &= \frac{(N\alpha + n^* \delta)^2}{2b(N + 1)^2} + n\left(\frac{(\alpha - n^* \delta)^2}{b(N + 1)^2} - K\right). \end{aligned} \tag{9}$$

2.1 Optimal Import Tariff

Suppose that the domestic government levies an import tariff t, per unit, on the foreign firms. Thus, the profit functions of the firms in both countries under ITP are given by

$$\Pi_i = (P - c)x_i - K, \tag{10}$$

$$\Pi^*_j = (P - c^* - t)x^*_j - K^*. \tag{10*}$$

Hence, the output of each firm in the domestic market at ITP equilibrium is given by

$$x^T = x^F + \frac{n^* t}{b(N + 1)}, \tag{11}$$

$$x^{*T} = x^{*F} - \frac{(n + 1)t}{b(N + 1)}. \tag{11*}$$

We assume that exports by foreign firms under ITP is positive, i.e.,

$$b(N+1)x^{*F}/(n+1) > t. \tag{12}$$

The total output in the domestic market is given by

$$X^{T} = X^{F} - \frac{n^{*}t}{b(N+1)}. \tag{13}$$

The welfare function of the domestic economy under ITP is given by

$$\begin{aligned} W^{T}(t) &= \int_{0}^{X^{T}} P(X)dX - P(X^{T})X^{T} + n\Pi(x^{T}) + tn^{*}x^{*T} \\ &= (b/2)X^{T2} + n\{bx^{T2} - K\} + tn^{*}x^{*T}. \end{aligned} \tag{14}$$

Thus, the first order condition is

$$\begin{aligned} \frac{\partial W^{T}}{\partial t} &= bX^{T}\frac{\partial X^{T}}{\partial t} + 2bnx^{T}\frac{\partial x^{T}}{\partial t} + n^{*}x^{*T} + tn^{*}\frac{\partial x^{*T}}{\partial t} \\ &= -\frac{n^{*}}{b(N+1)}bX^{T} + \frac{n^{*}}{b(N+1)}2bnx^{T} + n^{*}x^{*T} \\ &\quad - \frac{n+1}{b(N+1)}tn^{*} = 0. \end{aligned} \tag{15}$$

Taking into account (11), (11*), (13), and (15), we can derive an optimal import tariff as follows:

$$t^{0} = \frac{(2n+1)\alpha + [(n+1)^{2} - n^{*}n]\delta}{2(n+1)^{2} + n^{*}}. \tag{16}$$

Note that (16) satisfies (12) and that $t^{0} > 0$, taking into account (6).

Thus, from (11), (11*), (13), (14) and (16), the welfare of the domestic economy under an optimal import tariff policy is given by

$$W^T(t^0) = W^F + \frac{n^*}{2b(N+1)^2} \frac{\{(2n+1)\alpha + [(n+1)^2 - n^* n]\delta\}^2}{2(n+1)^2 + n^*}. \quad (17)$$

2.2 Optimal Production Subsidy

Suppose that the domestic government gives a production subsidy s, per unit, to the domestic firms. Thus, the profit functions of the firms in both countries under PSP are given by

$$\Pi_i = (P - c + s)x_i - K, \quad (18)$$

$$\Pi^*_j = (P - c^*)x^*_j - K^*. \quad (18*)$$

Hence, the output of each firm in the domestic market at PSP equilibrium is given by

$$x^S = x^F + \frac{(n^* + 1)s}{b(N + 1)}, \quad (19)$$

$$x^{*S} = x^{*F} - \frac{ns}{b(N + 1)}. \quad (19*)$$

We assume that exports by foreign firms under PSP is positive, i.e.,

$$b(N+1)x^{*F}/n > s. \quad (20)$$

The total output in the domestic market is given by

$$X^S = X^F + \frac{ns}{b(N + 1)}. \quad (21)$$

The welfare function of the domestic economy under ITP is given by

$$W^S(s) = \int_0^{X^S} P(X)dX - P(X^S)X^S + n\Pi(x^S) - snx^S$$
$$= (b/2)X^{S\,2} + n\{bx^{S\,2} - K\} - snx^S. \quad (22)$$

Beacuse it is assumed that no social costs are involved in the production subsidy transfer, the social surplus is in balance between the consumer surplus and the producer surplus.

From (22), the first order condition is

$$\frac{\partial W^S}{\partial s} = bX^S \frac{\partial X^S}{\partial s} + 2bnx^S \frac{\partial x^S}{\partial s} - nx^S - sn\frac{\partial x^S}{\partial s}$$

$$= \frac{n}{b(N+1)} bX^S + \frac{n^* + 1}{b(N+1)} 2bnx^S - nx^S$$

$$- \frac{n^* + 1}{b(N+1)} sn = 0. \tag{23}$$

Taking into account (19), (19*), (21), and (23), we can derive an optimal production subsidy as follows:

$$s^0 = \frac{(2n^* + 1)\alpha - n^*(n^* - n)\delta}{n(2n^* + 1)}. \tag{24}$$

Note that (24) satisfies (20) and that $s^0 > 0$, taking into account (6).

Thus, from (19), (19*), (21), (22) and (24), the welfare of domestic economy under an optimal subsidy policy is given by

$$W^S(s^0) = W^F + \frac{1}{2b(N+1)^2} \frac{\{(2n^*+1)\alpha - n^*(n^* - n)\delta\}^2}{2n^* + 1}. \tag{25}$$

From (17) and (25), we can see that the social welfare of the domestic country always increases, regardless of the policy chosen.

Before discussing the choice of optimal protection, we will investigate the effects of the cost difference on an optimal import tariff and an optimal production subsidy. From (16) and (24), we can derive as follows:

$$\frac{\partial t^0}{\partial \delta} > (<)\ 0 \leftrightarrow \frac{(n+1)^2}{n} > (<)\ n^*, \tag{26}$$

$$\frac{\partial s^0}{\partial \delta} > (<)\ 0 \leftrightarrow n > (<)\ n^*. \tag{27}$$

If the number of domestic firms is significantly larger (smaller) than that of foreign firms, an increase in the difference of costs increases (reduces) both an optimal import tariff and an optimal production subsidy. But, if the number of foreign firms lies in an intermediate range, i.e., $(n+1)^2/n > n^* > n$, an increase in the difference of costs increases an optimal import tariff, while it reduces an optimal production subsidy.

3. Choice of Optimal Protection

First, let us compare cases of the producer surplus under ITP and PSP. PSP directly increases the output of domestic firms so that exports by foreign firms are reduced. On the other hand, ITP restricts exports by foreign firms so that the output of domestic firms increases indirectly.

Taking into account (6), (11), (16), (19), and (24), we can derive as follows:

$$\Delta PS = n\Pi(x^T) - n\Pi(x^S) < 0 \ (\leftrightarrow x^T - x^S < 0). \qquad (28)$$

Thus, the producer surplus under ITP is less than that under PSP, regardless of the number of firms in each country, and the differences in their costs. But, if we consider producer surplus net tax in the case of PSP, we can derive as follows:

$$\Delta NPS = n\Pi(x^T) - n\{\Pi(x^S) - sx^S\} > 0. \qquad (29)$$

Thus, the producer surplus in the case of ITP is greater than the producer surplus net the tax in the case of PSP. Note that the producer surplus net the tax in the case of PSP is negative, and that the producer surplus in both cases (or the producer surplus net the tax in the case of PSP) decreases as δ increases.

Secondly, let us compare the consumer surplus under ITP and PSP. The consumer surplus under ITP is clearly less than that under PSP, since $X^T < X^S$. That is,

$$\Delta CS = \int_0^{X^T} P(X)dX - P(X^T)X^T - \left(\int_0^{X^S} P(X)dX - P(X^S)X^S\right) < 0$$
$$(\leftrightarrow X^T - X^S < 0). \qquad (30)$$

Note that the consumer surplus in both cases increases as δ increases.

As to tariff revenue, taking into account (26), we can derive as follows: If $(n+1)^2/n \geq n^*$, then tariff revenue increases as δ increases. Otherwise, tariff revenue increases are ambiguous as δ increases. If the number of foreign firms is significantly larger than that of domestic firms, tariff revenue decreases as δ increases.

Finally, we compare the social welfare of the domestic country under ITP and PSP, and discuss the choice of optimal protection.

From (17) and (25), we obtain

$$W^T(t^0) > (<)\ W^S(s^0) \leftrightarrow \Delta W(\delta) > (<)\ 0, \qquad (31)$$

where

$$\Delta W(\delta) = \frac{n^*\{(2n+1)\alpha + [(n+1)^2 - n^*n]\delta\}^2}{2(n+1)^2 + n^*} - \frac{\{(2n^*+1)\alpha - n^*(n^*-n)\}\delta^2}{2n^* + 1},$$

and $\alpha/n^* > \delta > 0$.

From (31) we present the following **Proposition**:

Proposition.

(1) If the number of foreign firms is larger than that of domestic firms, i.e., $n^* \geq n + 1$, then PSP is the optimal protection, regardless of the difference in costs.

(2) Otherwise, i.e., $n^* < n + 1$, depending on whether the

difference in the firms' costs is relatively small or large, the domestic government should choose PSP or ITP, respectively, as optimal protection. That is,

(i) If $0 < \delta < \tilde{\delta}(n, n^*)$, then PSP provides optimal protection.

(ii) If $\tilde{\delta}(n, n^*) < \delta < a/n^*$, then ITP provides optimal protection.

Proof. See **Appendix.**

First, suppose that the number of foreign firms is larger than that of domestic firms, i.e., $n^* \geq n + 1$. Since the consumer surplus under PSP considerably exceeds that under ITP, the social welfare under PSP is always greater than that of under ITP, even if the producer surplus net the tax under PSP is less than that under ITP, and even if we includ the tariff revenue generated by ITP. Note that the difference in social welfare, $\Delta W(\delta)$, remains negative, although it decreases, as δ increases.

Secondly, suppose that the number of foreign firms is less than that of domestic firms, i.e., $n + 1 > n^*$. If the difference of the firms' costs, δ, is within the boundary, as mentioned above, the social welfare under PSP is larger than that under ITP, since the consumer surplus unde PSP considerably exceeds that under ITP. But, if δ exceeds the boundary, the social welfare under PSP is less than that under ITP. This is because the difference in the consumer surplus in both cases decreases as δ increases. It is also because the producer surplus net the tax under PSP is less than that under ITP, and finally because tariff revenue increases as δ increases.

This proposition suggests that the government should choose an import tariff policy to promote social welfare if they know that domestic firms are less efficient than foreign firms, and that the number of domestic firms is equal to, or larger than that of foreign firms. The 'rent-snatching' effect of an import tariff policy is better than directly protecting less efficient domestic firms with a production subsidy policy.

4. CONCLUSIONS

We have shown that the choice of optimal protection for a domestic industry depends on the difference in the firms' costs and the number of firms in the presence of oligopoly. Because our model is very simple, our results may not apply directly to real industrial-trade policies. For example, a government can use both policies simultaneously, i.e., a mixed policy, while we have discussed the choice between a trade and an industrial policy. Hence, we can show that the social welfare in the case of the mixed policy is larger than that under just ITP or PSP, and that the level of import tariff or production subsidy in the case of the mixed policy is less than when using one alone. Thus, although the mixed policy is best, the government should choose PSP or ITP as the second best policy, according to the number of firms and the difference in the firms' costs.

Our model assumes that the domestic government knows the firms' cost functions. But, in practice, a government does not know them, at least ex ante; there is asymmetric information between firms and a government. Our next paper will analyze the choice of optimal protection under asymmetric information.

Appendix.

We can see that $\Delta W(\delta)$ is continuous and twice differentiable, for $\alpha/n^* > \delta > 0$. So, at $\delta = 0$, we have

$$\Delta W(\delta = 0) < 0. \tag{A.1}$$

Also, at $\delta = \alpha/n^*$, we have

$$\Delta W(\delta = \alpha/n^*) > (<)\ 0 \leftrightarrow n + 1 > (<)\ n^*. \tag{A.2}$$

Next, differentiating $\Delta W(\delta)$ with respect to δ, we derive

$$\frac{d\Delta W(\delta)}{d\delta} = \frac{2n^*(N+1)^2\{(2n^*+1)\alpha - (N+1)(n^* - n - 1)\delta\}}{\{2(n+1)^2 + n^*\}(2n^*+1)}. \tag{A.3}$$

We can derive that (A.3) is positive, for $\alpha/n^* > \delta > 0$. We also obtain as follows:

$$\frac{d^2\Delta W(\delta)}{d\delta^2} > (<)\ 0 \leftrightarrow n + 1 > (<)\ n^*. \tag{A.4}$$

Therefore, taking into account (A.1), (A.2), and (A.3), we can obtain as follows:

(i) If $n^* \geq n + 1$, $\Delta W(\delta) < 0$, for $\alpha/n^* > \delta > 0$.

(ii) If $n + 1 > n^*$,

$\Delta W(\delta) > 0$, for $\alpha/n^* > \tilde{\delta}(n, n^*) > \delta$,

$\Delta W(\delta) < 0$, for $\tilde{\delta}(n, n^*) > \delta > 0$,

where $\tilde{\delta}(n, n^*) = \{\delta \mid \Delta W(\delta) = 0\}$, $\alpha/n^* > \tilde{\delta}(n, n^*) > 0$.

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