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Optimal Trade Policy in Vertically Related Markets

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Abstract

We examine home country tariff and subsidy policies when a domestic firm uses an imported key input to produce its low-quality exports, and foreign firms produce high-quality exports as well as the key input. We show that the decisions of foreign vertically integrated firms on strategy regarding input supply depend on the tariff-inclusive and quality-adjusted comparative advantage between countries. We prove that the home country's optimal policy is to tax either its goods exports or its key input imports. We also show that without vertical integration, if and only if goods are not very quality-differentiated, the home country should subsidize either its goods exports and/or its key input imports. (JEL Classification: F12, F13)

I. Introduction

In a pioneering paper, Brander and Spencer [1985] proved that a country

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can use an export subsidy to raise its national welfare. The result stems from the strategic effect of the policy on variables decided by domestic and foreign firms in the final goods market. In practice, the results of Brander and Spencer [1985] seem to justify a country's prevailing policies, such as tax offset and refund for exportation, and financing with low interest. However, subsequent research has shown that their conclusion must be subject to various assumptions on the conduct of firms, industry structure, resource constraint and so on. For instance, Eaton and Grossman [1986] proved that if price competition is adopted by firms, export tax, instead of subsidy, improves the national welfare.[1]

In another innovative paper, Brander and Spencer [1984] proved that when facing a foreign monopolist, an importing country can use tariffs to generate the terms of trade effect and extract the foreign monopolist's profit. In any case, the imposition of tariffs on imports will reduce the consumer surplus. However, if the import demand curve is not too convex, the tariff revenues can outweigh the loss of consumer surplus and the national welfare can thereby be improved. Further research has shown that if the discriminatory tariffs can be applied to foreign firms with differences in production costs, the importing country can enjoy even higher social welfare.[2]

While the two theoretical themes do not seem to be related, the study on trade in newly industrializing countries [NIC] needs to use them simultaneously. Trade of NIC has unique features.

First of all, the NIC rely heavily on a supply of key input from developed countries to produce their exports. For instance, trade statistics show that intermediate inputs and machinery amounted to more than 85% of Taiwan's imports from Japan. Further examples of the international dependence on key inputs are plentiful for production in high-technology industries in Taiwan.[3] Specifically, more than 70% of Taiwan's imports of color high resolution cathode-ray television picture tubes [CRT tubes] and liquid crystal devices [LCD] came from Japan in the past five years.[4]

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1. See Horstman and Markusen [1986] for free entry, Miyagiwa [1992] for international shareholdings and Dixit and Grossman [1986] for resource constraints.
2. See Hwang and Mai [1991].
3. See Monthly Statistics of Imports: The Republic of China Taiwan District [1996].
4. The percentages were even higher for 1993 and 1994. See the data from footnote 3.

Secondly, while supplying key inputs to NIC firms, many firms from advanced countries also produce high-quality goods in the market to compete with exports from the NIC. For example, vertical integration, known as "vertical keiretsu" in Japan, is prevalent in many industries. The Toshiba Corp., Sharp Corp. and NEC Corp. belong respectively, to the business groups of Mitsui, Sanwa and Sumitomo.[5] All of them are main suppliers for Taiwan's imports that include many components for electrical equipment such as the TFT-LCD. However, they also produce delicate goods like notebook computers that use the LCD as one of the main parts, to compete with Taiwan's exports.

Thirdly, compared with those from advanced countries, NIC's exports are often inferior in quality, or at least perceived to be inferior by consumers in the world market. The inferiority of the low-quality goods may be due to poor design, poor product warranty, lack of brand-name recognition, or by consumer's judging the quality based on the country of origin. We can find evidence in the paper by Feenstra, Yang and Hamilton [1993]. They reported that Japan has a greater variety and products mix than Taiwan in industrial machinery and electrical equipment. They further hypothesized that the product differentiation has come from the high degree of vertical integration in Japan.

With the vertical linkage and quality differentiation between goods, the tariff on the input imports still has the terms of trade effect. The importing country still can use the tariff to fight the foreign monopoly power in the input market. However, if we consider the strategic effect of the aforementioned tariff, the tariff is inimical to the final goods firm of the input-importing country. Therefore, the strategic and terms of trade effects together must be taken into account in deciding the optimal trade policy. We will adopt this perspective in our paper.

In addition, in this paper we will explore the extent to which the degree of product differentiation between goods and the "vertical keiretsu" in the advanced country affect the optimal policy. Intuitively, if final goods are extremely quality-differentiated, the market will become separate. If this is the case, when facing a foreign monopolist in the input market, the input-

5. See Gerlach [1992].

importing country need not consider the strategic effect in the final goods market but rather the terms of trade effect alone in the input market. On the other hand, if foreign firms are vertically integrated, they will look for a maximization of the profit for the business group as a whole. They can use the input price as a strategic instrument to affect variables decided in the final goods market. Therefore, in deciding the optimal trade policy, we need to examine how the input price responds to the trade policy. In particular, we will investigate the condition under which foreign firms charge a relatively high input price and in doing so, foreclose the market.

In the literature, Chang and Kim [1989] employed an export-rivalry model to show that the less developed country should either tax its key input imports or its final goods exports. In a subsequent paper, Chang and Chen [1994] demonstrated how a change in a country's comparative advantage in terms of production costs affect the less developed country's trade policy and trade pattern. In a different framework, Spencer and Jones [1991] showed that the foreign government's policy may call for taxing or subsidizing on both its final goods and key input exports under Cournot competition; however, under Bertrand competition its optimal policy may tax the export of one goods but subsidize the other. Moreover, Spencer and Jones [1992] showed that the home country's import tariff on the final goods may cause the foreign integrated firms to lower the input price under the circumstances where the simple monopoly in the input market would have raised it. Recently, Lin and Hwang [1995] allowed the imported input to be used in variable proportion to produce the output. They proved that if the demand for the imported input is not too convex, the home country should impose a tariff on it. They also proved that whether the home country should tax or subsidize the final output depends not only on the curvature of the import demand but also on whether the input is inferior or not. Furthermore, allowing domestic production of intermediate inputs and using a general model different from ours, Ishikawa and Spencer [1996] showed that the incentive for export subsidy may be weakened in the presence of foreign firms in the input market.

In this paper, we investigate how the interplay between the degree of product differentiation and the foreign firm's structure in terms of whether there is vertical integration or not affects a country's optimal trade policy.

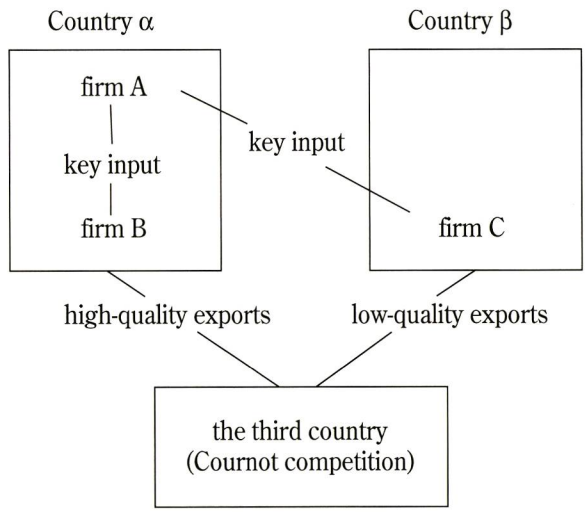
The remainder of the paper is organized as follows. Section II builds up a basic model. Section III examines the optimal import-export policy when foreign firms are not vertically integrated. Section IV investigates the optimal import-export policy in the case where foreign firms are vertically integrated. Section V gives conclusions and offers ideas for discussion.

II. The Basic Model

Consider a model of export rivalry as illustrated in figure 1. In country α, firm A produces a key input and firm B uses the key input to produce its high-quality exports (H goods) to the third country. In our model, we will examine two cases where firm A and firm B are and are not vertically integrated. In country β, firm C imports the key input from firm A and produces low-quality exports (L goods) to the third country. There is no domestic consumption in country α and β.

We assume that the final goods firms are Cournot competitors in the third country market. Firm A decides the price of the key input before the Cournot equilibrium is reached in the goods market. Following Spencer and Jones [1991], we argue that the sole input supplier can commit credibly to

Figure 1
The Basic Model



its pre-announced input price. This credibility is supported by the fact that it takes times to export the input and these inputs must be available to firm C at the time of production of the final goods. Country β's government sets its import tariff on the key input and/or export tax on the low-quality exports before the input price is determined.

Consider the demand side of the model. The consumers in the third country are represented by a real number t (type t) that measures the intensity of preference for quality. All types of consumers are distributed uniformly with density one on the closed interval $[0, T]$. Assume that a consumer buys at most one unit of the H or L goods but not both. Assume that a type t consumer has a utility level $U_j(t) = k_j t - P_j$ from goods j ($j = H, L$), where P_j denotes its price and k_j is its quality parameter. Without loss of generality, let $k_L \equiv 1$ and $k_H \equiv k$.

Therefore, k can stand for the relative quality index of the H goods and the degree of product differentiation between final goods. Then a type t consumer's utilities from the H and L goods are:

$$U_H(t) = kt - P_H \tag{1a}$$

$$U_L(t) = t - P_L \tag{1b}$$

Notice that a consumer will buy goods only when the utility is nonnegative. Let t_H (t_L) be the type of consumers who are indifferent toward buying and not buying the H (L) goods, and t_M be the type who are indifferent toward the two goods. These type values can be derived from (1a) and (1b): $t_H = P_H/k$, $t_L = P_L$, and $t_M = (P_H - P_L)/(k - 1)$. In the case where both goods are demanded in the market, it requires $t_L < t_M < T$. Those consumers having $t > t_M$ will buy the H goods and those between t_L and t_M will buy the L goods. The inverse demand functions of the H and L goods are:

$$P_H = kT - kZ_H - Z_L$$

$$P_L = T - Z_L - Z_H$$

Now consider the supply side of the model. We assume that one unit of the H and L goods production needs one unit of the key input. Specifically, let $C_H = W_H + r$ be the unit production cost of the H goods where W_H denotes the wage rate in country α and r stands for the input price. In the case

where firm A and B are vertically integrated, C_H is equal to $W_H + m$ in which m is the unit production cost of the key input. The unit production cost of the L goods is $C_L = W_L + r + \tau_i + \tau_L$ where W_L is the wage rate in country β and $\tau_i(\tau_L)$ denotes the import tariff (export tax) on the key input (L goods). Due to the production technology specified in our model, C_L is affected by the sum of τ_i and τ_L. We will use the combined rate $\tau \equiv \tau_i + \tau_L$ for the policy variable of country β.

III. Optimal Import-Export Policy without Vertical Integration

In this section we examine country β's optimal import-export policy when foreign firms in country α are not vertically integrated. We study how the interaction between the rent-extraction incentive in the input market and the profit-shifting incentive in the goods market affects the decisions of country β on import-export policy. We also explore the extent to which the degree of product differentiation affects country β's trade policy.

A. Goods Market

According to the demand and production technology specified in the previous section, the profit function of firm B and C are respectively,

$$\pi^B = (kT - kZ_H - Z_L - r - W_H)Z_H \tag{2}$$

$$\pi^C = (T - Z_H - Z_L - r - W_L - \tau)Z_L \tag{3}$$

The first-order conditions of profit maximization for both firms are respectively,

$$\partial\pi^B/\partial Z_H = (kT - 2kZ_H - Z_L) - (r + W_H) = 0 \tag{4}$$

$$\partial\pi^C/\partial Z_L = (T - Z_H - 2Z_L) - (r + W_L + \tau) = 0 \tag{5}$$

Terms in the first parenthesis of (4) and (5) denote the marginal revenues of firm B and C respectively. The remaining terms represent the tariff-inclusive marginal production cost. One can verify that the second-order and stability conditions hold as well.

Solving (4) and (5) gives the Cournot equilibrium in the goods market:

$$Z_L = [kT - (2k-1)r + (W_H - 2kW_L) - 2k\tau]/(4k-1) \quad (6)$$

$$Z_H = [(2k-1)T - r - (2W_H - W_L) + \tau]/(4k-1) \quad (7)$$

It follows that an increase in the import-export tariff, τ, will increase the quantity of high-quality goods and the profit of firm B. However, it will reduce the quantity of low-quality goods and the profit of firm C.

B. Input Market

Because one unit of goods production requires one unit of the key input, (6) and (7) can also be viewed as the derived demands for the key input. Since firm A and B are not vertically integrated, the total derived demand in the input market is the sum of (6) and (7). Let X denote the total demand for the key input: We have

$$\begin{aligned} X &= Z_H + Z_L \\ &= [(3k-1)T - 2kr - W_H - (2k-1)W_L - (2k-1)\tau]/(4k-1) \end{aligned} \quad (8)$$

By (8), one can verify that the intercept of the derived demand curve of the input increases with the degree of product differentiation between goods. In view of the inverse demand function of the high-quality goods, we find that this is because an increase in the product differentiation will expand the market size for the high-quality goods and indirectly raise the market share of the low-quality goods. By looking at (8) again, one can see that the extent to which the response of the derived demand for input to a change in the input price positively depends on the degree of product differentiation. The profit function of firm A is

$$\pi^A = rX - mX$$

The first-order condition for maximizing profit is

$$\begin{aligned} \partial\pi^A/\partial r &= X + (r-m)\, dX/dr \\ &= [(3k-1)T - (W_H + (2k-1)W_L) - (2k-1)\tau + 2km - 4kr]/(4k-1) = 0 \end{aligned}$$

Assume that the second-order condition holds. Further manipulation on the first-order condition gives the equilibrium input price:

$$r = [(3k - 1)T - (W_H - (2k - 1)W_L) - (2k - 1)\tau + 2km]/4k \qquad (9)$$

Notice that an increase in the import-export tariff will decrease the input price, *i.e.*, $dr/d\tau = -(2k - 1)/4k < 0$. This is because an increase in the import-export tariff will reduce the total derived demand as (8) shows. Moreover, in our model, we do not allow firm A to price-discriminate firm B and C in the market. If this were so, the input price charged would be higher to the lower cost firm than to the higher cost firm.[6]

C. Optimal Trade Policy

Let us define the social welfare of country β as the sum of the C firm profit and tariff revenue. Let $G(\tau)$ denote the social welfare. Then we have

$$G(\tau) = \pi^C(\tau) + \tau Z_L$$

Totally differentiating the social welfare function with respect to the import-export tariff gives

$$dG/d\tau = (\partial\pi^C/\partial Z_L)Z_{L\tau} + (\partial\pi^C/\partial Z_H)Z_{H\tau} + (\partial\pi^C/\partial r)r_\tau + (\partial\pi^C/\partial\tau) + Z_L + \tau Z_{L\tau},$$

where $\partial\pi^C/\partial s$ denotes the partial derivative of firm C's profit with respect to s, ($s = L$, H and r); $Z_{j\tau}$ denotes the total derivative of the quantity of goods j ($j = L$ and H) with respect to the import-export tariff τ. Applying (3) and (5) to the total differentiation of the social welfare with respect to the tariff yields

$$dG/d\tau = [-Z_L(\partial Z_H/\partial r)(dr/d\tau) + (-Z_L)(\partial Z_H/\partial\tau)] + [-Z_L(dr/d\tau)] + \tau[(\partial Z_L/\partial r)(dr/d\tau) + \partial Z_L/\partial\tau] \qquad (10)$$

Terms in the first bracket of (10) denote the well-known strategic effect of the trade policy. It consists of two parts. The first one is realized through its effect of the tariff on the input price which in turns affects in a negative way the quantity of high-quality goods. Since an increase in the tariff lowers the input price, this part is negative in sign. Furthermore, the second part is

6. See Degraba [1990] for a further derivation of this. However, even in the case of price discrimination, our results will not qualitatively change.

realized through the direct effect of the tariff on the quantity of the high-quality goods. It is also negative in sign. Consequently, the strategic effect is negative. This result gives the incentive to country β to subsidize its low-quality exports. The term in the second bracket denotes the terms of trade effect in the input market. Due to the negative relationship between the tariff level and input price, the terms of trade effect is positive. This result gives the incentive to country β to tax its input imports. The remaining terms denote part of the effect of the tariff on the tariff revenue. Its sign is indeterminate.

Therefore, (10) tells us that whether country β's government should tax its imports/exports depends on how the two counter forces interact with each other. Furthermore, since the terms of trade effect and part of the strategic effect are involved with how the input price is affected by the tariff, we collect terms in (10) and obtain

$$dG/d\tau = -Z_L(\partial Z_H/\partial r + 1)(dr/d\tau) + (-Z_L)(\partial Z_H/\partial \tau)$$
$$+ \tau[(\partial Z_L/\partial r)(dr/d\tau) + \partial Z_L/\partial \tau]$$

We see that if the high-quality goods had a derived demand curve with a slope less than -1, then the negative strategic effect would dominate the positive terms of trade effect. As a result, a subsidy may improve country β's welfare. However, it can be shown that the slope of the derived demand of the high-quality goods is greater than -1. Therefore, we have to compare the relative magnitudes of both strategic and terms of trade effects to decide the sign of the trade policy.

Furthermore, let us assume that the social welfare function is strictly concave in the import-export tariff τ. Using (6), (7) and (9) to arrange (10) gives

$$dG/d\tau = \{Z_L[2(4k^2 - 6k + 1)] + \tau(-4k^2 - 4k + 1)\}/4k(4k - 1) \qquad (11)$$

Equating (11) with zero dictates the optimal trade policy level:

$$\tau = -Z_L[2(4k^2 - 6k + 1)]/(-4k^2 - 4k + 1)$$

Define $g(k) \equiv 4k^2 - 6k + 1$ and $h(k) \equiv -4k^2 - 4k + 1$. Since $h(k)$ is negative for $k \geq 1$ and Z_L is positive in our model, the sign of $g(k)$ alone will determine the sign of the optimal policy.[7] One can verify that $g(k)$ is positive if and only

if k is greater than $k_0 \cong 1.3$. It implies that as long as goods are very quality-differentiated, *i.e.*, k is greater than 1.3, the terms of trade effect will outweigh the strategic effect and an import-export tax is called for. On the other hand, if goods are not very quality-differentiated, including the homogeneous goods case, *i.e.*, $k = 1$, then the strategic effect will dominate the terms of trade effect. Therefore, a subsidy on the imports and/or exports of country β is called for. We summarize these results by the following proposition:

Proposition 1: *Without vertical integration of foreign firms, if and only if the degree of product differentiation between goods is less than 1.3, the optimal policy for country β is to subsidize its imports of the key input and/or exports of the low-quality goods.*

IV. Optimal Import-Export Policy with Vertical Integration

In this section we explore the optimal import-export tax policy for country β when foreign firms in country α are vertically integrated. Since foreign firms are vertically integrated, they can use the input price to affect the equilibrium outcome in the final goods market. Particularly, how the input price responds to the policy variable τ becomes very important in this section. It is possible that the foreign firms choose an extremely high input price to force firm C to exit the market. Therefore, we will examine the condition in which market foreclosure will not occur. We also investigate how the strategic effect and terms of trade effect are affected by vertical integration of firms in country α.

A. Goods Market

The profit functions of firm A, B and C are respectively,

$$\pi^{A+B} = [(P_H - m - W_H)Z_H] + [(r - m)Z_L] \equiv \pi^B + \pi^A \qquad (2')$$

$$\pi^C = (P_L - r - W_L - \tau)Z_L \qquad (3')$$

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7. In view of (6), we need to assume a set of parameters to assure a positive equilibrium quantity of the low-quality goods.

Terms in the first bracket of (2′) denote the foreign firms profit in the final goods market. The remaining terms denote the profit from sales of key inputs. As in the previous section, we assume that the input price is determined before the goods market equilibrium is reached. Therefore, the first-order conditions for both C and $A + B$ firms are respectively,

$$\partial\pi^{A+B}/\partial Z_H = (kT - 2kZ_H - Z_L) - (m + W_H) = 0 \qquad (4')$$

$$\partial\pi^{C}/\partial Z_L = (T - Z_H - 2Z_L) - (r + W_L + \tau) = 0 \qquad (5')$$

Since the second-order and the stability conditions hold, we solve (4′) and (5′) to obtain the Cournot equilibrium in the goods market:

$$Z_L = [kT - 2kr + (W_H - 2kW_L) + m - 2k\tau]/(4k - 1) \qquad (6')$$

$$Z_H = [(2k - 1)T - (2W_H - W_L) + (r + \tau) - 2m]/(4k - 1) \qquad (7')$$

Notice that under the specification of our model, the effect of a 1% increase in the tariff on equilibrium quantity of both goods will be canceled out by a 1% decrease in the input price. This feature is different from that in the absence of vertical integration in country α. It has a significant implication for the decision of the trade policy discussed below.

In addition, since the vertically integrated firms will maximize the profit of the whole business group, we argue that the input price will be charged at a marginal cost within the group. However, by (6′) and (7′), one can see that if the foreign firms can credibly announce a lower input price which is less than the marginal cost, foreign firms will have a higher market share and profit in the final goods market. But in our model we can not support this credibility.[8]

B. Input Market

Since firm A and B are vertically integrated, only (6′) can be viewed as the derived demand for the key input in the input market. Profits from the

8. We thank a referee for raising this issue with us. Indeed, if the foreign firms can make a credible announcement on its input price as in the case of the government's subsidy on the input production, then the input price within the business group may be lower than the marginal cost.

vertically integrated firms are

$$\pi^{A+B} = (kT - kZ_H - Z_L - m - W_H)Z_H + (r - m)Z_L \equiv \pi^B + \pi^A$$

To maximize the profit of firm A and B, we differentiate their profit function with respect to the input price and obtain

$$\partial\pi^{A+B}/\partial r = (\partial\pi^B/\partial Z_H)(dZ_H/dr) + (\partial\pi^B/\partial Z_L)(dZ_L/dr) + d\pi^A/dr$$

Using (4′), (6′) and (7′), we can rearrange the total differentiation into

$$\partial\pi^{A+B}/\partial r = 2kZ_H/(4k - 1) + Z_L - 2k(r - m)/(4k - 1) \qquad (8')$$

The first term in (8′) denotes the strategic effect of the input price on the equilibrium outcome in the final goods market. It is positive in sign. The remaining terms stand for the effect of the input price on the profit from the sales of input.

Furthermore, equating (6′) with zero implicitly defines an input price r^* for market foreclosure. When the input price is charged higher than r^*, firm C will exit the market. Simple manipulation gives $r^* = [kT + (W_H - 2kW_L) + m - 2k\tau]/2k$. By inserting r^* into (8′), we get

$$\partial\pi^{A+B}/\partial r = 2[k(W_L + \tau + m) - (W_H + m)]/(4k - 1) \qquad (9')$$

(9′) is the foreign firms' marginal profit with respect to the input price and is evaluated at the market foreclosure level. We assume that the profit function of foreign vertically integrated firms is strictly concave in its input price. Then, if the sign of (9′) is negative, the equilibrium input price will be lower than the market foreclosure level. Otherwise, market foreclosure will occur. Therefore, we have the following proposition regarding the market foreclosure condition when goods are quality-differentiated.

Proposition 2: *When goods are quality-differentiated, if and only if the tariff-inclusive cost of country β plus the input production cost, $(W_L + \tau + m)$, is less than the quality-adjusted production cost of high-quality goods, $(W_H + m)/k$, market foreclosure will not occur.*

Proposition 2 tells us that the trade pattern is decided by the tariff-inclusive and quality-adjusted comparative advantages of trading countries. Intu-

itively, when foreign firms supply the key input to the C firm, they will encourage it to enter the final goods market. Hence, the foreign firms will have a lower profit in the final goods market. But this loss will be compensated enough by the sales of the key input to firm C. In the equilibrium, a tariff-inclusive and quality-adjusted comparative advantage of country β must be required. It turns out that it is also a sufficient condition to guarantee this profitable transaction. The result in Proposition 2 can be easily applied to the case where goods are homogeneous [$k = 1$]. Now, let us assume that $k(W_L + \tau + m) < (W_H + m)$. So, from Proposition 2 the key input market will not be foreclosed. However, this assumption also sets an upper limit on the tariff level. Other things being equal, if the tariff level is higher than the upper limit, market foreclosure will occur. Next, equating (8′) with zero gives an interior solution to the input price:

$$r = [k(8k-3)T - W_H - 4k(2k-1)(W_L + \tau) + (4k+1)(2k-1)m] \\ /2k(8k-3) \qquad (10)$$

Notice that the effect of an increase in the import-export tax on the input price is $dr/d\tau = -2(2k-1)/(8k-3)$. In the absence of vertical integration, we have $dr/d\tau = -(2k-1)/4k$. One can verify that the latter is greater than the former. Both of them are greater than negative one. It tells us that the response of input price to a change in the import-export tax is stronger in the presence of vertical integration.

C. Optimal Trade Policy

As we assumed in the previous section, the social welfare of country β is the sum of the C firm profit and tariff revenue.

$$G(\tau) = \pi^C(\tau) + \tau Z_L$$

Totally differentiating the social welfare function with respect to τ gives

$$\begin{aligned} dG/d\tau &= (\partial\pi^C/\partial Z_L)Z_{L\tau} + (\partial\pi^C/\partial Z_H)Z_{H\tau} + (\partial\pi^C/\partial r)r_\tau + (\partial\pi^C/\partial\tau) + Z_L + \tau Z_{L\tau} \\ &= [-Z_L(\partial Z_H/\partial r)(dr/d\tau) + (-Z_L)(\partial Z_H/\partial\tau)] + [-Z_L(dr/d\tau)] \\ &\quad + \tau[(\partial Z_L/\partial r)(dr/d\tau) + \partial Z_L/\partial\tau] \qquad (11') \end{aligned}$$

We see that there are two forces in deciding the optimal trade policy. The second bracket in (11′) denotes the policy's terms of trade effect which is positive in sign. Terms in the first bracket in (11′) denote the strategic effect of the policy. However, since an increase in tariff will lower the input price which in turns reduces the quantity of high-quality goods, the sign of the strategic effect is indeterminate at first glance. Nevertheless, (7′) predicts that other things being equal, both changes in the input price and in the tariff level will have the same effect on the quantity of high-quality goods, *i.e.* $\partial Z_H/\partial r = \partial Z_H/\partial \tau > 0$. Also, by (10), the effect of an increase in the tariff on the input price will be less than one, *i.e.*, $dr/d\tau + 1 > 0$. Therefore, we conclude that in this case the strategic effect is still negative.

To decide the optimal trade policy, we use (6′) and (7′) to rearrange (11′) into

$$dG/d\tau = [(4k - 3)Z_L - 2k\tau]/(8k - 3) \tag{12}$$

As we did in the previous section, we assume that the social welfare function is strictly concave in the tariff. Now, equating (12) with zero implicitly decides the optimal tariff level, $\tau = [(4k - 3)Z_L]/2k$. It follows that when foreign firms are vertically integrated, regardless of the degree of product differentiation between goods, the terms of trade effect will dominate the strategic effect. We conclude that the optimal policy for country β is to tax its imported inputs and/or low-quality exports.

Moreover, we argue that the optimal tariff will not result in a relatively high input price and foreclose the market. To see this, let τ^* be equal to $(W_H + m)/k - (W_L + m)$. Then, under this condition, (9′) tells us that foreign vertically integrated firms will foreclose the market and Z_L will be zero. However, evaluated by $\tau = \tau^*$, (12) is negative in sign. Since the social welfare function is strictly concave in the tariff, we conclude that the optimal import-export tariff level will be lower than τ^*. We summarize the results in this section by the following proposition:

Proposition 3: *When foreign firms are vertically integrated, regardless of product differentiation between goods, country β should tax either its key input imports or its low-quality goods exports. The optimal tariff level will not result in a market foreclosure.*

V. Conclusions

Trade literature has shown that if imports are supplied by a foreign monopolist and the demand is not too convex as to the origin, a tariff can improve the national welfare. Meanwhile, if firms are engaged in Cournot competition in the goods market, a subsidy is needed to raise the national welfare. In the case without vertical integration of foreign firms, we have shown that if and only if the degree of quality-differentiation between goods is less than 1.3, the input dependent country should subsidize its final goods exports and/or key input imports. However, when foreign firms are vertically integrated, either a tariff on the imported input or a tax on the export of low-quality goods is the dominant strategy for the input dependent country.

There are many ways that the model in our paper can be extended. One possible extension of the research is to consider the catch-up in technology of the input dependent country and to examine the implication of this for trade policy.

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