Industrial Structure, Trade, and Foreign Direct Investment

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This paper investigates some trade-investment structures between two countries with identical industry structure consisting of intermediates firms and final goods firms. In the former part of this paper, comparisons among trade regimes under the two countries model is made. The result concludes that wage rate under trade liberalization in a final goods sector becomes higher than under autarky policy of final goods sector. And the proposition is obtained that the best trade regime did not involve trade in final products. In the latter part of this paper, the possibility of mutual penetration of foreign investment under the game-theoretic framework is investigated. The result shows that the mutual foreign direct investment is realized as a Nash equilibrium and this is the case of a prisoner's dilemma. This conclusion may indicate that there is a room for the government to interfere the economy in terms of regulation policy of trade and foreign direct investments. (*JEL* Classifications: F11, F21)

I. Introduction

Asia has become the most dynamic growth center in the world. In particular, the growth rate of trade within the region exceeded that for its trade with other regions, and consequently direct investment within the region has increased rapidly. This means that the economic interdependence within the region has greatly increased.

In this paper we try to investigate the theory of intra-economic interdependence through intra-industry trade and foreign direct investment

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[**Seoul Journal of Economics** 1995, Vol. 8, No. 2]

TABLE 1
TRANSITION IN REAL GROWTH RATE IN THE WORLD

	Nominal GNP (1991) Billion of $	Real Growth Rate (%)				
		1989	1990	1991	1992	1993
World	21,617	3.4	2.2	0.6	1.7	2.2
U.S.A.	5,695	2.5	1.2	-0.7	2.6	2.7
Japan	3,382	4.7	4.8	4.0	1.3	-0.1
EC	6,249	3.5	3.0	0.8	1.1	-0.2
Asia	1,613	5.5	5.7	5.1	7.8	8.7
NIEs	578	6.3	6.9	7.3	5.3	6.2
ASEAN	290	8.8	7 7	6.3	5.8	6.5
China	371	4.4	3.9	7.5	12.8	11.0

Source: IMF

TABLE 2
TRANSITION IN WORLD TRADE

		Nominal world trade (1992) Billion of $	Real Growth Rate of Trade (%)				
			1989	1990	1991	1992	1993
World		3,645	6.7	4.5	2.4	4.6	3.0
	U.S.A.	448	10.7	7.6	7.2	6.9	4.7
Export	Japan	349	4.2	5.7	2.5	0.7	5.2
	EC	1,456	6.9	5.4	2.2	2.3	2.3
	Asia	577	8.2	8.2	11.8	11.1	11.8
	U.S.A.	554	3.9	1.7	0.6	11.6	7.7
Import	Japan	233	7.9	6.0	2.8	-0.7	5.0
	EC	1,514	7.9	6.6	5.3	2.6	1.6
	Asia	602	13.1	8.3	11.2	12.0	11.9

Source: IMF

after surveying economic interdependence between Japan and Asia which has greatly increased.

Since 1985 of Plaza Accord, Japanese foreign direct investment has rapidly increased. In this case the foreign direct investment can be divided largely into two types.

The first type is the cost pursuing type of direct investment. Investment into regions, which has increased as an effect of the appreciation of the yen on production costs, are included in this type of investment. The

TABLE 3
TRANSITION IN FDI IN JAPANESE MANUFACTURING
(Units: Million of dollar, %)

Year	1985	1988	1989	1990	1991	1992	1993
World	2,352	13,805	16,284	15,486	12,311	10,057	11,132
	(100)	(100)	(100)	(100)	(100)	(100)	(100)
North America	1,223	9,191	9,586	6,793	5,868	4,177	4,146
	(52.0)	(66.6)	(58.9)	(43.9)	(47.7)	(41.5)	(37.2)
Europe	323	1,548	3,090	4,593	2,690	2,101	2,041
	(13.7)	(11.2)	(19.0)	(29.7)	(21.9)	(20.9)	(18.3)
Asia	460	2,370	3,220	3,068	2,928	3,104	3,659
	(19.6)	(17.2)	(19.8)	(19.8)	(23.8)	(30.9)	(32.9)
NIEs	253	775	1,347	805	640	439	735
	(10.8)	(5.6)	(8.3)	(5.2)	(5.2)	(4.4)	(6.6)
ASEAN	166	1,360	1,553	2,028	1,945	1,808	1,474
	(7.1)	(9.9)	(9.5)	(13.1)	(15.8)	(18.0)	(13.2)
China	22	203	206	161	309	650	1,377
	(0.9)	(1.5)	(1.3)	(1.0)	(2.5)	(6.5)	(12.4)

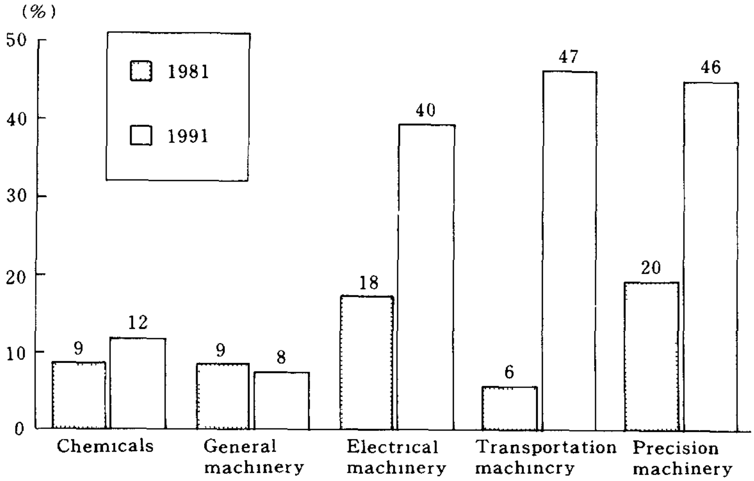
Source: MITI

direct investment towards Asia is fundamentally this type of investment. The investment into Asia of the latter half of the 1980's established Asia as a production base.

The second type is the market intention type of direct investment, which is to attempt to take advantage of market expansion merit by being an insider when market integration occurs and exporting becomes difficult due to export quantity restrictions and so on. The horizontal division of labour type investment of transportation equipment and the electrical machine industry towards North America and Europe is such. However, recently increasing direct investment towards Asia (particularly, China) by Japanese companies are of this type.

Table 3 shows the trend of foreign direct investment of Japanese manufacturers since 1985.

As the appreciation of the yen is going on, the Japanese companies in Asia are costly to procure the components from Japanese suppliers and in effect procurement rate of local contents in Asia increases rapidly. This is mainly due to advancement of Japanese components companies to Asia. And also the investment towards Asia is stimulating not only the production transfer but also the movements of constructing



source: MITI

FIGURE 1

RATIO OF INTRA-FIRM TRADE IN JAPANESE MAIN INDUSTRIES

the production network like procuring the components, sales management, research and development and so on, among local regions in Asia, This is a factor of further increase of intra-area trade in Asia. In fact, main industries are increasing the intra-firm trade as Figure 1 shows.

II. The Basic Model

A. Production

Consider a world economy which has two countries, designated home and foreign. Each country has an imperfectly competitive industry consisting of final good sector and intermediate good sector. For simplicity, we assume that these countries have identical technologies in both production of final and intermediate products. Each country has a monopolist in final good sector before trading. After opening the final good market, monopolists will engage in cournot competition in both home and foreign markets, which leads to international duopoly.

Final products are costlessly assembled from various types of intermediate components. Final goods production techniques are identically assumed to be the following CES production functions:

$$X = \left(\sum_{i=1}^{n} \phi_i^{\beta} \right)^{\frac{1}{\beta}}, \tag{1}$$

where $0 < \beta < 1$, and ϕ_i is the ith intermediate input. The elasticity of substitution between any two components is $\delta \equiv 1/(1 - \beta) > 1$. This specification follows Ethier (1982), and yields increasing returns due to the higher degrees of specialization of the intermediate inputs.[1] Therefore this industry will have strong incentive to use the more kinds of intermediate inputs potentially.

We now specify the intermediate goods production techniques. The intermediate production also exhibits increasing returns, which is at the *firm* level, not at the *industry* level. To produce an intermediate component requires a fixed labor input, with constant marginal labor input thereafter. Thus the labor input for production of any intermediate component i is identically given by

$$l_i = \begin{cases} 0 & \text{if } \phi_i = 0 \\ a + b\phi_i & \text{if } \phi_i > 0 \end{cases}, \tag{2}$$

where ϕ_i is the quantity of the intermediate component produced by intermediate good firm i. The labor input is specific to the intermediate good sector, and its endowments are exogenously given by L_k ($k = h, f$), where subscripts h and f designate home and foreign, respectively.

B. Intermediate Good Market Equilibrium

We shall derive the intermediate good market equilibrium price and quantity. For given final output X and intermediate price q_i ($i = 1,\ldots, n$), the conditional demand for the intermediate input i by final firm is given by

$$\phi_i = X\left(\frac{q_i}{Q}\right)^{\frac{-1}{(1-\beta)}}, \quad i = 1,\ldots,n, \tag{3}$$

[1]In a symmetric equilibrium all intermediate inputs would bear the same price and producer of final goods would employ the same quantities $\phi_i = \phi$ of each. Then the product function (1) can be reduced to $X = n^{1/\beta}\,\phi$. The same amount of resources is devoted to the intermediate production, so we can define $\Phi \equiv n\phi$ to measure the resources embodied in final goods. Hence for fixed amounts of resources, factor productivity is given by $X/\Phi = n^{(1-\beta)/\beta}$. With $0 < \beta < 1$, we observe that the productivity rises with the number of the intermediate inputs.

where the price index Q is given by

$$Q \equiv \left(\sum_{i=1}^{m} q_i^{\frac{\beta}{(\beta-1)}} \right)^{\frac{(\beta-1)}{\beta}}. \tag{4}$$

Each intermediate good firm faces its own demand. Producers of intermediates behave as monopolists with respect to their own differentiated components, while the intermediate good sector itself is subject to free entry. Then the profit-maximization problem of representative producer of intermediates i is formulated by

$$\max_{q_i} \ \pi_i = q_i \phi_i - w(a + b\phi_i), \qquad i = 1, \ldots, n, \tag{5}$$

for given wage rate w. As in the literature such as Krugman (1980, 1981) and Ethier (1982), we assume a large number of intermediate firms and ignore the integer constraint placed on n. The price elasticity of demand facing every producer of intermediates (3) is thus $\sigma = 1/(1 - \beta)$. Therefore, the mark-up pricing policy by intermediate good firm i bears the common optimal price of intermediates:

$$q_i = bw/\beta, \quad i = 1, \ldots, n. \tag{6}$$

Intermediate good firms earn supernormal profits in the short-run equilibrium, which causes the free entry of new firms. In the long-run equilibrium, supernormal profits will vanish. Thus the zero profit condition yields the common long-run output of intermediates:

$$\phi \equiv \frac{a\beta}{b(1-\beta)}. \tag{7}$$

The number of intermediate good firms is determined by the full-employment constraint:

$$\sum_{i=1}^{n} l_i = \sum_{i=1}^{n} (a + b\phi_i) = L_k, \qquad k = h, f. \tag{8}$$

Substituting (7) into (8) yields the number of intermediate good firms in country k:

$$n_k \equiv \frac{L_k}{a + b\phi} = \frac{L_k(1-\beta)}{a}, \quad k = h, f. \tag{9}$$

Note that these two equilibrium value (7) and (9) are constant.

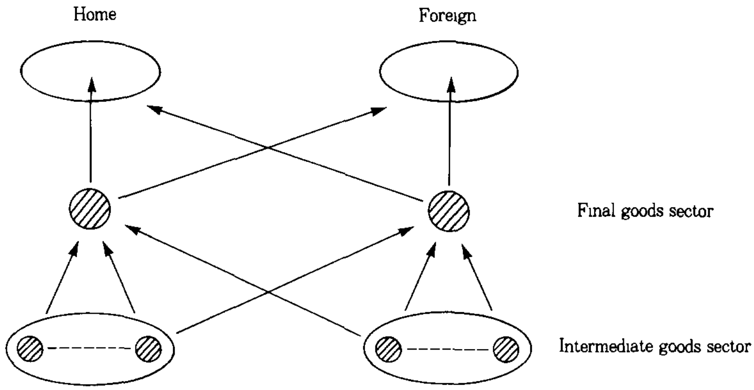


Figure 2
Free Trade in Intermediates and Final Products

III. The Short-Run Free Trade Equilibrium

Let us now allow the world economy to trade in both intermediate and final goods. The number of intermediate good firms, wage rate, and sector-specific labor supply in country i are denoted by n_i, w_i, and L_i ($i = h, f$), respectively. If we assume both countries are completely identical, then labor endowments are equal, i.e., $L_h = L_f = L$. Therefore the long-run equilibrium will dictate $n_h = n_f = n$ and $w_h = w_f = w$. The later long-run free trade equilibrium analysis will exploit these properties.

In this section, we derive the short-run free trade equilibrium. First, we derive the derived demand for domestic and foreign intermediates by country i's final good firm to produce any output level of X_i and intermediate input prices of both countries. Then we obtain final good firm's cost function. Next, specifying the demand side of final goods, we can determine the sales in home and foreign final good markets. Figure 2 shows free trade system between two countries in the model.

A. Trade in Intermediates

We begin with the free trade equilibrium in intermediates market. In the free trade equilibrium, a single brand of intermediate product is produced by a single firm because both final firms tend to employ various types of intermediates and the intermediate production requires a fixed cost. Hence each final good firm demands both domestic and foreign intermediates. The previous analysis gives us the domestic price of country i's intermediates bw_i/β. On the other hand, what about an export price of country j's intermediates to country i ($j \neq i$)? To determine it, we assume there are transport costs of the "iceberg" type: whenever a good is shipped, part of it melts away on route, so that only a fraction g arrives, $0 < g < 1$. Therefore ϕ units of intermediate export require to produce ϕ/g units in domestic country, where $0 < g < 1$. Then the export-profit-maximization problem for intermediate good firm of country j is, corresponding to (5),

$$\max_{q_j^i} \ \pi_i = q_j^i \phi_j^i - w_j\left(a + b\frac{\phi_j^i}{g}\right), \qquad j \neq i = h, f, \tag{10}$$

where q_j^i and ϕ_j^i designate an export price and quantity to country i's final good firm set by country j's intermediate good firm. The derived demand for country j's intermediates by country i's final good firm ϕ_j^i is corresponding to (3), so the optimal export price of intermediates is given by

$$q_j^i = \frac{bw_j}{g\beta}, \quad j \neq i = h, f. \tag{11}$$

Under this pricing policy, to derive the domestic and export supply level of each country's intermediates, we rewrite the price index (4) as follows:

$$Q = \left(n_i q_i^{\frac{\beta}{(\beta-1)}} + n_j q_j^{i\frac{\beta}{(\beta-1)}} \right)^{\frac{(\beta-1)}{\beta}} \tag{4)$'$ (}$$

Substituting (6), (11), and (4)$'$ into (3), we obtain the domestic and export supply level of each country's intermediate products:

$$\phi_i = \left\{ n_i + n_j\left(\frac{gw_i}{w_j}\right)^{\frac{1}{\alpha}} \right\}^{\frac{-1}{\beta}} X_i,$$

$$\phi_j^i = \left\{ n_i\left(\frac{w_j}{gw_i}\right)^{\frac{1}{\alpha}} + n_j \right\}^{\frac{-1}{\beta}} X_i, \tag{12}$$

where $\alpha \equiv (1-\beta)/\beta$. Then the ratio of foreign inputs to domestic inputs in country i's final production is given by

$$\frac{\phi_j^i}{\phi_i} = \left(\frac{g w_i}{w_j} \right)^{\frac{1}{(1-\beta)}} \tag{13}$$

Making use of (6), (11), (12), and (13), we obtain the total cost function of country i's final good firm in the short-run equilibrium given by

$$\begin{aligned} C_i(X_i) &= n_i q_i \phi_i + n_j q_j^i \phi_j^i + F \\ &= q_i \phi_i \left(n_i + n_j \frac{q_j^i}{q_i} \cdot \frac{\phi_j^i}{\phi_i} \right) + F \\ &= \frac{b w_i}{\beta} \left\{ n_i + n_j \left(\frac{q w_i}{w_j} \right)^{\frac{1}{\alpha}} \right\}^{-\alpha} X_i + F, \end{aligned} \tag{14}$$

where F is a common sunk cost of country i ($i = h, f$). Differentiating (14) with respect to X_i yields a constant short-run marginal cost of country i's final good firm:

$$c_i = \frac{b w_i}{\beta} \left\{ n_i + n_j \left(\frac{q w_i}{w_j} \right)^{\frac{1}{\alpha}} \right\}^{-\alpha}, \quad i \neq j = h, f. \tag{15}$$

The short-run marginal cost is decreasing in the numbers of intermediates n_i and n_j due to increasing returns in the degree of the specialization of intermediates.

B. Trade in Final Products

We have taken the output level of final products as exogenously given. In this subsection we shall determine it by means of the specification of the demand side of final goods. Country i's inverse demand function is assumed to be $P_i = A_i - D_i$, where A_i is a positive constant, and D_i is total demand for final goods in country i ($i = h, f$). We assume each market is segmented and final good firms engage in Cournot competition, then there is also two-way trade in final products. Both final product markets comprise domestic and import products. Let x_i be domestic sales by country i's final good firm, and x_i^j its exports to country j, then the total profit of country i's final good firm is given by

$$\Pi_i = x_i(A_i - c_i - (x_i + x_j^i)) + x_i^j\left\{A_j - \frac{c_i}{g} - (x_i^j + x_j)\right\} - F, \quad i = h,\ f,$$

where g is the "iceberg" type of cost parameter, $0 < g < 1$. Therefore the short-run Cournot equilibrium outputs are given by

$$x_i = \frac{1}{3}\left(A_i - 2c_i + \frac{c_j}{g}\right), \tag{16}$$

$$x_i^j = \frac{1}{3}\left(A_j - \frac{2c_i}{g} + c_j\right). \tag{17}$$

Here we make a following assumption:

Assumption 1
There exists a positive export by each final good firm, i.e.,

$$\frac{1}{2}(A_j + c_j) > \frac{c_i}{g}. \tag{18}$$

This assumption implies that country j's monopoly price before trade exceeds the marginal cost of country i's export. (18) gives final good firm of country i an incentive for entry to county j's final good market by exporting. Under Assumption 1, two countries engage in two-way trade in the identical final products. Moreover, the equilibrium profit and price are given by

$$\Pi_i = \frac{1}{9}\left(A_i - 2c_i + \frac{c_j}{g}\right)^2 + \frac{1}{9}\left(A_j - \frac{2c_i}{g} + c_j\right)^2 - F, \tag{19}$$

$$P_i = \frac{1}{3}\left(A_i + c_i + \frac{c_j}{g}\right). \tag{20}$$

Of course, final good firm's marginal costs c_i and c_j are given by (15).

IV. The Long-Run Equilibrium and Welfare

We have constructed the short-run trade model for given wage rate and performed the analysis. The purposes of this section are to determine the long-run equilibrium wage rates and marginal costs of final good firms and to explore its properties of economic welfare. The industry in question consists of final good sector dominated by international duopoly and intermediate sector dominated by monopolistic competition. Therefore, we can characterize the four trade regimes as follows: (1) autarky, (2) trade in intermediates alone, (3) trade in final products alone, and (4) trade in both intermediates and final products. In each regime, we derive its economic welfare and reveal which regime is the most desirable.

For the derivation of the long-run equilibrium in each regime, we assume completely identical economies. Thus the equilibrium wage rates are equalized across the countries, $w_h = w_f = w$, and the numbers of intermediates are same in both countries, $n_h = n_f = n$. Because of such a symmetric equilibrium, we focus only on the home market equilibrium. We adopt the following notations in trade regime i ($i = 1,\ldots, 4$):

w^i = the long-run equilibrium wage rate
c^i = marginal cost of final good firm
X^i = total output of final good firm
CS^i = consumer surplus
PS^i = producer surplus
$W^i = CS^i + PS^i$ = economic welfare

Note that zero profits in monopolistically competitive intermediate good sector play no role in welfare analysis. The following subsections derive the long-run economic welfare in each regime and make comparisons among trade regimes.

A. The Long-Run Equilibrium of Regime 1 and 2

In both regime 1 and 2, final good sector in each country is monopolized. So to derive the equilibrium values of regime 1, we have only to set the transport cost parameter g equal to zero in the equilibrium values of regime 2 since the difference between regime 1 and 2 is whether they trade in intermediates or not.

A) Regime 2: Trade in intermediates alone

In regime 2, two countries trade in intermediates alone. Identical inverse demand function is given by $P = A - X$. Then the final output by monopolist is $X^2 = (A - c^2)/2$. Final good firm uses n types of domestic intermediates and n types of foreign intermediates to produce X^2 units of final products. To determine the marginal cost c^2 endogenously, we use the following long-run equilibrium condition:

$$\phi = \phi_h + \frac{\phi_h^f}{g}$$

$$= n^{\frac{-1}{\beta}} X^2 \left\{ (1+g^{\frac{1}{\alpha}})^{\frac{-1}{\beta}} + \frac{(1+g^{\frac{-1}{\alpha}})^{\frac{-1}{\beta}}}{g} \right\} \tag{21}$$

$$= G^{-1} n^{\frac{-1}{\beta}} X^2,$$

where $G = (1 + g^{1/\alpha})^{\alpha}$; $\alpha \equiv (1 - \beta)/\beta$. $0 < g < 1$ yields $1 < G < 2^{\alpha}$. Then the inverse of the index G is interpreted as a reduction rate of increasing returns due to specialization by transport costs. The right-hand side of equation (21) represents the derived demands for home country's intermediates by home and foreign final good firms. The second equality of equation (21) is owing to the symmetric equilibrium $X_h^2 = X_f^2 = X^2$. On the other hand, the left-hand side of equation (21) represents the long-run supply of home intermediates given by equation (7). Solving for c^2 equation (21), we obtain the long-run marginal cost $c^2 = A - 2G\phi n^{1/\beta}$. Then the total output of final products and its equilibrium price are given by $X^2 = G\phi n^{1/\beta}$ and $P^2 = A - G\phi n^{1/\beta}$, respectively.

Next we shall derive the long-run equilibrium wage rate w^2. To do so, we have only to substitute the long-run marginal cost c^2 into equation (15). Because of the symmetric equilibrium, $n_i = n$ and $w_i = w_2$ ($i = h, f$), we obtain easily the equilibrium wage rate $w^2 = (\beta n^{\alpha}/\beta)(A - 2G\phi n^{1/\beta})$.

Finally, it is straightforward to show that consumer surplus and producer surplus are given by

$$CS^2 = \frac{1}{2} G^2 \phi^2 n^{\frac{2}{\beta}} \quad \text{and} \quad PS^2 = G^2 \phi^2 n^{\frac{2}{\beta}}.$$

Therefore, we obtain economic welfare of regime 2

$$W^2 = CS^2 + PS^2 = \frac{3}{2} G^2 \phi^2 n^{\frac{2}{\beta}}.$$

B) Regime 1: Autarky

To obtain the equilibrium values of regime 1, we just set $g = 0$, that is, $G = 1$ in the equilibrium values of regime 2:

$$c^1 = A - 2\phi n^{\frac{1}{\beta}}, \qquad w^1 = \frac{\beta n^{\alpha}}{b}(A - 2\phi n^{\frac{1}{\beta}}),$$

$$X^1 = \phi n^{\frac{1}{\beta}}, \quad P^1 = A - \phi n^{\frac{1}{\beta}},$$

$$CS^1 = \frac{1}{2}\phi^2 n^{\frac{2}{\beta}}, \quad PS^1 = \phi^2 n^{\frac{2}{\beta}},$$

$$W^1 = \frac{3}{2}\phi^2 n^{\frac{2}{\beta}}.$$

B. The Long-Run Equilibrium of Regime 3 and 4

In both regime 3 and 4, final good sector in each country is dominated by international duopoly. So to derive the equilibrium values of regime 3, the transport costs of the intermediates being reduced to the index G, we have only to set the transport cost parameter G equal to 1 in the equilibrium values of regime 4 since the difference between regime 3 and 4 is whether they trade in the intermediates or not.

A) Regime 4: Trade in both intermediate and final products

Cournot equilibrium (16) and (17) give total output of final good firm:

$$X^4 = \frac{2}{3}\left(A - \frac{1+g}{2g}c^4\right).$$

Following the previous subsection, we obtain the long-run equilibrium condition:

$$\phi = \frac{2}{3}\left(A - \frac{1+g}{2g}c^4\right)n^{\frac{-1}{\beta}}G^{-1}. \tag{22}$$

Solving equation (22) for c^4, we determine endogenously the long-run marginal cost:

$$c^4 = \frac{2g}{1+g}\left(A - \frac{3}{2}G\phi n^{\frac{1}{\beta}}\right).$$

Then the long-run total output and its equilibrium price are given by $X^4 = G\phi n^{1/\beta} = X^2$ and $P^4 = A - G\phi n^{1/\beta} = P^2$, respectively. This implies that total long-run output is independent of trade in final products since the difference between regime 2 and 4 is whether they trade in final products or not and that total long-run output depends solely on the number of intermediates, alternatively, the market size of the intermediates.

Substituting c^4 into equation (15) as before, we obtain the long-run equilibrium wage rate:

$$w^4 = \frac{2g}{1+g}\frac{\beta n^{\alpha}}{b}\left(A - \frac{3}{2}G\phi n^{\frac{1}{\beta}}\right).$$

Using equations (16) and (17), we obtain the long-run sales in each market:

$$x_i^4 = \frac{1}{1+g}\{(1-g)A-(1-2g)G\phi n^{\frac{1}{\beta}}\},$$

$$x_i^{j4} = \frac{1}{1+g}\{(2-g)G\phi n^{\frac{1}{\beta}}-(1-g)A\}.$$

To ensure the positive export, we make the following assumption:

Assumption 2

$$(2-g)G\phi n^{\frac{1}{\beta}} > (1-g)A.$$

If n, that is, L is large enough to support the final demand A, this condition will tend to hold. Under this assumption, there are two-way trades at both final and intermediate goods stages in the long-run equilibrium. This is an extension of the results of Krugman (1979), Brander (1981), Ethier (1982), and Brander and Krugman (1983).

Next, using the above equilibrium values, we can calculate the consumer surplus:

$$CS^4 = \frac{1}{2}G^2\phi^2 n^{\frac{2}{\beta}} = CS^2.$$

Producer surplus consists of the profits in home and foreign markets:

$$\begin{aligned} PS^4 &= (x_i^4)^2 + (x_i^{j4})^2 \\ &= \frac{1}{2}G^2\phi^2 n^{\frac{2}{\beta}} + 2\left(\frac{1-g}{1+g}\right)^2\left(A-\frac{3}{2}G\phi n^{\frac{1}{\beta}}\right)^2. \end{aligned}$$

Therefore, economic welfare in regime 4 is given by

$$\begin{aligned} W^4 &= CS^4 + PS^4 \\ &= G^2\phi^2 n^{\frac{2}{\beta}} + 2\left(\frac{1-g}{1+g}\right)^2\left(A-\frac{3}{2}G\phi n^{\frac{1}{\beta}}\right)^2. \end{aligned}$$

B) Regime 3: Trade in final products alone

To obtain the equilibrium values of regime 3, we just set $G = 1$ in the equilibrium values of regime 4:

$$c^3 = \frac{2g}{1+g}\left(A - \frac{3}{2}\phi n^{\frac{1}{\beta}}\right),$$

$$w^3 = \frac{2g}{1+g}\frac{\beta n^{\alpha}}{b}\left(A - \frac{3}{2}\phi n^{\frac{1}{\beta}}\right),$$

$$X^3 = \phi n^{\frac{1}{\beta}} = X^1, \quad P^3 = A - \phi n^{\frac{1}{\beta}} = P^1,$$

$$x_i^3 = \frac{1}{1+g}\{(1-g)A - (1-2g)\phi n^{\frac{1}{\beta}}\},$$

$$x_i^{j3} = \frac{1}{1+g}\{(2-g)\phi n^{\frac{1}{\beta}} - (1-g)A\},$$

$$CS^3 = \frac{1}{2}\phi^2 n^{\frac{2}{\beta}} = CS^1,$$

$$PS^3 = \frac{1}{2}\phi^2 n^{\frac{2}{\beta}} + 2\left(\frac{1-g}{1+g}\right)^2\left(A - \frac{3}{2}\phi n^{\frac{1}{\beta}}\right)^2,$$

$$W^3 = \phi^2 n^{\frac{2}{\beta}} + 2\left(\frac{1-g}{1+g}\right)^2\left(A - \frac{3}{2}\phi n^{\frac{1}{\beta}}\right)^2,$$

where we make the following assumption to ensure the positive export:

Assumption 3

$$(2-g)\phi n^{\frac{1}{\beta}} > (1-g)A$$

Note that this assumption is more restrictive than Assumption 2. We have derived all the long-run equilibrium values in each regime. To prevent all the marginal costs or wage rate from being negative, we make also the following assumption:

Assumption 4

$$A > 2G\phi n^{\frac{1}{\beta}}.$$

C. Comparisons of the Long-Run Equilibrium

In this subsection, we make comparisons of long-run equilibrium values between four trade regimes.

A) Comparison of marginal costs

The previous subsection's results about maginal cost can be summarized as the following lemma.

***Lemma* 1**

The following relationship between regime i's marginal cost c^is, (i = 1,..., 4) must hold:

$$c^3 > c^1 > c^2 \text{ and } c^3 > c^4 > c^2.$$

***Proof*:** From $1 < G < 2^{\alpha}$, it is obvious that $c^1 > c^2$ and $c^3 > c^4$ hold. Then the difference between c^1 and c^3 is

$$c^3 - c^2 = \frac{1}{1+g}\{(2-g)\phi n^{\frac{1}{\beta}} - (1-g)A\} > 0,$$

where the inequality uses Assumption 3. Similarly, we obtain

$$c^4 - c^2 = \frac{1}{1+g}\{(2-g)G\phi n^{\frac{1}{\beta}} - (1-g)A\} > 0,$$

where the inequality uses Assumption 2.

Q.E.D.

This lemma will tell us that the more competitive final good sector leads to the more inefficient final production. The intuitive explanation for this result is straightforward. In general, trade in final products will expand the final production temporarily, because final good sector become more competitive. Final good firms demand for more quantities of intermediates, which leads to higher prices of intermediates and raises the long-run equilibrium wage rate in the event. Thus marginal costs will be pulled up by the cost pressure. On the other hand, trade in intermediates will promote the increasing returns in final good production. Then final good firm demand for less intermediates, which softens the labor market and decreases the wage rate. The lower prices of intermediates makes the marginal costs of final good production decline in the long-run equilibrium.

B) Comparison of wage rates

The previous subsection's results about wage rate can state clearly the relationship only between regime 1 and 3 and between regime 2 and 4. It can be summarized as the following proposition:

***Proposition* 1**

The following relationship between regime i's wage rate w^is, (i = 1,..., 4) must hold:

$$w^1 < w^3 \text{ and } w^2 < w^4.$$

***Proof*:** The difference between regime 1 and 2 is

$$w^1 - w^3 = \frac{\beta n^\alpha}{b(1+g)}\{(1-g)A-(2-g)\phi n^{\frac{1}{\beta}}\} < 0,$$

where the inequality uses Assumption 3. And the difference between regime 2 and 4 is

$$w^2 - w^4 = \frac{\beta n^\alpha}{b(1+g)}\{(1-g)A-(2-g)G\phi n^{\frac{1}{\beta}}\} < 0,$$

where the inequality uses Assumption 2.

Q.E.D.

The intuitive explanation for Proposition 1 is similar with Lemma 1. The greater final goods market by trade in final products require the greater demand for intermediates, which raises the equilibrium wage rates.

C) comparisons of consumer surplus, producer surplus, and economic welfare

It is straightforward to show the following proposition:

***Proposition* 2**

The following relationship between regime i's consumer surplus CS^is, (i = 1,..., 4) must hold:

$$CS^1 = CS^3 < CS^2 = CS^4,$$

that is, regimes of trade in the intermediates are superior to any other regime from the point of view of consumer welfare.

This proposition tells us that the decline of the degree of monopoly in final good sector does not improve consumer surplus. Therefore consumers cannot gain from trade in final products. They can gain only from trade in intermediates by the decrease in price of final products.

Next we make a comparison of producer surplus among four trade regimes. Then we obtain the following proposition:

***Proposition* 3**
The following relationship between regime i's producer surplus PS^is, (i = 1,..., 4) must hold:

$$PS^3 < PS^1 < PS^2 \text{ and } PS^4 < PS^2.$$

***Proof*:** $1 < G < 2^{\alpha}$ yields $PS^1 < PS^2$ easily. Next we derive necessary and sufficient condition for $PS^3 < PS^1$:

$$\begin{aligned} PS^3 < PS^1 &\Leftrightarrow \left(\frac{1-g}{1+g}\right)^2 \left(A - \frac{3}{2}\phi n^{\frac{1}{\beta}}\right)^2 < \frac{1}{4}\phi^2 n^{\frac{2}{\beta}} \\ &\Leftrightarrow (1-g)A < (2-g)\phi n^{\frac{1}{\beta}}. \end{aligned} \tag{23}$$

This condition is nothing but Assumption 3. similarly,

$$PS^4 < PS^2 \Leftrightarrow (1-g)A < (2-g)G\phi n^{\frac{1}{\beta}}. \tag{24}$$

This condition coincides with Assumption 2.

Q.E.D.

Finally, we obtain our first main results in the model. Proposition 2 and 3 give us the following proposition about economic welfare:

***Proposition* 4**
Regime i's economic welfare W^i, (i = 1,..., 4) should be ranked as follows:

$$W^3 < W^1 < W^2 \text{ and } W^4 < W^2.$$

***Proof*:** The result is trivial from Proposition 2 and 3.

Q.E.D.

Proposition 4 is somewhat surprising. The best trade regime does not involve trade in final products. This is because free trade in final products does not improve consumer surplus and just reduces producer surplus.

V. Mutual Penetration of Foreign Direct Investment

It is an interesting phenomenon that very similar countries mutually penetrate by foreign direct investment (FDI) each other. This phenomenon can be explained by using two-way trade (*intra*-industry trade) model.[2] The present paper explains mutual penetration of final good firms by means of FDI. Foreign direct investment means setting up a subsidiary in a rival country in this paper. For simplicity, we assume the world economy does not trade in intermediates.[3] Therefore the subsidiary must use only the intermediates in its rival country. The main purpose of the remainder of the paper is to investigate the welfare implication of mutual penetration of FDI in the long-run equilibrium.

We divide final good firm's activities into the headquarter activity and the plant activity. The headquarter activity is associated with firm-specific fixed(sunk) costs F, while the plant activity is associated with variable costs.[4] We assume that final good firms can move plants, but not headquarters, internationally and that FDI does not require additional firm-specific fixed costs. The marginal cost is country-specific in the sense that foreign subsidiary's plants and domestic headquarter's plants have the same marginal cost because they are located in the same country and employ the intermediates from the same intermediate sector to produce final products. Final good firms can escape from transport costs by FDI. That is, establishing subsidiary in its rival country is equivalent to the elimination of transport costs. Hence, each firm has two perfectly substitutive strategies; exporting and investing abroad.

Final good firm's behaviour can be characterized by the two-stage game. In the *second stage* of the game, final good firms compete in

[2]Krugman (1983) discussed, for the first time, such a phenomenon in a monopolistic competition trade model. On the other hand, Dei (1990) also explained it in a model of reciprocal dumping model, that is, a homogeneous product Cournot duopoly model in an international framework. Our model may potentially explain such a mutual penetration of both final product and intermediate component manufacturers at the same time.

[3]Under free trade in intermediates, discussing FDIs by final good firms is analytically of great difficulty. However in a symmetric equilibrium the analysis will be easier.

[4]Horstman and Markusen(1987, 1991) assume that the plant activity requires plant-specific fixed costs as well. This paper omits plant-specific fixed costs because of comparison with Dei (1990)'s result.

TABLE 4
PAYOFF MATRIX OF THE FIRST-STAGE GAME

	Foreign Firm's Strategy	
	Export	FDI
Home Firm's Export	(Π_h^{EE}, Π_f^{EE})	(Π_h^{EI}, Π_f^{EI})
Strategy FDI	(Π_h^{IE}, Π_f^{IE})	(Π_h^{II}, Π_f^{II})

Cournot fashion for given first-stage choices. In the *first stage* of the game, they choose between *exporting* or *investing*. The payoffs according to the various first-stage decisions can be obtain from Cournot equilibria of the second-stage game discussed in the previous section and are set out in Table 4. Π_k^{ij} in payoff matrix denotes the profits of country k's final good firm in state (i, j) where home firm chooses strategy i, $(i = E, I)$, and foreign firm chooses strategy j, $(j = E, I)$, where E represents export strategy and I represents investment strategy. State (E, E) corresponds to trade regime 3 in the previous section. Therefore $\Pi_h^{EE} = \Pi_f^{EE} = PS^3$. State (I, I) is a symmetric choice by final good firms, so we have only to set transport cost parameter g equal to 1 in the value of Π_k^{EE} to obtain Π_k^{II}, $(k = h, f)$. Therefore, $\Pi_k^{II} = (1/2)\phi^2 n^{2/\beta}$.

Calculating the off-diagonal payoffs Π_k^{ij} $(i \neq j)$ in the matrix, we can derive the subgame perfect equilibrium and explain the mutual penetration by means of FDI. But the payoffs of state (i, j), $(i \neq j)$ are not straightforward to calculate because final good firm's choices are asymmetric and the equilibrium wages are not equalized across the countries. For instance, Figure 3 shows state (I, E), that is, the situation that only home final good firm invests abroad.

Let us now calculate the payoff of state (I, E). In state (I, E), home final good firm adopts FDI strategy, while foreign final good firm adopts exporting strategy. Then each final good firm's profits are given by

$$\Pi_h^{IE} = (P_h - c_h)\, x_h + (P_f - c_h^f)\, x_h^f - F \tag{25}$$

and

$$\Pi_f^{IE} = \left(P_h - \frac{c_f}{g}\right)x_f^h + (P_f - c_f)x_f - F, \tag{26}$$

where c_i^j $(i \neq j = h, f)$ denotes the marginal cost of country i's subsidiary located in country j. Country i's subsidiary and country j's headquarter are located in the same country, so $c_i^j = c_j$. Thus c_h^f in equation (25) is equal to c_f, that is, the home subsidiary firm is on an equal footing

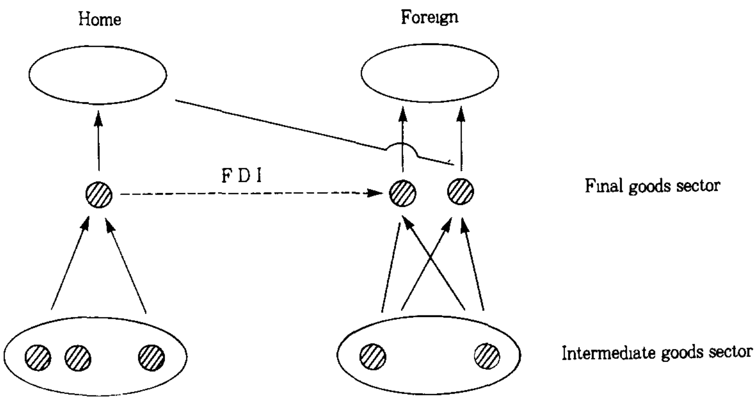


FIGURE 3
TRADE VS. FDI BY HOME FINAL GOOD FIRM

with the foreign headquarter. Then the second term in the right-hand side of equation (25) represents the subsidiary's profit. Therefore we obtain Cournot equilibrium in each market as follows:

$$x_h = \frac{1}{3}\left(A - 2c_h + \frac{c_f}{g}\right),$$
$$x_f^h = \frac{1}{3}\left(A - \frac{2c_f}{g} + c_h\right), \tag{27}$$
$$x_h^f = \frac{1}{3}(A - c_f) = x_f.$$

Next we seek the derived demand for each country's intermediates by each final good firm. In the home intermediate good market, the demand for home intermediates is derived from home headquarter alone. Then the long-run equilibrium condition is given by

$$\phi = n^{\frac{-1}{\beta}} x_h = \frac{1}{3}\left(A - 2c_h + \frac{c_f}{g}\right) n^{\frac{-1}{\beta}}. \tag{28}$$

Rearranging (28) yields an equation in c_h and c_f:

$$2c_h - \frac{c_f}{g} = A - 3\phi n^{\frac{1}{\beta}}. \tag{29}$$

On the other hand, the demand for foreign intermediates is derived not only from foreign final good firm, but also from home subsidiary. Then the long-run equilibrium condition is given by

$$\phi = n^{\frac{-1}{\beta}}(x_f + x_f^h + x_h^f) = \frac{1}{3}\left(3A + c_h - \frac{2(g+1)}{g}c_f\right)n^{\frac{-1}{\beta}}, \tag{30}$$

where we exploit the assumption of identical technology. Rearranging (30) yields another equation in c_h and c_f which is a counterpart to equation (29):

$$-c_h + \frac{2(g+1)}{g}c_f = 3(A - \phi n^{\frac{1}{\beta}}). \tag{31}$$

Solving simultaneous equations (29) and (31) for c_h and c_f, we obtain the long-run marginal costs of state (*I*, *E*):

$$c_h^{IE} = \frac{2g+5}{4g+3}\left\{A - \frac{3(2g+3)}{2g+5}\phi n^{\frac{1}{\beta}}\right\}, \tag{32}$$

$$c_f^{IE} = \frac{7g}{4g+3}\left(A - \frac{9}{7}\phi n^{\frac{1}{\beta}}\right). \tag{33}$$

Substituting (32) and (33) into (15) respectively, we obtain the long-run equilibrium wage rates of state (I, E):

$$w_h^{IE} = \frac{2g+5}{4g+3}\frac{\beta n^{\alpha}}{b}\left\{A - \frac{3(2g+3)}{2g+5}\phi n^{\frac{1}{\beta}}\right\}, \tag{34}$$

$$w_f^{IE} = \frac{7g}{4g+3}\frac{\beta n^{\alpha}}{b}\left(A - \frac{9}{7}\phi n^{\frac{1}{\beta}}\right). \tag{35}$$

Substituting (32) and (33) into (27) we obtain the long-run Cournot equilibrium as follows:

$$x_h^{IE} = \phi n^{\frac{1}{\beta}},$$

$$x_f^{hIE} = \frac{2(g-1)}{4g+3}A + \frac{3-2g}{4g+3}\phi n^{\frac{1}{\beta}}, \tag{36}$$

$$x_h^{fIE} = \frac{1-g}{4g+3}A + \frac{3g}{4g+3}\phi n^{\frac{1}{\beta}} = x_f^{IE}.$$

Then the equilibrium profits (payoffs) of state (*I*, *E*) are given by

$$\Pi_h^{IE} = (x_h^{IE})^2 + (x_h^{fIE})^2$$

$$= \phi^2 n^{\frac{2}{\beta}} + \left(\frac{1-g}{4g+3} A + \frac{3g}{4g+3} \phi n^{\frac{1}{\beta}} \right)^2, \tag{37}$$

$$\Pi_f^{IE} = (x_f^{hIE})^2 + (x_f^{IE})^2$$

$$= \left\{ \frac{2(g-1)}{4g+3} A + \frac{3-2g}{4g+3} \phi n^{\frac{1}{\beta}} \right\}^2 + \left(\frac{1-g}{4g+3} A + \frac{3g}{4g+3} \phi n^{\frac{1}{\beta}} \right)^2. \tag{38}$$

Due to the symmetry of the model, the payoffs of state (E, I) is easy to be obtained, $\Pi_i^{EI} = \Pi_j^{IE}$, $(i \neq j = h, f)$.

Now we have calculated all the payoffs in Table 4. Then we shall derive the first-stage Nash equilibrium. To do so, we have to make comparisons between the payoffs.

$$\Pi_h^{EI} - \Pi_h^{EE} \tag{39}$$

$$= \frac{1}{2} \left\{ \phi^2 n^{\frac{2}{\beta}} - 4 \left(\frac{1-g}{1+g} \right)^2 \left(A - \frac{3}{2} \phi n^{\frac{1}{\beta}} \right)^2 \right\} + \left(\frac{1-g}{4g+3} A + \frac{3g}{4g+3} \phi n^{\frac{1}{\beta}} \right)^2.$$

From (23), the first term in the right-hand side of equation (39) is positive. Therefore $\Pi_h^{IE} > \Pi_h^{EE}$, that is, final good firm will choose FDI strategy for foreign final good firm's exporting strategy.

Finally, we shall make a comparison of the payoffs between state (E, I) and (I, I).

$$\Pi_h^{II} - \Pi_h^{EI}$$

$$= \frac{1}{2} \phi^2 n^{\frac{2}{\beta}} - \left\{ \frac{2(g-1)}{4g+3} A + \frac{3-2g}{4g+3} \phi n^{\frac{1}{\beta}} \right\}^2 - \left(\frac{1-g}{4g+3} A + \frac{3g}{4g+3} \phi n^{\frac{1}{\beta}} \right)^2$$

$$> \frac{1}{2} \phi^2 n^{\frac{2}{\beta}} - \frac{\phi^2 n^{\frac{2}{\beta}}}{4g+3} [\{-2(2-g) + 3 - 2g\}^2 - \{(2-g) + 3g\}^2] \tag{40}$$

$$= \left[\frac{1}{2} - \frac{1}{(4g+3)^2} \{1 - (g+2)^2\} \right] \phi^2 n^{\frac{2}{\beta}}$$

$$> 0 \quad \Leftrightarrow \quad \Pi_h^{II} - \Pi_f^{EI},$$

where the first inequality uses Assumption 3 and the last inequality uses $0 < g < 1$. (40) implies that home final good firm will choose FDI strategy for foreign final good firm's FDI strategy.

We summarize the above results as the following proposition:

***Proposition* 5**

$$\Pi_h^{EI} > \Pi_h^{EE}, \text{ and } \Pi_h^{II} > \Pi_h^{EI},$$

that is, FDI is the dominant strategy for both home and foreign final good firms.

Therefore the mutual FDI is realized as Nash equilibrium. However $\Pi_h^{EE} > \Pi_h^{II}$ implies that this Nash equilibrium is the case of the prisoner's dilemma.

Final part of this section shows the welfare implication of the mutual FDI equilibrium. Consumer surplus does not change by the shift from state (E, E) to (I, I), but producer surplus declines as we have seen. Hence we obtain the following results about the influence of the mutual penetration of FDI on the world welfare:

***Proposition* 6**

The mutual penetration of foreign direct investment by final good firms will worsen the world welfare in the identical world economy.

This result contrasts strikingly with the results of Krugman (1983) and Dei (1990). Their papers lead to the conclusion that global welfare increases. But our paper leads to the opposite conclusion to them in spite of escaping from transport costs.

VI. Concluding Remarks

In this paper we investigated some trade-investment structures between two countries with identical industry structure consisting of intermediates firms and final goods firms. To be sure, one of sources of the rapid development of Asian countries is the gap of productivity or production cost among Asian areas. In spite of the fact, as a new trend of the economic development, we can find many phenomena indicating the interdependence of economies in the areas, in particular, increasing and deepening of horizontal division of labour in terms of trades and foreign direct investment. We focused on the new stage of Asian economies.

In the former part of our paper, we made comparisons among trade regimes under the two countries model. As a result, we concluded that wage rate under trade liberalization in a final goods sector becomes higher than under autarky policy of final goods sector. And also we obtained a proposition that the best trade regime did not involve trade in final products. This is somewhat surprising. However we must note that our analysis is a partial equilibrium one. In fact we need to add more consideration about the effect of wage increase on the demand of final goods. In the latter part of our paper, we investigated the possibility of mutual penetration of foreign investment under the game-theoretic framework. As a result, we showed that the mutual foreign direct investment was realized as a Nash equilibrium and this was the case of a prisoner's dilemma. This conclusion may indicate that there is a room for the government to interfere the economy in terms of regulation policy of trade and foreign direct investments.

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Comment

Wan-Jin Kim*

Increasing returns and imperfect competition have become increasingly important ingredients in modern trade theory. Conventional trade theory based on constant returns and perfect competition is going through quite revolutionary changes. Theoretical models which incorporate economies of scale *within the firm* and the compatible market structure in international trade usually follow one of the two approaches, namely, the Chamberlinian approach and the Cournot approach. The Chamberlinian approach assumes the monopolistic competition among firms producing differentiated products with scale economies, whereas the Cournot approach develops the models of oligopoly in international markets.

This paper introduces a model which combines the two approaches in an interesting way, namely, oligopoly in final products market and monopolistic competition in the market for intermediates. The model is a partial equilibrium model in the sense that the demand for the final product is not a function of profit and wage income generated in the model. After introducing the basic model, the paper compares the welfare levels of the various trade regimes and reports interesting welfare implications of the model. The paper also deals with foreign direct investment. The general conclusion is consistent with the literature. In other words, the trades occur within the industry between similar countries. The source of the gains from trade is the economies of scale realized in the intermediates industry by the enlarged market. The peculiar feature of the model is that trade in the final product only does not change the output level of the final products in each country in spite of increased competition. This is because the level of final product is exclusively determined by the technology of intermediates industry and by the fixed amount of sector-specific labor. Because of this peculiar feature, consumer surplus does not change after opening the final products market.

Now I would like to make two comments and one suggestion.

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My first comment is concerned with the welfare measure used in the model. The paper defines the economic welfare as the sum of consumer surplus and producer surplus. But I think the correct measure of welfare should include wage income also. Even though the model employs a partial equilibrium approach, wage level is determined endogenously and changes according to the trade regimes. If we ignore the transport costs, then the decrease in producer surplus after trade in final products is exactly matched by the increase in wage income, so that the welfare in my measure does not change, since consumer surplus does not change. So, if there is any reduction in welfare, it is due to the waste of transport costs. This possibility was already pointed out by Brander and Krugmann (1983). I think this explains the somewhat surprising results of Proposition 3 and 4 in the paper.

My second comment is about application of the model in explaining the ever increasing interdependence between Japan and other Asian countries through trade and foreign direct investment. I agree with Professor Hosoe that *intra*-industry trade exploiting the economies of scale as explained in the model becomes more important. One of the contribution of this paper, I think, is indeed to direct our attention to the increasing importance of *intra*-trade between Japan and other Asian countries. But I still think that the more important part of the trade between Japan and other Asian countries at present is *inter*-industry trade induced by technology gap and wage differential. And this kind of trade could be better explained by the dynamic theories about technological change and trade. It seems that the paper fails to provide strong evidence showing the increase in *intra*-industry trade between Japan and Asia. Statistics in Figure 1, which shows the increased ratio of intra-firm trade in Japanese industries include not just the trade between Japan and Asia, but the trade between Japan and U.S.A. and EC. Therefore, It seems to me that lots of work is yet to be done to close the gap between the data and the model.

Finally, I would like to suggest a direction for the possible improvement of the model. As I have mentioned earlier, the model in this paper is based on a partial equilibrium approach. But wages are determined endogenously given the amount of sector-specific labor. I think it is a little bit unrealistic to assume that the amount of sector-specific labor is fixed. And because of this assumption, the level of output could not change even after the trade in the final products. To avoid such an unrealistic conclusion, we could extend the model to the general equilibrium setting. This can be done in various ways. For example, we may close the model by explicitly introducing the consumers who demand final product so as to maximize utility given income constraints. And we may allow the wage differential between countries in autarky and analyze the effect of trade and foreign direct investment.

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