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FOREIGN INVESTMENT AND INTERMEDIATE GOODS TRADE

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I. Introduction

This paper discusses foreign investment in the case of a continuum of intermediate goods. For their analysis of trade in a continuum of intermediate goods, Dixit and Grossman (1982) and Sanyal (1983) adapted Dornbusch, Fischer, and Samuelson (1977, 1980)'s model of a continuum of final goods. However, they were not concerned with foreign investment. This paper is heavily based on Sanyal (1983)'s model of Ricardian type. The analytical device we will use to consider foreign investment is that 'labour' in his model is regarded as 'composite input' which is produced with capital and labour.

The most important paper on foreign investment in a trade model with intermediate goods is that of Kemp and Ohyama (1978), in which there exists a single intermediate good, oil. They and the following authors: Findlay (1977), Tower (1979) and, Lawrence and Levy (1982), chiefly discussed the extent to which oil producing country and oil consuming country can exploit each other by means of commercial policies. Our interest is not in this problem. The reason is that as assumed below, each country is able to produce the final good by itself i.e. in autarky. Under this assumption, there is obvious limit to complete exploitation.

We are mainly concerned with the manner in which foreign investment is determined and affected jointly with the stages of intermediate goods produced actually in each country. The remainder of this paper proceeds as follows. In the next section, we introduce the model with composite inputs. Section III develops a geometrical treatment of equilibrium. Section IV investigates the effects of opening of foreign investment. Section V analyses the effects of tariffs which are imposed on intermediate goods. Finally, Section VI draws conclusions.

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II. The Model

Consider a world of two countries, home and foreign. There are one final good and two factors of production, capital and labour. The production structure is segregated into two tiers. Each country produces first its own composite input with capital and labour under the neoclassical technology. Next the composite input is combined with intermediate goods in vertical processes. Capital is internationally mobile, while labour and composite inputs are trapped within national boundaries.

Intermediate goods are indexed by i on an interval $[0, 1]$ according to the processes they passed through. The final good comes out at $i=1$. In each process, fixed coefficients prevail between the intermediate good and the composite input. Units of measure are chosen so that one unit of the intermediate good at stage $i+di$ requires the use of one unit of the intermediate good at stage i and $a(i)di$ units of home composite input ($a^*(i)di$ units of foreign one). All intermediate goods and the final good are tradeable without transport costs.

We assume that

$$(1) \qquad \gamma(i) \equiv \frac{a^*(i)}{a(i)}, \qquad \gamma'(i) > 0,$$

i.e. the ratio of foreign to home composite input requirements per unit of output goes up as further processing is carried on. This implies that the foreign country has comparative advantage in upstream stages and the home country in downstream stages.

Let p and p^* represent the price of composite input in the home and foreign country respectively, in terms of the final good. Competitive producers engaging in the process from i to $i+di$ compare the cost of composite input per unit of output in the foreign country $p^*a^*(i)di$ with that in the home country $pa(i)di$. The stage $\tilde{i}$ which satisfies

$$(2) \qquad p^*a^*(\tilde{i})d\tilde{i} = pa(\tilde{i})d\tilde{i},$$

is called the marginal stage. Under the ranking (1), the processes below $\tilde{i}$ are exclusively undertaken by the foreign country. The processes above $\tilde{i}$ are assigned to the home country.

The marginal stage $\tilde{i}$ is always located in the interior of the interval. Otherwise, the composite input in one country would not be used at all and as a result any labour in this country would not be employed. Flexibility of all prices ensures that every country has an opportunity to produce something.

We have chosen units so that the amount of the final good produced, X also represents the amount of the intermediate good produced at each stage. In the foreign country the process from i to $i+di$ needs $Xa^*(i)di$ units of composite input. Total demand for composite input can be written as $XA^*(\tilde{i})$, where $A^*(\tilde{i}) \equiv \int_0^{\tilde{i}} a^*(i)di$. Supply of composite input is given by the neoclassical production function $F^*(K^*+J,\ L^*)$, where K^* is the capital stock owned by foreign nationals, J the capital stock invested in the foreign country by home nationals (J is negative when the foreign country is the source country), L^* the labour force in the foreign country. Thus the market clearing condition for foreign composite input is

$$XA^*(\tilde{i}) = F^*(K^*+J,\ L^*). \tag{3}$$

Similarly, the market clearing condition for home composite input is written as

$$XB(\tilde{i}) = F(K-J,\ L), \tag{4}$$

where $B(\tilde{i}) \equiv \int_{\tilde{i}}^1 a(i)di = A(1)-A(\tilde{i})$.

Under perfect competition, the difference between the price of the intermediate good at stage $i+di$ and that at stage i must be equal to the unit cost of composite input required in this process. Hence the price of the intermediate good at stage i is the sum of the unit cost of composite input up to stage i. The competitive profit condition for the final good becomes

$$p^*A^*(\tilde{i}) + pB(\tilde{i}) = 1, \tag{5}$$

where the price of the final good is set to unity.

Note that $dA^*(\tilde{i}) = a^*(\tilde{i})d\tilde{i}$ and $dB(\tilde{i}) = -a(\tilde{i})d\tilde{i}$. We can rewrite (2) as

$$p^*dA^*(\tilde{i}) + pdB(\tilde{i}) = 0. \tag{6}$$

Capital's marginal product in producing composite input in the foreign country is $F_K^*(K^* + J,\ L^*)$, where F_K^* is the partial derivative of F^* with respect to the first argument. The corresponding marginal product of capital in the home country is $F_K(K-J,\ L)$. In the absence of taxes and other impediments to capital movements, the value of capital's marginal product in terms of the final good must be equated between countries:

$$(7) \qquad p^* F_K^*(K^* + J,\ L^*) = pF_K(K - J,\ L).$$

Five equations (3)−(7) determine five variables X, $\tilde{i}$, J, p and p^* endogenously once K, L, K^* and L^* are given as parameters.

III. Equilibrium

To save a space, let us refer to home (foreign) composite input as home (foreign) input. From (3) and (4) we can see that two inputs, home and foreign, are produced with the two types of country-specific labour and internationally-mobile capital. This means that a bowed-out transformation schedule in the specific-factors model[1] is readily applied to a transformation curve between home and foreign inputs in our model. In Figure 1, the T^*T locus shows this curve.

Equation (5) suggests that the final good is after all a blend of foreign input and home input. We can construct the unit isoquant for the final good U^*U in Figure 1 as does Sanyal (1983). OU^* represents $A^*(1)$ and OU represents $B(0)$. The U^*U curve is negatively sloped and bowed in toward the origin, because

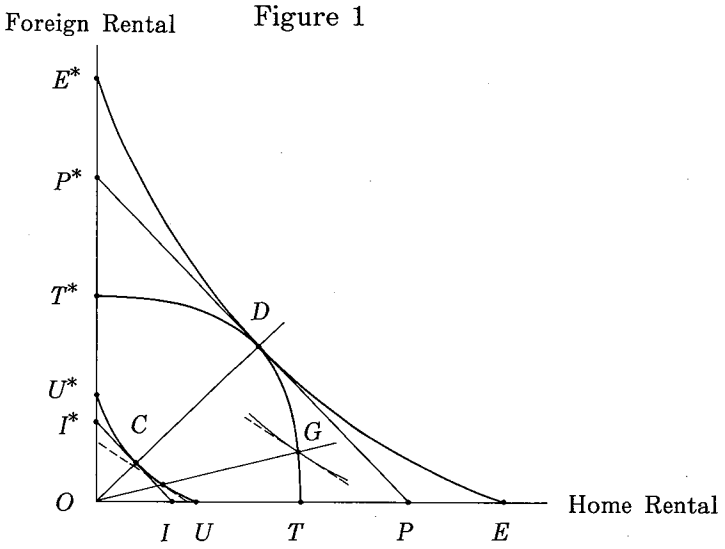
$$\frac{dA^*(i)}{dB(i)} = -\frac{a^*(i)}{a(i)} = -\gamma(i) < 0$$

and

$$\frac{d^2A^*(i)}{dB(i)^2} = -\gamma'(i)\frac{di}{dB(i)} = \frac{\gamma'(i)}{a(i)} > 0.$$

1. For this schedule, see Caves and Jones (1985, p.93).

Figure 1



The fact that $di/dB(i) = -1/a(i) < 0$ implies that i rises as we move up along the U^*U curve.

Suppose for a while that relative price of home input in terms of foreign input p/p^* is given as a parameter. As (5) and (6) state, the marginal stage $\tilde{i}$ is implicitly determined by point C where the iso-cost line I^*I is tangent to the U^*U curve. OI^* illustrates $1/p^*$ and OI illustrates $1/p$.

The marginal rate of transformation of foreign input for home input is

$$-\frac{dF^*(K^*+J, L^*)}{dF(K-J, L)} = -\frac{F_K^*(K^*+J, L^*)\,dJ}{F_K(K-J, L)(-dJ)} = \frac{F_K^*(K^*+J, L^*)}{F_K(K-J, L)}.$$

What (7) means is that such marginal rate must be equal to p/p^*. Therefore (7) is satisfied at point D where the price line P^*P touches the T^*T curve. The P^*P line is parallel to the I^*I line.

If a given p/p^* is the equilibrium price, point C lies on the OD line as drawn in Figure 1. From (3) and (4) we obtain $A^*(i)/B(i) = F^*(K^*+J, L^*)/F(K-J, L)$. Accordingly, equilibrium is demonstrated by point D of tangency between the T^*T curve and the isoquant E^*E. Two isoquants, U^*U and E^*E are homothetic. The amount of the final good is measured by OD/OC, OE^*/OU^*, or OE/OU.

IV. Opening of Foreign Investment

As we have shown, in the case of perfect mobility of capital, the return to capital is the same between countries at point D on the T^*T curve in Figure 1. If capital is immobile and if fixed amounts of capital and labour allow countries to produce the composite inputs at some point but D along the T^*T schedule, there is an international differential in the rental on capital. Within region TD, home rental is lower than foreign rental. At point G for example, the negative of the slope of the isoquant p/p^* is smaller than the negative of the slope of the T^*T curve F_K^*/F_K. On the other hand, we find higher home rental within region T^*D.

Suppose initially that capital movement is prohibited and that countries produce two inputs at point G. And then let countries open to international investment. The world economy shifts from point G to point D. The effects of opening of foreign investment are easily examined.

Seeking higher return, home capital moves to foreign country. Production of composite input decreases at home and increases abroad. Since home input becomes scarce, p/p^* rises. Changes in OI and OI^* reveal that p goes up whereas p^* goes down. The isoquant with larger output is attained and the amount of the final good X increases. The counterclockwise movement from G to D causes an increase in the marginal stage $\tilde{i}$. The source (home) country narrows the range of stages and the host (foreign) country widens it. The processes between old and new marginal stages are transferred with capital.

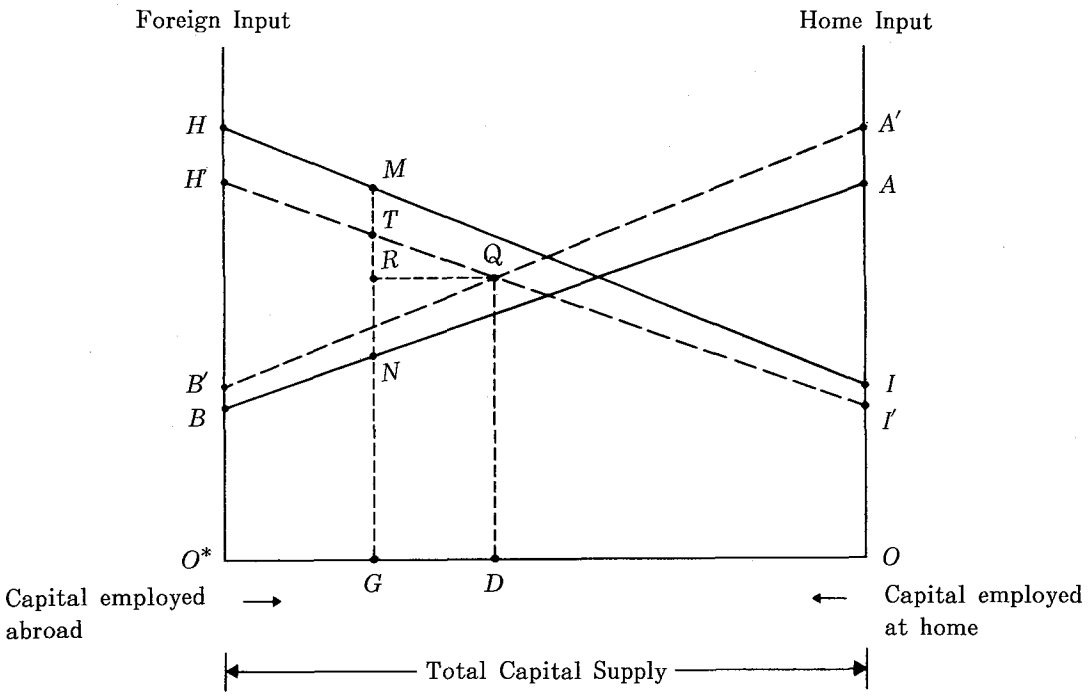
It is convenient for us to use notations F and F^* in order to denote the amount of home and foreign inputs instead of production function. The value added in the home country is pF and the value added in the foreign country is p^*F^*. Since p and F ($p^*$and F^*) change in the opposite direction, either of the two value added may decrease. However, both cannot decrease, because we obtain $pF+p^*F^*=X$ from (3), (4) and (5).

Income of the home country in terms of the final good is given by $pF+pF_KJ$. This also represents the amount of the final good consumed

by the home country C: $C=pF+pF_K J$. The foreign country earns and consumes the final good by the amount of $C^*=p^*F^*-p^*F_K^*J=p^*F^*-pF_K J$. How do C and C^* change?

Figure 2 depicts the value-of-the-marginal-product-of-capital (VMPC) curves. For simplicity they are drawn as straight lines. Before investment, home VMPC line is AB and foreign one is HI. The initial allocation of capital is shown by point G. Foreign rental MG is higher than home rental NG. After investment, AB shifts upward to $A'B'$ and HI shifts downward to $H'I'$ in accordance with a rise in p and a fall in p^*. Capital GD flows into the foreign country. Home rental rises from NG to QD, while foreign rental falls from MG to QD. By contrast, changes in the wage rate are ambiguous. Labour's marginal product in producing composite input in the home country F_L decreases but p rises. Home wage rate pF_L may go up or down. The same result holds with respect to foreign wage rate $p^*F_L^*$.

Figure 2



Home consumption C increases from $ANGO$ to $A'QRGO$ at a higher rate than p. Foreign consumption C^* changes from $HMGO^*$ to $H'QRGO^*$. C^* may increase or decrease. Change in C^* can be separated into two parts. $HMTH'$ represents a decrease in C^* associated with a fall in p^*in the absence of foreign investment, while TQR represents an increase in C^* caused by foreign investment at new p^*. Though Figure 2 shows the case in which net change is negative, this change can be positive.

We have shown that consumption in the source country necessarily increases and consumption in the host country may rise or fall. Note that world consumption always increases, because $C+C^*=X$. In Figure 2, $OA'QH'O^*$ must be larger than $OANMHO^*$. This implies that if an unrequited transfer of income or the final good to the host country is appropriately implemented, foreign investment can make both countries better off. That is, there is a potential gain from foreign investment.

Turn to the effects of foreign investment on goods trade. Independently of whether foreign investment is allowed or not, the foreign country does not produce the final good. It produces intermediate goods from stage 0 to the marginal stage, exports the intermediate good at the marginal stage, and imports the final good. After investment, the foreign country expands the range of stages and exports the intermediate good at a higher stage than before. Since production of the final good increases, the amount of the intermediate good at each stage increases, too. Total exports of the intermediate good after investment embody a larger volume of the intermediate good exported before. In this sense, foreign investment promotes quantitatively exports of intermediate goods. But the value of the intermediate good exported in terms of the final good may increase or decrease, because this value is the same as the value added in the foreign country p^*F^*. The volume of the final good imported is equal to C^*. Hence, the change in this volume is ambiguous.

So far we have taken the case in which the foreign country becomes the host country. Now consider briefly the opposite case in which capital moves from the foreign to the home country. Clearly, $\tilde{i}$ falls while X rises. After investment, the source (foreign) country exports a larger volume of the intermediate good at a lower stage.

Nothing can be said about whether foreign investment promotes quantitatively exports of intermediate goods or not. The change in the value of exports of the source country is ambiguous as well as the change in p^*F^*. The volume of the final good imported, however, increases because C^* must rise.

After all, two cases discussed above suggest that foreign investment promotes quantitatively exports of the host country, namely imports of the source country.

Trade in composite inputs is hiding behind actual trade in goods. Exports of the intermediate good from one country are regarded as exports of its own composite input. Its imports of the final good can be viewed as imports of its input and the other country's input. Thus two inputs are implicitly traded under goods trade. As shown above, foreign investment deteriorates the 'factoral' terms of trade p/p^* for the host country. This is the reason why the host country may be worse off.

V. Tariffs on Intermediate Goods

Suppose initially that the world economy is at the equilibrium under free trade and free capital movement, that is, at point D in Figure 1. Suppose next that the home country imposes a uniform tariff on intermediate goods on a value-added basis at the rate t. For any process from i to $i+di$, producers must compare $(1+t)p^*a^*(i)di$ with $pa(i)di$. The marginal stage $\tilde{i}$ is given by

$$(2') \qquad (1+t)\,p^*a^*(\tilde{i})d\tilde{i} = pa(\tilde{i})d\tilde{i}.$$

This and the ranking (1) imply that the foreign country can produce intermediate goods between stages 0 and $\tilde{i}$ at a lower cost, while the home country can produce intermediate goods between stages $\tilde{i}$ and 1 at a lower cost. The marginal stage $\tilde{i}$ indicates the international division of processes, as in Section II. Thus, necessary modification in our model is just replacing p^* in (5) and (6) with $(1+t)p^*$. (3), (4) and (7) remain intact. Our model can be written as

$$(3) \qquad XA^*(\tilde{i}) = F^*(K^* + J, L^*),$$

$$(4) \quad XB(\tilde{i}) = F(K - J, L),$$

$$(5') \quad (1+t)\, p^* A^*(\tilde{i}) + pB(\tilde{i}) = 1,$$

$$(6') \quad (1+t)\, p^* dA^*(\tilde{i}) + pdB(\tilde{i}) = 0,$$

$$(7) \quad p^* F_K^*(K^* + J, L^*) = pF_K(K - J, L).$$

If capital were fixed at the initial level regardless of the tariff, X and $\tilde{i}$ in (3) and (4) would not change. With $\tilde{i}$ held constant, $(1+t)p^*$ and p in (5′) and (6′) would not change, either. Since $(1+t)p^*$ remains constant, tariffs would lower p^*. In (7), foreign rental becomes smaller than home rental at a given J. A tariff creates an incentive for capital to move from the foreign to the home country.

As J decreases, F_K^* goes up and F_K goes down. p/p^* must increase to maintain (7). Production point D in Figure 1 shifts downward along the T^*T schedule to a point, say, point G where the new price line reflecting new p/p^* is tangent to the T^*T schedule. It is obvious that X and F^* decrease and F increases. New equilibrium point G is a point of tangency between the isoquant and the iso-cost line. Their slope reflects the price ratio inclusive of the tariff, $p/(1+t)p^*$.

The clockwise movement from D to G lowers $\tilde{i}$ and p while raises $(1+t)p^*$. Tariffs drive away capital from the foreign country, contract the range of stages abroad, and expand the range of stages at home. The stages move with capital as in Section IV. A rise in p/p^* and a decline in p must decrease p^*. Such a drop in p^* and a rise in $(1+t)p^*$ mean a rise in tp^*.

Continuous tangency between the T^*T transformation curve and the price line whose slope reflects p/p^* ensures that the comparative statics properties are exactly the same as in the specific-factors model. Noting a rise in p/p^*, we can obtain without proof,

$$(\hat{pF_L}) > \hat{p} > (\hat{pF_K}) > \hat{p^*} > (\hat{p^*F_L^*}) \quad [2]$$

where a hat denotes the relative change in a variable: $\hat{p} \equiv dp/p$. Combining this with $\hat{p} < 0$, we have

$$(\hat{pF_K}) < 0 \quad \text{and} \quad (\hat{p^*F_L^*}) < 0.$$

2. For this relationship, see Caves and Jones (1985, p.508).

That is, tariffs lower the world rental and the wage rate abroad.

The home country's consumption C is given by

$$C = pF + pF_K J + tp^* F^*$$

where $tp^*F^*(=tp^*XA^*(\tilde{i}))$ represents the tariff revenue transferred to home nationals. As we have demonstrated, a rise in t increases F and tp^* while decreases p, pF_K, J and F^*. Therefore, the effect of a tariff on C is ambiguous. If the home country can impose the optimal tariff, C will increase. However, $C^*(=p^*F^* - pF_K J)$ will decrease, because of a fall in $X(=C+C^*)$.

VI. Conclusions

The key assumption that composite input is produced from capital and labour is equivalent to the assumption that the shape of the unit isoquant between capital and labour is identical for each stage within the same country. We have chosen the former assumption, because it gives the model a simplified structure which makes the analysis easier.

The basic result of this paper is that the stages of intermediate goods produced move internationally with capital in the same direction. Opening of foreign investment, i.e. removal of an obstacle to foreign investment improves resource allocation in the world and increases production of the final good. The host country expands the range of stages, while the source country shrinks the range of stages. The factoral terms of trade, i.e. the relative price of composite input alters in favour of the source country and makes it better off. Without a compensatory transfer of income between countries, the host country may be worse off. If the host country has comparative advantage in upstream stages, it will export the intermediate good at a higher marginal stage by a larger amount. On the other hand, if the source country has comparative advantage in upstream stages, it will export the intermediate good at a lower marginal stage by a larger amount.

In the case of tariffs on intermediate goods, tariff-induced foreign investment distorts the allocation of capital, thus decreasing output of the final good. Capital and the stages move to the tariff-levying country, because it becomes a better place to produce. Tariffs harm

labourers in the country exporting intermediate goods and capitalists in the world.

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References

CAVES, R.E. and JONES, R.W. (1985). *World Trade and Payments. 4th ed.* Boston: Little, Brown.

DIXIT, A.K. and GROSSMAN, G.M. (1982). Trade and protection with multistage production. *Review of Economic Studies,* 49, 583-594.

DORNBUSCH, R., FISCHER, S. and SAMUELSON, P.A. (1977). Comparative advantage, trade, and payments in a Ricardian model with a continuum of goods. *American Economic Review,* 67, 823-839.

_____, _____ and _____ (1980). Heckscher-Ohlin trade theory with a continuum of goods. *Quarterly Journal of Economics,* 95, 203-224.

FINDLAY, R. (1979). Economic development and the theory of international trade. *American Economic Review,* 69, 186-190.

KEMP, M.C. and OHYAMA, M. (1978). On the sharing of trade gains by resource-poor and resource-rich countries. *Journal of International Economics,* 8, 93-115.

LAWRENCE, C. and LEVY, V. (1982). On sharing the gains from international trade: The political economy of oil consuming nations and oil producing nations. *International Economic Review,* 23, 711-721.

SANYAL, K.K. (1983). Vertical specialization in a Ricardian model with a continuum of stages of production. *Economica,* 50, 71-78.

TOWER, E. (1979). Economic imperialism and resource nationalism: Comment on Kemp and Ohyama. *Journal of International Economics,* 9, 423-427.