Welfare Enhancing Direct Investment

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Abstract
This paper provides a model to consider the conditions under which an acceptance of foreign direct investment is welfare enhancing in a multi-commodity multi-factor framework. Contrary to the pessimistic conventional wisdom of capital imports and welfare, we provide a justification for the acceptance of foreign capital and the diversification of industrial structure in developing countries. A sufficient condition for an acceptance of foreign capital to be welfare enhancing is that all domestic factors move into the new export sector in equal proportion to the endowments of factors.

Keywords: Uzawa-Hamada-Brecher-Diaz Alejandro proposition, FDI, GDP Function
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1. Introduction

As the recent experiences demonstrate, instead of the import substitution policy, many developing countries are trying to diversify the industrial structure and making export-led growth by accepting foreign direct investment. In order to consider the implications of these policies, it is necessary to provide a model to justify the acceptance of foreign capital.

The analysis of capital imports and welfare was a hot issue in 1970s and 1980s and many seminal papers have been written on this topic. Among them, Bhagwati(1973), Minabe(1974), Brecher and Diaz Alejandro(1977), Brecher and Choudhri(1982), Brecher and Findlay(1983) and Srinivasan (1983) made important contributions to the analyses in this field. Specifically, Brecher and Diaz Alejandro(1977) showed that the capital imports under a tariff is immiserizing. In the two previous papers in Japanese, Uzawa(1969) and Hamada (1971) also showed that the capital imports under a tariff is always welfare reducing for a small open economy. These papers produced a conventional wisdom: the Uzawa-Hamada-Brecher-Diaz Alejandro proposition. Also the welfare effects of a free trade zone and export processing zone have attracted considerable attentions among trade theorists and papers such as Hamada (1974), Miyagiwa (1986) and Beladi and Marjit(1992) have been written.

However this conventional wisdom is pessimistic and do not explain the reality of many developing countries. Furthermore these previous papers have a limitation in dimensionality. The recent experiences in developing countries have necessitated to visit the conventional wisdom and to consider the analyses of capital imports and welfare. The purpose of this paper is to provide a model to consider the conditions under which an acceptance of foreign capital is welfare enhancing in a multi-dimensional framework. We

will provide a sufficient condition for welfare enhancing capital imports.

This paper is organized as follows. In section 2, we consider the implications of the conventional wisdom and point out three related models on capital imports and welfare. In section 3, we identify salient features of direct investment. Based on these sections, the section 4 develops the model of this paper. In section 5, we derive a condition for welfare enhancing foreign capital imports and consider its implications. In section 6, we take up the same problem in a three-sector three-factor model and derive a weaker condition. The section 7 concludes the paper. In the appendix, we provide an analysis to justify our assumption in two cases.

2. The Uzawa-Hamada-Brecher-Diaz Alejandro proposition

In order to justify our analysis, we first take up the Uzawa-Hamada-Brecher-Diaz Alejandro proposition in the Heckscher-Ohlin model. This proposition says that a capital import under a tariff is welfare reducing. In this section, we first explain the intuitions and then consider the reasons by the use of a duality approach where the foreign capital and domestic capital are assumed to be identical. A model assumed is a small open economy that imports capital intensive goods with a tariff.

Suppose an increase in capital imports under a tariff. Then it increases the output of imports, reduces the quantity of imports, and thus the tariff revenue. The reduction of tariff revenue reduces its welfare. This is the intuition of this proposition. However the same result is obtained when a tariff rate increases at given foreign capital. Suppose the price of imports increases by an increase in tariff. Then it raises the return to capital intensively used in the import sector. An increase in return to capital increases the

repatriation to foreign capital and causes a loss of welfare. Consider the intuition by the use of a simple model.

Assume that this economy produces two commodities, Y_1 and Y_2, by the use of two factors, capital K and labor L, under the usual assumptions. The first good is the exportable and labor intensive and the second good is the importable and capital intensive; $k_2 > k_1$, where $k_j \equiv K_j / L_j$, $j = 1,2$. Let the relative price of the second good in terms of the first be p ($\equiv p_2 / p_1$). The first good is the numeraire and its price is normalized to one. Define the GDP function: $G(p,K,L) \equiv \max\left[Y_1(K_1,L_1) + pY_2(K_2,L_2)\right]$ subject to full employment. $G(\cdot)$ is assumed to be homogeneous of degree one and convex in prices and concave in factor supply. We have; $G_p = Y_2, G_{pK} > 0, G_{pp} > 0, G_K = r, G_L = w$. Define the expenditure function: $E(p,u) \equiv \min\left[D_1 + pD_2\right]$ subject to $U(D_1,D_2) = u$, where D_j denotes the consumption of j th good and u is the level of utility. Both goods are assumed to be normal. $E(\cdot)$ is assumed to be homogeneous of degree one and concave in prices and increasing in utility. We have; $E_p = D_2$, $E_{pp} < 0$, $E_{pu} > 0$. The import demand is: $M_2 = E_p(p,u) - G_p(p,K,L)$. Let the specific tariff on imports and the foreign capital be t and K_f respectively. Then the budget equation is:

$$E(p,u) = G(p,K,L) + tM_2 - G_K(p,K,L)K_f, \qquad (1)$$

where, tM_2 is the tariff revenue and $G_K(p,K,L)K_f$ is the repatriation to foreign capital.

From (1), we obtain:

$$\frac{du}{dK_f} = \frac{-tG_{pK} - K_f G_{KK}}{(E_u - tE_{pu})}. \qquad (2)$$

In (2), since $E(\cdot)$ is homogenous of degree one in prices, we have: $(E_u - tE_{pu}) > 0$. Thus

the signs of (2) depend on G_{pK} and G_{KK}. First, in the Heckscher-Ohlin model under incomplete specialization, any change in factor supply does not affect factor prices. Thus we have: $G_{KK} = 0$. Second, since the second sector is capital intensive, we have: $G_{pK} > 0$. Under these specifications, we obtain: $du / dK_f < 0$. This is the Uzawa-Hamada-Brecher-Diaz Alejandro proposition and the capital imports is welfare reducing. It is clear that this pessimistic result comes from two facts: $G_{KK} = 0$ and $G_{pK} > 0$. Thus we see that if $G_{KK} < 0$ and $G_{pK} < 0$, the capital import is welfare enhancing. These aspects will be reflected in the model settings in section 4.

In this connection, we point out three models related to the capital imports and welfare. The first is the specific factor model. Srinivasan(1983) uses a specific factor model to analyze the effects of capital imports. If the foreign capital is specific to the import sector, the second term of the numerator in (2) is $-K_f G_{KK} > 0$. Thus the welfare can increase as the result of capital imports. The second is the free trade zone model. In this field, the classical paper is Hamada(1974). By the use of a standard Heckscher-Ohlin model, it shows that an exogenous increase in foreign capital within the zone decreases national welfare if the import sector is capital intensive. Mayagiwa(1986) also considers the impacts of establishing a free trade zone by the government subsidy in order to promote the diversification of industry and exports. It shows that the establishment of a free trade zone as the third sector can increase welfare regardless of the relative factor intensity of a zone based industry. The third is the export processing zone model. Beladi and Marjit(1992) considers the welfare effects of an expansion of the export processing zone by the use of a three sectors, three factors (two capitals and one labor) model. It assumes that domestic capital is used in the traditional import and export sector but not in the export processing

zone. Using such a model, it shows that if the economy imports capital intensive good under a given tariff, an increase in foreign capital in the export processing zone decreases its welfare. It also shows that an increase in foreign capital increases the output of imports and decreases that of exports, making the anti-trade growth.

The above models and results, however, are not consistent with the realities of many developing countries. We need a model in order to consider the conditions under which a capital import is welfare enhancing.

3. Features of Direct Investment

Our model is based on the reflections of the pessimistic conventional wisdom as well as the previous analyses of foreign direct investment (FDI). In this section, we point out the salient features of FDI in order to set out our model in the next section.

The analyses of FDI started from Caves(1971) in 1970s. Since then many seminal papers including Helpman(1984), Helpman and Krugman(1985), Ethier(1986), Wong(1995), Markusen(2002), Feenstra(2004), and Navaretti and Venables (2004) have been written. These papers demonstrate that FDI should be differentiated from the capital movement in the Heckscher-Ohlin model and that it has following features:

(i) it is made in order to use the firm specific advantages in the host countries

(ii) it is cross-hauling within an industry

(iii) it is a key vehicle of technology transfer

(iv) it is made by the non-financial multinational firms to control subsidiaries.

These features have been gathered into an agreed definition: it is an international transfer of firm specific managerial resources or assets by multinational firms. However,

we think that another positive feature should be added: it is a starter of new export sector in the host countries. Thus we define direct investment as a movement of sector specific foreign capital that is a starter of new export sector in the host country.

FDI is divided into two types; Vertical FDI (VFDI) and Horizontal FDI (HFDI). While the HFDI is the market-oriented investment and is popular among developed countries, the VFDI is the cost-oriented investment and is popular between developed and developing countries. Our model is related to the VFDI. A VFDI is to be grasped from two aspects. From the aspect of developed countries, FDI is made in order to use the managerial resources to obtain cost advantages in the vertical production processes. From the aspect of developing countries, FDI is expected to produce following results. First, it should be welfare enhancing. Second, it works to diversify their industrial structure and attain the export-led growth.[1] Third, it is characterized as a starter of new export sector.

Based on these analyses, we provide a model in order to justify the acceptance of FDI. Our model has following features. First, it is a multi-dimensional model with foreign capital. Secondly, the foreign capital is distinguished from the domestic capital and it is accepted in the new export sector rather than the previous sectors.

4. The Model

Suppose a small open developing country that produces n commodities $(j = 1,...,n)$ by the use of m factors $(i = 1,...,m)$ before a direct investment takes place. The multi-dimensionality is a first feature of our model.

The production function of each commodity is assumed to be twice-continuously differentiable, increasing, linearly homogeneous, and strictly-quasi-concave in all factors of

production:

$$y_j = f^j(x_{1j}, x_{2j}, ..., x_{mj}), \quad j = 1, ..., n. \tag{3}$$

It is assumed that the m factors are inelastically supplied and the full employment condition holds for each of them:

$$\bar{x}_i = \sum_{j=1}^{n} x_{ij}, \quad i = 1, ..., m, \tag{4}$$

where, $\bar{x}_i$ is the domestic supply of i th factor. All commodity and factor markets are competitive.

Let $p^T \equiv (p_1, p_2, ..., p_n)$ be the commodity price vector.[2] The GDP function is defined:

$$F(p, \bar{x}) \equiv \max \sum_{j=1}^{n} p_j f^j(x_{1j}, ..., x_{mj}), \tag{5}$$

with respect to x_{ij} $(i = 1, ..., m, j = 1, ..., n)$ subject to (4), where $\bar{x}^T \equiv (\bar{x}_1, ..., \bar{x}_m)$ is the factor-endowment vector of the economy.

Now, suppose that the foreign capital, x_{00}, comes into this country and that a new export sector that produces 0 th good is started by accepting this foreign capital and using existing domestic m factors of production.[3] We assume that not only foreign capital, x_{00}, but also existing m domestic factors, x^0, are used in the production of new export good. The assumption that the all existing domestic factors are used in the new export sector is the another feature of our model.[4] This assumption is justified by the following reasons. First, a new export sector cannot be established without the supports of all domestic sectors. Second, the expansion of exports and the diversification of industrial structure are the important targets of these countries. These targets will be supported by

the previous sectors. As x_{00} is the sector specific foreign capital and the new export sector is started by the acceptance of this foreign capital, we define it as FDI.

The production function of the new export sector is:

$$y_0 = f^0(x_{00}, x_0), \tag{6}$$

where, $x_0^T \equiv (x_{10},...,x_{m0})$ is the domestic factors used in the new export sector and it has m dimension. We assume that this function also satisfies all the standard properties as a neo-classical production function. The new export good is exported at the fixed world price.

Integrating the pre-FDI GDP function with the production function of the 0 th good, we can formulate the post-FDI GDP function:

$$G(p_0, p, \bar{x}, x_{00}) \equiv \max\left[p_0 f^0(x_{00}, x_0) + F(p, \bar{x} - x_0)\right] \tag{7}$$

with respect to x_0. It is assumed that $G(\cdot)$ is differentiable and concave with respect to $\bar{x}$ and x_{00}. Assuming the existence of the interior solution to this maximization problem, we can write the first order condition:

$$p_0 f_{x_0}^0(x_{00}, x_0) = F_x(p, \bar{x} - x_0), \tag{8}$$

where, $f_{x_0}^0(x_{00}, x_0)^T \equiv (\frac{\partial f^0(x_{00}, x_0)}{\partial x_{10}},...,\frac{\partial f^0(x_{00}, x_0)}{\partial x_{m0}})$,

$$F_x(p, \bar{x} - x_0)^T \equiv (\frac{\partial F(p, \bar{x} - x_0)}{\partial(\bar{x}_1 - x_{10})},...,\frac{\partial F(p, \bar{x} - x_0)}{\partial(\bar{x}_m - x_{m0})}).$$

(8) shows that the value of marginal product of each existing factor of production is equal between the 0 th sector and previous sectors. Therefore, m equations in (8) are the profit maximization conditions. Assume that there exists a unique x_0 that satisfies (8).

Now, let us turn to the demand side of the model. Denoting the expenditure function of the whole residents of the country by $E(p_0, p, u)$ and assuming that the government of

this country imposes import tariffs and transfers the whole tariff revenue to the residents in a lump-sum manner, we can write the budget constraint:

$$E(p_0, p, u) = G(p_0, p, \bar{x}, x_{00}) + \Gamma^T \left[E_p(p_0, p, u) - G_p(p_0, p, \bar{x}, x_{00})\right] - G_{x_{00}}(p_0, p, \bar{x}, x_{00}) x_{00}, \quad (9)$$

where, $\Gamma^T \equiv (0,...,0,t_{h+1},t_{h+2},...,t_n)$ is the import tariff vector. We assume that the first h sectors including the 0 th sector are export sectors and from $h+1$ to n sectors are import sectors. It is assumed that there exits no non-traded goods and all goods are normal. The second term of the right hand side of (9) is the tariff revenue and the third term is the repatriation to foreign capital. Since p_0 and p are the domestic prices, by denoting the foreign prices by p_0^* and p^*, we have following relationships:

$$p_0 = p_0^*,$$

$$p = \Gamma + p^*.$$

We assume that (9) determines the welfare level u uniquely and it is denoted by u^e.

5. The Analyses

Now, we derive our main result. The total differentiation of (9) with respect to u^e and x_{00} yields,

$$\begin{aligned}
&\left[E_u(p_0, p, u^e) - \Gamma^T E_{pu}(p_0, p, u^e)\right] du^e \\
&= G_{x_{00}}(p_0, p, \bar{x}, x_{00}) dx_{00} - \Gamma^T G_{px_{00}}(p_0, p, \bar{x}, x_{00}) dx_{00} \\
&- G_{x_{00}}(p_0, p, \bar{x}, x_{00}) dx_{00} - G_{x_{00}x_{00}}(p_0, p, \bar{x}, x_{00}) x_{00} dx_{00} \\
&= -\left[\Gamma^T G_{px_{00}}(p_0, p, \bar{x}, x_{00}) + G_{x_{00}x_{00}}(p_0, p, \bar{x}, x_{00}) x_{00}\right] dx_{00}.
\end{aligned}$$

This produces:

$$\frac{du^e}{dx_{00}} = -\frac{\left[\Gamma^T G_{px_{00}}(p_0, p, \bar{x}, x_{00}) + G_{x_{00}x_{00}}(p_0, p, \bar{x}, x_{00})x_{00}\right]}{E_u(p_0, p, u^e) - \Gamma^T E_{pu}(p_0, p, u^e)}. \tag{10}$$

The effects of an increase in direct investment on welfare are demonstrated by (10). Let us check the signs of (10). First, the denominator of (10) has to be positive. Since the partial derivative of the expenditure function with respect to welfare u is linearly homogeneous in p_0 and p, we have the Euler condition: $E_u = p_0 E_{up_0} + p^T E_{up}$. We see that $E_u = p_0 E_{up_0} + (p^* + \Gamma)^T E_{up} > \Gamma^T E_{up}$. Thus the signs of (10) depend on the numerator. First, due to the concavity of the GDP function with respect to $\bar{x}$ and x_{00}, $G_{x_{00}x_{00}}(p_0, p, \bar{x}, x_{00}) \leq 0$. It is clear that $G_{x_{00}}$ is the rental rate of direct investment. Thus, as the supply of x_{00} increases, the rental rate declines. This is the economic reason why $G_{x_{00}x_{00}}(p_0, p, \bar{x}, x_{00}) \leq 0$. Thus what remains to analyze in the numerator is the term $\Gamma^T G_{px_{00}}(p_0, p, \bar{x}, x_{00})$.

Recalling the definition of the GDP function (7), we see:

$$G_p(p_0, p, \bar{x}, x_{00}) = F_p(p, \bar{x} - x_0). \tag{11}$$

Therefore, we have:

$$G_{px_{00}}(p_0, p, \bar{x}, x_{00}) = -F_{px}(p, \bar{x} - x_0)\frac{dx_0}{dx_{00}}. \tag{12}$$

Thus the sign of $G_{px_{00}}(p_0, p, \bar{x}, x_{00})$ depends on two terms, $F_{px}(p, \bar{x} - x_0)$ and $\frac{dx_0}{dx_{00}}$.[5]

As $F_{px}(p, \bar{x} - x_0)$ is the change in the output vector of domestic sectors as the result of an increase in domestic factor supply, it is positive. Thus if the vector $\frac{dx_0}{dx_{00}}$ is positive, the FDI is welfare enhancing. For this purpose, we introduce a following assumption:

Assumption 1. There is a positive small value α, such that $\frac{dx_0}{dx_{00}} \approx \alpha \bar{x}$.

This assumption implies that all domestic factors move into the new export sector in equal proportion to the endowments of factors. When a FDI takes place, it attracts the existing factors to the new export sector until the rewards to the existing domestic factors is equal between the new export sector and the previous sectors. The assumption 1 says that all factors move into the new export sector in equal proportion to the endowments of factors.

Under this assumption, we see from (12) that $G_{px_{00}}(p_0, p, \bar{x}, x_{00})$ is a negative vector, which implies that $\Gamma^T G_{px_{00}}(p_0, p, \bar{x}, x_{00}) < 0$. From (10), we obtain a following result:

Result 1. An increase in foreign direct investment is welfare enhancing under the assumption 1.

The assumption 1 is a sufficient condition for welfare enhancing direct investment and its intuition is as follows. The movement of all domestic factors into the new export sector reduces the outputs of all previous sectors including the import sectors. Let the output vector of previous sectors as $y^T \equiv (y_1, y_2, ..., y_n)$. Under the assumption 1, we have: $dy^T / dx_{00} < 0$, i.e., $dx_0 / dx_{00} > 0$ implies $dy^T / dx_{00} < 0$. This increases the quantity of imports, tariff revenue and welfare.

By the use of the definition of $p^T \equiv (p_1, p_2, ..., p_n)$, we have a following remark:

Remark 1. By the assumption of differentiability of $G(\cdot)$, there exists a reciprocity relation between quantities and prices, i.e., $dy^T / dx_{00} < 0$ implies $dw_0 / dp^T < 0$.[6]

The implications of the remark 1 are as follows. At given direct investment, suppose that the prices of domestic products increase by a tariff on imports. An increase in the prices of domestic products increases the prices of domestic factors, which in turn, at given p_0, reduces the return to direct investment w_0 .The reduction of w_0 reduces the repatriations to foreign country and increases the welfare of this country. We have:

Remark 2. Let the output vector of import sectors as $y_m^T = (y_{h+1,\ldots,} y_n)$. Then a necessary condition for an acceptance of foreign capital to be welfare enhancing is $dy_m^T / dx_{00} < 0$. If $dy_m^T / dx_{00} < 0$, an acceptance of foreign capital reduces the outputs of all import sectors and increases the tariff revenue and welfare.

Now confirm the differences between the capital import in Heckscher-Ohlin model and ours. In the former, it is a two sectors two factors model, the importable good is capital intensive and the foreign capital and domestic capital are identical. In such a case, an increase in foreign capital increases the output of imports and reduces imports and tariff revenue. The reduction of tariff revenue reduces its welfare. In contrast, our model is a multi sectors multi factors model, the foreign capital is different from the domestic capital and specific to the new export sector. As the result of FDI, if all domestic factors move into the new export sector in equal proportion, it reduces the level of outputs of all previous sectors including the import sectors. This increases tariff revenue and welfare.

What remains to consider is the plausibility of the assumption 1. At first it seems to be severe. However this assumption will be justified if we consider following aspects. First, the

new export sector can be considered as a small size of the economy or a linear contraction of the economy. Second, without the support of previous domestic sectors, foreign capital can not lead to the development of new export sector. These aspects will justify the assumption 1.

6. Three Sectors Three Factors Model

In this section, we consider the same problem in a three-sector three-factor model and derive a weaker condition for welfare enhancing direct investment.

Assume three sectors: sector 0 is the new export sector, sector 1 the traditional export sector and sector 2 the import sector. The second commodity is imported with tariffs. Assume three factors: factor x_0 is the foreign capital specific to 0 sector while factors x_1 and x_2 are the domestic factors used in all three sectors. Letting the factor returns to three factors be w_0, w_1, w_2 respectively, the zero profit condition is:

$$p_0 = c^0(w_0, w_1, w_2), \tag{13}$$

$$p_1 = c^1(w_1, w_2), \tag{14}$$

$$p_2 = c_2(w_1, w_2). \tag{15}$$

Differentiating these three equations totally assuming p_0 to be fixed, we obtain:

$$dw_0 = -\frac{1}{c_0^0}\left[c_1^0 dw_1 + c_2^0 dw_2\right],$$

$$dw_1 = \frac{c_2^2}{\Delta} dp_1 - \frac{c_2^1}{\Delta} dp_2, \tag{16}$$

$$dw_2 = -\frac{c_1^2}{\Delta} dp_1 + \frac{c_1^1}{\Delta} dp_2,$$

where, $\Delta \equiv c_1^1 c_2^2 - c_1^2 c_2^1 = c_1^1 c_1^2 \left[\frac{c_2^2}{c_1^2} - \frac{c_2^1}{c_1^1} \right]$.

From (16), we obtain:

$$\frac{dw_0}{dp_1} = \frac{c_1^0 \left[\frac{c_2^0}{c_1^0} - \frac{c_2^2}{c_1^2} \right]}{c_0^0 c_1^1 \left[\frac{c_2^2}{c_1^2} - \frac{c_2^1}{c_1^1} \right]}, \quad \frac{dw_0}{dp_2} = \frac{c_1^0 \left[\frac{c_2^1}{c_1^1} - \frac{c_2^0}{c_1^0} \right]}{c_0^0 c_1^2 \left[\frac{c_2^2}{c_1^2} - \frac{c_2^1}{c_1^1} \right]}. \tag{17}$$

In (17), $\frac{c_2^0}{c_1^0}, \frac{c_2^1}{c_1^1}$, and $\frac{c_2^2}{c_1^2}$ are the factor intensity of the second factor relative to the first factor in the new export sector, traditional export sector and import sector respectively. The parenthesis in the denominator of (17) is the difference in the factor intensity between the import sector and the traditional export sector. If the import sector is intensive in the second factor relative to the traditional export sector, it is positive. On the other hand, the parenthesis in numerator of (17) is the differences in the factor intensity between the new export sector and the import sector or traditional export sector. We introduce a following assumption:

Assumption 2. $\min\left[\frac{c_2^1}{c_1^1}, \frac{c_2^2}{c_1^2} \right] < \frac{c_2^0}{c_1^0} < \max\left[\frac{c_2^1}{c_1^1}, \frac{c_2^2}{c_1^2} \right]$.

Under the assumption 2, from (17), we obtain:

Result 2 $\frac{dw_0}{dp_1} = \frac{dy_1}{dx_0} < 0$ and $\frac{dw_0}{dp_2} = \frac{dy_2}{dx_0} < 0$.

The result 2 shows that if the factor intensity in the new export sector lies between the two previous sectors an acceptance of direct investment reduces the outputs of two previous sectors, increasing imports, tariff revenue and welfare. The assumption 2 is weaker than

the assumption 1 because we just require that the factor intensity of the second factor relative to the first factor in the new export sector lies between that of other two sectors. We do not need that all domestic factors move into the new export sector in equal proportion to the endowment of factors. If this assumption is satisfied, an acceptance of foreign capital reduces the outputs of two previous sectors, increasing tariff revenue and welfare. It is clear that the Result 2 shows up more sharply. It should also be noted that our result is optimistic and that our model is more general than that of Beladi and Marjit (1992), because both domestic factors are used in the new export sector.

7. Conclusions

This paper provided a model to consider the welfare effects of capital imports in a multi-dimensional framework and derived a sufficient condition for welfare enhancing direct investment. Our result is optimistic and contrary to the pessimistic conventional wisdom. Our model is based on the more general assumptions that the foreign capital is different from the domestic capital and all domestic factors are used in the new export sector. Under these assumptions, we showed that an acceptance of foreign capital not only increases welfare but also establishes a new export sector in developing countries. This paper also provided a three-commodity three-factor model and derived a weaker condition.

A number of topics suggest themselves for the further researches. First, the assumption 1 may be too strong. We provided two justifications. However a weaker assumption that reduces only the outputs of import sectors may be desirable. Also the assumption 1 should be examined empirically. Second, the level of technology in the previous sectors may change as the result of direct investment and the full repatriation of direct investment may not be

the case. Third, the assumptions such as perfect competition, perfect factor mobility and full employment may not be suitable for the developing countries. Fourth, the new export good may be consumed domestically. If this is the case, an increase in the variety of consumption may increase its welfare. The generalizations to these aspects are left for the further researches. In spite of these facts, contrary to the conventional wisdom, this paper provided a sufficient condition to justify the acceptance of direct investment in a multi-dimensional framework.

Appendix

In this appendix, we consider why the assumption 1

$$\frac{dx_0}{dx_{00}} \approx \alpha\bar{x} \qquad \text{(a0)}$$

holds in two cases: one is when the number of existing commodity n is equal to that of factor m and the other is when they are different.

Case 1. $n = m$

Denote the cost function of the new export sector by $c^0(w_0, w)y_0$, where y_0 is the output of that sector and w is the m dimensional vector of factor prices which is determined by

$$p_i = c^i(w_1,...,w_m), \quad i = 1,...,n.$$

Let $w(p)$ be the solution vector to this system of equations. Using this solution vector, we can write

$$p_0 = c^0(w_0, w(p)), \qquad \text{(a1)}$$

$$x_{00} = c_0^0(w_0, w(p))y_0, \qquad \text{(a2)}$$

$$x_0 = (c_1^0(w_0, w(p))y_0,...,c_m^0(w_0, w(p))y_0)^T. \qquad \text{(a3)}$$

The first equation determines w_0 as $w_0(p_0, p)$, and the rest of equations determine y_0 and x_0. Thus we see that

$$x_0 = \frac{x_{00}}{c_0^0(w_0(p_0, p), w(p))} (c_1^0(w_0(p_0, p), w(p)), ..., c_m^0(w_0(p_0, p), w(p)))^T .$$

Therefore, if the m-dimensional vector

$$(c_1^0(w_0(p_0, p), w(p)), ..., c_m^0(w_0(p_0, p), w(p)))^T$$

is proportional to $\bar{x}$, so is x_0, i.e., $x_0 \approx \alpha \bar{x} x_{00}$. In this case we have:

$$\frac{dx_0}{dx_{00}} \approx \alpha \bar{x} .$$

Case 2. $n \neq m$

In this case, $w(= F_x)$ generally depends not only on p but also on $\bar{x} - x_0$. Thus (a1) - (a3) can be rewritten as:

$$p_0 = c^0(w_0, w(p, \bar{x} - x_0)), \quad \text{(a4)}$$

$$x_{00} = c_0^0(w_0, w(p, \bar{x} - x_0)) y_0 , \quad \text{(a5)}$$

$$x_0 = (c_1^0(w_0, w(p, \bar{x} - x_0)) y_0, ..., c_m^0(w_0, w(p, \bar{x} - x_0)) y_0)^T . \quad \text{(a6)}$$

(a4) determines w_0 as $w_0(p_0, p, \bar{x} - x_0)$ for given p_0, p, and $\bar{x} - x_0$. Then from (a5), we can determine y_0. By the use of these, (a6) is written as:

$$x_0 = x_{00} H(p_0, p, \bar{x} - x_0), \quad \text{(a7)}$$

where, $H(p_0, p, \bar{x} - x_0) \equiv (H_1(p_0, p, \bar{x} - x_0), ..., H_m(p_0, p, \bar{x} - x_0))^T$

$$\equiv \left(\frac{c_1^0(w_0(p_0, p, \bar{x} - x_0), w(p, \bar{x} - x_0))}{c_0^0(w_0(p_0, p, \bar{x} - x_0), w(p, \bar{x} - x_0))}, ..., \frac{c_m^0(w_0(p_0, p, \bar{x} - x_0), w(p, \bar{x} - x_0))}{c_0^0(w_0(p_0, p, \bar{x} - x_0), w(p, \bar{x} - x_0))}\right)^T .$$

Totally differentiating (a7) with respect to x_0 and x_{00}, we obtain:

$$dx_0 = H(p_0, p, \bar{x} - x_0) dx_{00} + x_{00} \nabla [H(p_0, p, \bar{x} - x_0)] dx_0 ,$$

or

$$\frac{dx_0}{dx_{00}} = H(p_0, p, X) - x_{00}\nabla[H(p_0, p, X)]\frac{dx_0}{dx_{00}}, \qquad \text{(a8)}$$

where, $X \equiv (X_1,...,X_m)^T = (\bar{x}_1 - x_{10},...,\bar{x}_m - x_{m0})^T$ and

$$\nabla[H(p_0, p, X] \equiv \begin{bmatrix} \frac{\partial H_1(p_0, p, X)}{\partial X_1} & . \; . \; . & \frac{\partial H_1(p_0, p, X)}{\partial X_m} \\ . & . \; . \; . & . \\ . & . \; . \; . & . \\ . & . \; . \; . & . \\ \frac{\partial H_m(p_0, p, X)}{\partial X_1} & . \; . \; . & \frac{\partial H_m(p_0, p, X)}{\partial X_m} \end{bmatrix}.$$

From (a8), considering the definition of $H(\cdot)$, we have:

$$\frac{dx_0}{dx_{00}}\Big|_{x_{00}=0} = H(p_0, p, \bar{x} - x_0) =$$

$$\left(\frac{c_1^0(w_0(p_0, p, \bar{x} - x_0), w(p, \bar{x} - x_0))}{c_0^0(w_0(p_0, p, \bar{x} - x_0), w(p, \bar{x} - x_0))},...,\frac{c_m^0(w_0(p_0, p, \bar{x} - x_0), w(p, \bar{x} - x_0))}{c_0^0(w_0(p_0, p, \bar{x} - x_0), w(p, \bar{x} - x_0))}\right)^T. \qquad \text{(a9)}$$

Since our basic assumption is that the coefficient vector of the new export sector is approximately proportional to the endowment vector of the existing factors, i.e., since we assume:

$$\left(\frac{c_1^0(w_0(p_0, p, \bar{x}), w(p, \bar{x}))}{c_0^0(w_0(p_0, p, \bar{x}), w(p, \bar{x}))},...,\frac{c_m^0(w_0(p_0, p, \bar{x}), w(p, \bar{x}))}{c_0^0(w_0(p_0, p, \bar{x}), w(p, \bar{x}))}\right)^T \approx \alpha\bar{x}.$$

Thus we obtain (a0) as:

$$\frac{dx_0}{dx_{00}}\Big|_{x_{00}=0} \approx \alpha\bar{x}.$$

Footnotes

1. On the analysis of industrialization by the acceptance of foreign technology, see Chen and Shimomura(1998).

2. In what follows, each vector is a column vector. The superscript T implies the transpose of the vector.

3. x_{00} will come into this country as long as its marginal product is greater than that in the foreign country.

4. The movement of all domestic factors into the new export sector reduces the production of outputs of all previous sectors including imports, increasing the quantity of imports and welfare. Our model and assumptions come from the reflections of the conventional wisdom as well as the analyses of direct investment.

5. $G_{px_{00}}(p_0, p, \bar{x}, x_{00})^T = (\frac{dy_1}{dx_{00}}, \frac{dy_2}{dx_{00}}, ..., \frac{dy_n}{dx_{00}})^T$ is considered as a Rybczynski effect.

6. See, for example, Chang(1979) and Jones(1977).

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