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DUTY-FREE ZONE IN A HARRIS-TODARO ECONOMY: A NOTE

Manash Ranjan GUPTA*,[1]

Abstract: We consider a small open Harris-Todaro economy with the rural sector consisting of a 'Duty-Free Zone' and a 'Non-Duty Free Zone'. Capital is non-shiftable between the urban sector and the rural sector, but perfectly shiftable between the two sub-sectors of the rural sector. A policy of expanding the Duty-free Zone though the reduction in import-duty on the intermediate goods used in that sector affects unemployment and national income; and the nature of the effects depends on the relative capital-intensity of the two sub-sectors of the rural sector. We get the opposite results when the tariff on the final product is reduced.

1. INTRODUCTION

There has been a recent literature related to the effects of the expansion of the 'Duty-Free Zone' (DFZ) on the welfare of the host country. The pioneering paper is of Hamada (1974) and this uses a 2×2 Heckscher-Ohlin (H.O.) model. There are other papers using the H.O. frame work—for example—Rodriguez (1976), Hamilton and Svensson (1982), Young (1987), Beladi and Marjit (1992) etc.

However, a common motive for setting up a DFZ in a less developed economy is high domestic unemployment. Young and Miyagiwa (1987) (hereafter called YM) have made a theoretical analysis of the DFZ using the Harris–Todaro (1970) model. In this model, the DFZ is located in the rural sector and the wage-rate in the DFZ is identical to that in the agricultural sector.[1] Migration of labour takes place from the DFZ and the agricultural sector to the urban sector (which is a non-duty free manufacturing sector). Also capital is not shiftable from one sector to the other.[2] The expansion of the DFZ takes place through the reduction in

* Dept. of Economics, Jadavpur University, Calcutta–700 032, India.

[1] *Please communicate to*: Manash Ranjan Gupta, Arabinda Sarani, Basunagar, P. O. Madhyamgram, Dist. North 24–Parganas, West Bengal, India.

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1. We feel it an objectionable assumption, but do not replace it in this extension.

2. Perfect capital-mobility between the urban sector and the rural sector in the Harris-Todaro model has been considered by various authors. For example, see Corden and Findley (1975), Khan (1980), Batra and Naqvi (1987) etc.

import-duty on the intermediate goods used in the DFZ.[3] YM (1987) consider the effects of the expansion of the DFZ on the unemployment and welfare of the host country.

Once a DFZ is created in the rural area, it is expected to lead to a substantial flight of capital from agriculture to the DFZ and this should be considered while analysing the effects of the expansion of the DFZ. Rate of return to capital in the DFZ is expected to be higher and less uncertain than that in agriculture because the agricultural sector in a less developed economy generally suffers from the problems of production-uncertainties. There are interesting empirical findings related to this point in the case of Falta, (a duty-free Zone in West Bengal, India) which is located in the rural region. Agricultural investment in the villages near Falta is substantially lower than that in the other villages of West Bengal. Rates of interest in the informal credit market are also very high, and money-lending to the non-agriculturists is a very important side-business of the rich farmers in those villages. Capital non-shiftability between the DFZ and the agricultural sector is an inappropriate assumption in this case.[4] In the present paper, we extend the model of Young and Miyagiwa (1987) in this direction. We assume that capital is perfectly mobile between the DFZ and the agricultural sector, though do not introduce capitalmobility between the rural sector and the urban sector.

The model is described in Section 2 and the effects of the expansion of the DFZ are analysed in Section 3. The major results are the followings: The reduction in the import-duty on the intermediate goods used in the DFZ raises (lowers) unemployment if the DFZ is more (less) capital intensive than the agricultural sector. Also the effects on factor income remains indeterminate in either case. However, in YM (1987), this policy necessarily lowers unemployment and raises the factor income.

2. THE MODEL

We consider a small open economy with an urban sector and a rural sector. The rural sector is further divided into two sub-sectors—a Duty Free Zone (DFZ) producing a manufactured good and an agricultural-sector. The urban sector consists of only the non-duty free manufacturing sector. We first consider that there is no traiff on the imports of final goods; and hence prices of the final goods produced in those sectors are internationally given.

Both the manufacturing sectors, i.e., the urban sector and the DFZ in the rural sector use intermediate inputs which are imported. Per-unit requirement of the

3. The removal of tariff on the final goods was key feature in the analysis of Hamada (1974), Rodriguez (1976), Hamilton and Svensson (1982), Beladi and Marjit (1992), But Young (1987) and Young and Miyagiwa (1987) consider the reduction of tariff on the intermediate goods. Miyagiwa (1986) considers the expansion of the DFZ through the increase in export-subsidy.

4. For a detail analysis on this point, see Adhikari (1992).

intermediate input is assumed to be technological constants in both the sectors.[5] Tariffs are imposed on the imports of these intermediate goods. However, the tariff-rate in the case of rural manufacturing sector is far lower than that in the case of urban manufacturing sector. It is in this sense the rural manufacturing sector is called the 'Duty Free Zone'.[6] Expansion of the DFZ takes place through the reduction in the rate of tariff on intermediate imports in that sector.

In each of these sectors, capital and labour are the two primary inputs used as arguments in the production function. The net output is a linear homogenous function of capital and labour. All other standard neoclassical properties are satisfied by the production-function.

Wage-rate in the urban sector is institutionally fixed. But the wage-rates in the two sub-sectors of the rural sector are equal and perfectly flexible.

Total labour endowment of the economy is given and is normalized to unity. Rural labour force migrates to the urban sector and the rural-urban migration mechanism is of Harris–Todaro (1970) type.

There is no shiftability of capital between the urban sector and the rural sector. But there is perfect mobility of capital between the two sub-sectors of the rural area, i.e., the agricultural sector and the DFZ. This is a point that makes the present model different from the other models. Entry of foreign capital is allowed to the DFZ and the inflow of foreign capital is positively related to its rate of return. We also assume foreign capital and domestic capital to be perfectly substitutes.[7]

All the relevant markets are perfectly competitive and each representative firm maximizes profit.

Let 1, 2 and 3 stand for the urban sector, the DFZ and the agricultural sector respectively. Other notations consist of the followings:

P_i = World price of the product produced in the ith sector; $i=1, 2$ and 3.
m_i = Per-unit requirement of the intermediate input in the ith sector; $i=1, 2$.
f_i = Intensive production function in the ith sector.
Y_i = Level of gross output in the sector i.
Π_i = World price of the intermediate input used in the ith sector.
T_i = Specific tariff-rate on the imported intermediate input in the ith sector.
$X_i = P_i-(1+T_i)m_i\Pi_i$ = Value-added per unit in the ith sector; $i=1, 2$.
k_i = Capital-labour ratio in the sector i.
L_i = Level of employment in the sector i.
a_{L_i} = Per-unit labour requirement in the ith sector.
a_{k_i} = Per-unit capital-requirement in the ith sector.

5. This is a strong assumption. It rules out the possibility of change in the derived demand for the other factors of production through the change in import-duty on the intermediate product. The fall (rise) in the tariff-rate on the intermediate import, in this case, implies only a rise (fall) in the value-added per unit of the product. We shall justify the assumption in the concluding section in the context of the result available in the literature.

6. Strictly speaking, it is a low tariff Zone.

7. It is a simplifying assumption.

W = Institutionally fixed urban wage-rate.
V = Rural wage-rate.
q = Interest-rate in the urban sector.
r = Interest-rate in the rural sector.
L_u = Level of urban unemployment.
λ = (L_u/L_1) = Rate of urban unemployment with respect to urban employment.
$\bar{K}_R$ = Exogeneously given stock of domestic capital in the rural sector.
$\bar{K}_1$ = Exogeneously given stock of capital in the urban sector.
K_F = Supply of foreign-capital in the DFZ.
$\bar{L}$ = 1 = Given labour endowment in the economy.

The equational structure of the model is the following:

Perfect capital-mobility and labour mobility between the sector 2 and sector 3 gives us the same wage-rate, V, and the interest-rate, r. The competitive equilibrium conditions in these two product markets ensure the equality between price and unit cost. Hence, we have,

$$X_2 = a_{L_2} \cdot V + a_{K_2} \cdot r ; \tag{1}$$

and

$$P = a_{L_3} \cdot V + a_{K_3} \cdot r . \tag{2}$$

In the urban sector, the profit-maximizing conditions are the followings:

$$X_1(f_1(k_1) - f_1^1(k_1) \cdot k_1) = \bar{W}; \tag{3}$$

and

$$X_1 f_1^1(k_1) = q . \tag{4}$$

Level of employment in the urban sector is given by the following:

$$L_1 = (\bar{K}_1/k_1) . \tag{5}$$

Total labour endowment of the economy is normalized to unity. Hence,

$$L_1 + L_2 + L_3 + L_u = 1 . \tag{6}$$

The Harris–Todaro (1970) migration equilibrium condition in this case is given by the following:

$$\bar{W}L_1 = V(L_1 + L_u) . \tag{7}$$

Here $(L_1/(L_1 + L_u))$ is the probability of getting an urban job of the representative rural migrant and $(\bar{W}L_1/(L_1 + L_u))$ is his expected urban wage rate. Actual rural wage-rate is equal to the expected urban wage rate in the migration-equilibrium.

Equation (7) can be expressed in the following alternative form:

$$\lambda = (\bar{W}/V) - 1 \tag{7.1}$$

Using equations (6), (7.1) and (5), we have,

$$L_2+L_3=1-(\bar{W}/V)\cdot(\bar{K}_1/k_1)\,. \tag{8}$$

Supply of foreign-capital is a positive function of its rate of return. Hence

$$K_F=K_F(r) \quad \text{with} \quad K_F^1(r)>0\,. \tag{9}$$

Full-utilization of the capital-stock in the rural sector leads to the following equation:

$$L_2k_2+L_3k_2=K_R+K_F\,. \tag{10}$$

The production-function of the ith sector is given by the following:

$$(1-m_i)Y_i=f_i(k_i)L_i\,. \tag{11}$$

This completes the equational structure of the model. We now describe how the system works. Given X_1 and W, equation (3) determines R_1 and then equation (4) determines q. The value of L_1 is obtained from equation (5).

The two sector rural economy behaves like a Heckscher–Ohlin system. Input–output coefficients are functions of V and r. So given X_2 and P_3, equations (1) and (2) determine the values of V and r. Then equation (7.1) determines λ; and equation (9) determines K_F. Then the values of L_2 and L_3 are obtained solving equations (8) and (10) simultaneously. Ultimately the set of three equations shown by (11) determine the values Y_1, Y_2 and Y_3.

3. THE RESULTS

The input–output coefficients in the rural sector are chosen by minimizing unit cost in each sub-sector. Hence we have the following conditions:

$$V\cdot \mathrm{d}a_{L_2}+r\cdot \mathrm{d}a_{K_2}=0\,;$$

and

$$V\cdot \mathrm{d}a_{L_3}+r\cdot \mathrm{d}a_{K_3}=0\,.$$

So, the total differentials of the equations (1) and (2) are given by the followings:

$$\mathrm{d}X_2=a_{L_2}\cdot \mathrm{d}V+a_{K_2}\cdot \mathrm{d}r\,; \tag{12}$$

$$\mathrm{d}P_3=a_{L_3}\cdot \mathrm{d}V+a_{K_3}\cdot \mathrm{d}r\,. \tag{13}$$

Putting $\mathrm{d}P_3=0$, we find the followings:

$$(\mathrm{d}V/\mathrm{d}X_2)=\frac{a_{K_3}}{a_{L_2}\cdot a_{K_3}-a_{K_2}\cdot a_{L_3}}\,;$$

and

$$(\mathrm{d}r/\mathrm{d}X_2)=\frac{-a_{L_3}}{a_{L_2}\cdot a_{K_3}-a_{K_2}\cdot a_{L_3}}.$$

Hence,

$$(\mathrm{d}V/\mathrm{d}X_2)\gtrless 0 \qquad \text{if} \quad a_{L_2}\cdot a_{K_3}\gtrless a_{K_2}\cdot a_{L_3};$$

and

$$(\mathrm{d}r/\mathrm{d}X_2)\lesseqgtr 0 \qquad \text{if} \quad a_{L_2}\cdot a_{K_3}\gtrless a_{K_2}\cdot a_{L_3}.$$

Hence, $a_{L_2}\cdot a_{K_3}>(<)a_{K_2}\cdot a_{L_3}$ implies that the sector 2 is more labour (capital) intensive than the Sector 3. Note that

$$\mathrm{d}X_2=-\Pi_2\cdot m_2\mathrm{d}T_2.$$

Hence the expansion of the DFZ, i.e., Sector 2, through a reduction in T_2 implies a rise in X_2. This leads to the following proposition:

PROPOSITION 1. *The expansion of the DFZ through the reduction of import-duty on intermediate imports raises (lowers) the rural wage-rate and lowers (raises) the rural interest-rate if the DFZ is more labour (capital) intensive than the agricultural sector.*

This is basically a stolper-Samuelson theorem because the two-sector rural economy in this model behaves like a two-sector neo classical full-employment model.

Also note that

$$L_u=\lambda L_1.$$

Here L_1 is determined by equation (5) and hence is independent of X_2. But equation (7.1) shows that λ rises (falls) as V falls (rises). Now, using proposition 1, we can establish the next proposition.

PROPOSITION 2. *The expansion of the DFZ through the reduction in the tariff on intermediate imports lowers (raises) the urban unemployment if the DFZ is more labour (capital) intensive than the agricultural sector.*

In the model of YM (1987), the tariff-reduction on the imports of intermediate goods in the DFZ necessarily lowers the urban unemployment. However, in our model, the result is dependant on the relative capital-intensity of the DFZ and the agricultural sector.[8]

8. Dutta-Choudhuree and Adhikari (1992) consider capital-mobility between the urban sector and the agricultural sector. Their model is otherwise similar to the model of YM (1987) and hence does not consider capital shiftability between the agricultural sector and the DFZ, though the DFZ is located in the rural area. In the model of Dutta Choudhuree and Adhikari (1992) unemployment, L_u, may rise with the expansion of DFZ. But there does not change; and L_1 rises if the urban sector is more capital-intensive (in value terms) than the agricultural sector. Their result is independent of the capital-intensity of the DFZ.

The intuitive explanations behind the propositions 1 and 2 are as follows: The model has three distortions: (i) An institutionally fixed urban wage rate; (ii) A tariff on the intermediate good imported in the DFZ; and (iii) A tariff on the intermediate good imported in the urban manufacturing sector. Expansion of the DFZ is defined as the reduction of the second type of distortion. This raises the value-added per unit in the sector 2, i.e., the DFZ, over the unit cost (wage cost plus interest cost) in that sector which encourages additional production there. This raises (lowers) the demand for capital-labour ratio if the DFZ is relatively capital (labour) intensive to the agricultural sector. So the first round effect is a rise (fall) in the interest-rate at the given wage-rate. However, this raises (lowers) the unit cost in the agricultural sector. Since the price of the agricultural product remains unchanged, the second round effect is a fall (rise) in the wage-rate which reestablishes the equality between the price and unit cost in the agricultural sector.

Reduction of the second type of distortion now affects the rate of urban unemployment resulting from the first type of distortion. In the Harris-Todaro (1970)migration-equilibrium condition, expected urban wage rate is equal to the actual rural wage-rate. A rise (fall) in the rural wage-rate raises (lowers) the expected urban wage-rate. Since the actual urban wage-rate is fixed, probability of getting an urban job is increased (reduced). So the rate of urban unemployment, λ, is reduced (increased).

Note that the third type of distortion, i.e., the tariff on the intermediate good imported in the urban sector is not affected in this process.

The working is marginally different in YM (1987) where there is no capital mobility between the DFZ and agricultural sector. Reduction in tariff on the intermediate good in the DFZ raises the demand for labour. So the rural wage-rate rises and hence migration is discouraged. Relative capital-intensities of these two sectors have no role to play here because capital is sector-specific.

Now we analyse the effects of the expansion of the DFZ on the factor income, N_1, which is equal to the income earned by the factor-owners of the country. Here,

$$N_1 = \bar{W}L_1 + V(L_2 + L_3) + q \cdot \bar{K}_1 + r \cdot \bar{K}_R ;$$

and using equations (6) and (7) we have

$$N_1 = V + q \cdot \bar{K}_1 + r \cdot \bar{K}_R .$$

Note that a change in X_2 does not affect q. Hence,

$$(\mathrm{d}N_1/\mathrm{d}X_2) = (\mathrm{d}V/\mathrm{d}X_2) + \bar{K}_R(\mathrm{d}r/\mathrm{d}X_2) . \tag{16}$$

Using equation (13) and putting $\mathrm{d}P_3 = 0$, we have

$$\mathrm{d}V = -(a_{K_3}/a_{L_3})\mathrm{d}r . \tag{17}$$

Now using equations (16) and (17), we have,

$$(\mathrm{d}N_1/\mathrm{d}X_2) = (1 - \bar{K}_R \cdot (a_{L_3}/a_{K_3}))(\mathrm{d}V/\mathrm{d}X_2) . \tag{18}$$

Now using proposition 1, we can establish the following proposition:

PROPOSITION 3: (i) *Suppose that the DFZ is more labour intensive than the agricultural sector. Then the expansion of the DFZ raises (lowers) the factor income if the capital-labour ratio in the agricultural sector is greater (less) than the domestic capital-stock in the rural sector.* (ii) *Suppose that the DFZ is less labour intensive than the agricultural sector. Then the expansion of the DFZ raises (lowers) the factor income if the capital-labour ratio in the agricultural sector is less (greater) than the domestic capital Stock in the rural sector.*

So the expansion of the DFZ does not necessarily raise the factor income. But in YM (1987), it must raise the factor income.[9]

The intuitive explanation behind the proposition 3 is as follows. Here the total factor income consists of three components: (i) total wage income, (ii) total interest income in the urban sector, and (iii) total interest income in the rural sector. As the urban wage-rate is fixed, the urban interest-rate is also so in equilibrium; and hence, given the urban sector's capital stock, interest-income in the urban sector is independent of the expansion of the DFZ. In a Harris-Todaro model, average wage rate is always equal to the rural wage rate; and hence total wage-income is equal to the rural wage-rate multiplied by the level of labour-endowment of the economy. Expansion of the DFZ affects the rural wage-rate and the interest-rate. So the effect of the expansion of the DFZ on total factor income depends on its effects on rural wage-rate and interest-rate. As the price of the agricultural product remains unchanged, the magnitude of change in the interest-rate in the rural sector due to an unit change in the rural wage-rate (in the opposite direction) is determined by the capital-intensity of agricultural production. Labour endowment, of the economy is, by assumption; normalized to unity. So it is the relationship between the capital intensity of agricultural production and the total domestic capital-stock of the rural sector which ultimately determines whether an unit change in one factor price more than (or less than) offsets the consequent reverse change in the other factor price.

The mechanism is different in YM (1987) because of the assumption of capital-nonshiftability. The rural wage rate rises and the interest rate in agricultural sector is reduced. However, this raises the total wage income plus agricultural interest-income. Urban sector's interest income remains unchanged in equilibrium as the urban wage-rate is fixed. The interest-income in the DFZ is repatriated because the DFZ is operated by foreign-capital only. So the total factor income must rise.

We now establish another proposition whose mathematical derivations are given in the Appendix. The intuitive explanations are given below the proposition.

PROPOSITION 4. *The reduction in tariff on the imports of intermediate inputs in*

9. In the model of Dutta Choudhree and Adhikari (1992), the expansion of DFZ does not affect the factor inome.

the DFZ raises its level of output and lowers the agricultural output.

Suppose that the DFZ is more labour intensive than the agricultural sector. Then a rise in X_2 will raise V and lower r. Hence K_F will fall and this implies a reduction in the availability of capital-input for the rural sector. Similarly a rise in V implies a lower level of urban unemployment rate and hence a reduction in the urban-labour force. So the labour-availability for the rural sector goes up. Also with rise in V and fall in r, both the DFZ and the agricultural sector will shift towards more capital-intensive production. So k_1 and k_2 will rise. Now, in order to maintain the balance between the demand and availability of each factor-capital or labour, obviously the labour-intensive sector should expand and the capital-intensive sector should contract.

Similarly when the DFZ is more capital intensive than the agricultural sector, a rise in X_2 lowers V and raises r. So the entire system starts moving in the reverse direction and the ultimate result is the expansion of the capital-intensive sector.

This completes the intuitive explanation of the proposition 4; and we now consider the effect on the tariff-revenue of the government, N_2. Here,

$$N_2 = T_1 \cdot m_1 \Pi_1 Y_1 + T_2 \cdot m_2 \Pi_2 Y_2 .$$

A change in T_2 (implying an opposite change in X_2) does not affect, Y_1. Hence,

$$(\mathrm{d}N_2/\mathrm{d}T_2) = m_2\Pi_2 \cdot Y_2 + T_2 \cdot T_2 m_2 \Pi_2 \cdot (\mathrm{d}Y_2/\mathrm{d}X_2)(\mathrm{d}X_2/\mathrm{d}T_2) .$$

Here the first term stands for the loss of tariff-revenue at the initial volume of imports; and the second term represents the increase in the tariff-revenue due to increase in the volume of imports. A reduction in T_2 raises N_2 if the second term dominates the first term.

The effect on national income, denoted by N, is given by the following:

$$(\mathrm{d}N/\mathrm{d}T_2) = (\mathrm{d}N_1/\mathrm{d}T_2) + (\mathrm{d}N_2/\mathrm{d}T_2) .$$

In this model, even if $(\mathrm{d}N_2/\mathrm{d}T_2) < 0$, we may not get a negative $(\mathrm{d}N/\mathrm{d}T_2)$ because the first-term is not necessarily negative. (See the proposition 3). Hence, we can prove the following proposition.

PROPOSITION 5. *The expansion of the DFZ through the reduction in import-duties on the imports of intermediate goods does not necessarily raise the national income even if it raises the tariff-revenue.*

Such a possibility does not arise in the existing models. In YM (1987) such a policy, if it raises the tariff-revenue, must improve the national income. This is because the factor-income effect is always positive there.

There are three different income-groups in the working class in this model: (i) The workers in the urban sector earning the wage-rate, W; (ii) The rural workers earning the wage-rate, V; and (iii) the unemployed workers who do not earn anything. The relative frequency distribution of wage-income is given by the

following:

Wage-rate	:	W	V	0
Employment	:	L_1	(L_2+L_3)	L_u

The expansion of the DFZ does not affect W and L_1. If the DFZ is more labour-intensive than the agricultural sector, then a fall in T_2 (implying a rise in X_2) raises the rural wage-rate, V. So λ falls and hence, given L_1, $L_u=\lambda L_1$ falls. So (L_2+L_3) rises. So a part of the already unemployed labour force gets employment in the rural sector at a higher wage-rate. This must improve the income-distribution of the workers. The opposite result is obtained when the agricultural sector is more labour intensive. Hence, we can establish the following:

PROPOSITION 6. *If the DFZ is more (less) labour intensive than the agricultural sector, the reduction in tariff on intermediate imports in DFZ will improve (worsen) the income-distribution of the workers.*

In YM (1987), this inequality is necessarily reduced, though they do not make any formal analysis of this aspect.

4. CONCLUSION

In this paper we have followed the line adopted by YM (1987) and hence consider the location of the DFZ in the rural sector; and its expansion through the reduction in tariff on the imported intermediate goods used in that sector. The additional point we consider is the capital mobility between the DFZ and the NDFZ in the rural area. The validity of the YM (1987) results depends on the relative capital intensity of those two sectors. Our many results are opposite to those in YM (1987) when the DFZ is more capital-intensive than the agricultural sector—a case which is likely in a less developed country with a backward agriculture.

The alternative mode of expansion of the DFZ is the reduction of tariff on final goods and this was the key feature of the DFZ for the authors like Hamada (1974), Rodriguez (1976), Hamilton and Svensson (1982), Beladi and Marjit (1992) etc. We get the opposite results in our model when the tariff on final good produced in the DFZ is reduced. In this case, $T_i=0$ for $i=1, 2$ and 3; and $X_i=(1+t_i)P_i-m_i\Pi_i$ where t_i is the specific tariff-rate on the import of the ith final good. A fall in t_i implies a fall in X_i. So if the policy of expansion of the DFZ is adopted through the reduction in the tariff-rate on the import of the final-good produced in DFZ, then X_2 will fall and hence we get the opposite results. Unemployment as well as inequality is reduced when the DFZ is more capital-intensive (The effects on factor income and national income are indeterminate). So the relative capital-intensity of the DFZ and the agricultural sector and the mode of expansion of the DFZ are related issues to be considered in this model.

The location of the DFZ in the urban sector may also alter the results of a

model because then the DFZ is a labour-receiving sector (not a labour supplying sector). Since the unemployment is specific to the urban sector and is the result of the rural-urban migration, the effects of the expansion of the DFZ on unemployment can not be independent of whether the DFZ is located in the urban area or the rural area.

Lastly, we come to supply the weak excuse for the restrictive assumptions in our model. One such assumption is the technological constancy of the per-unit requirement of intermediate good in the DFZ. It rules out the possibility of substitution between the intermediate good and other inputs; and hence the substitution effect due to change in the tariff-rate. The fall in the tariff-rate on the imports of the intermediate good in this case implies a rise in the value-added per unit. But if we consider the possibility of substitution, then a fall in this tariff-rate raises m_2, (the per unit requirement of intermediate good in the DFZ); and the lowering of tariff will raise the value-added per unit only if the price-elasticity of demand for intermediate input is less than unity. This will also produce a lower loss of tariff revenue at the initial volume of imports than that with constant m_2. But the volume of import effect with variable m_2 may be higher or lower than that with constant m_2, because, though m_2 will rise, Y_2 rises by a smaller amount as the effect of a change in T_2 on X_2 is smaller in this case than the case with constant m_2.

Perfect substitution between domestic capital and foreign capital in the DFZ is another strong assumption; and this is stronger when the flow of foreign-capital is associated with an advanced level of technology. We make this assumption only from the view point of simplicity. If we allow imperfect substitution between foreign capital and domestic capital and introduce foreign capital as a third input in the production function of the DFZ, then we need to determine three factor prices in the rural sector which the price-subsystem of that sector can not do with only two equations.

APPENDIX

Here the mathematical proof of the proposition 4 is presented.

We consider the following equations:

$$L_2k_2 + L_3k_3 = \bar{K}_R + K_F(r)$$

$$L_2 + L_3 = 1 - (\bar{W}/V)(\bar{K}_1/k_1)$$

and the total differentials of this equations are given by the following:

$$(\mathrm{d}L_2/\mathrm{d}X_2)k_2 + (\mathrm{d}L_3/\mathrm{d}X_2)k_3 = A_1 \; ; \quad \text{and}$$

$$(\mathrm{d}L_2/\mathrm{d}X_2) + (\mathrm{d}L_3/\mathrm{d}X_2) = A_2$$

where,

$$A_1 = K_F^1(r) \cdot (\mathrm{d}r/\mathrm{d}X_2) - L_2(\mathrm{d}k_2/\mathrm{d}X_2) - L_3(\mathrm{d}k_3/\mathrm{d}X_2)\,; \quad \text{and}$$

$$A_2 = (\bar{K}_1/k_1)(\bar{W}/V_2)(\mathrm{d}V/\mathrm{d}X_2)\,.$$

When the sector 2 is more labour intensive, then

$$(\mathrm{d}V/\mathrm{d}X_2) > 0\,; \quad (\mathrm{d}r/\mathrm{d}X_2) < 0\,; \quad (\mathrm{d}k_2/\mathrm{d}X_2) > 0\,; \quad (\mathrm{d}k_3/\mathrm{d}X_2) > 0\,.$$

Hence, $A_1 < 0$ and $A_2 > 0$.

But when the sector 2 is more capital-intensive, then

$$(\mathrm{d}V/\mathrm{d}X_2) < 0\,; \quad (\mathrm{d}r/\mathrm{d}X_2) > 0\,; \quad (\mathrm{d}k_2/\mathrm{d}X_2) < 0\,; \quad (\mathrm{d}k_3/\mathrm{d}X_2) < 0\,.$$

Hence, $A_1 > 0$ and $A_2 < 0$.

Now,

$$(\mathrm{d}L_2/\mathrm{d}X_2) = \frac{A_1 - A_2 k_3}{K_2 - k_3}\,;$$

and

$$(\mathrm{d}L_3/\mathrm{d}X_2) = \frac{A_2 K_2 - A_1}{K_3 - k_3}$$

If $K_2 < K_3$, then $A_1 < 0$ and $A_2 > 0$. Hence,

$$(\mathrm{d}L_2/\mathrm{d}X_2) > 0 \quad \text{and} \quad (\mathrm{d}L_3/\mathrm{d}X_2) < 0\,.$$

If $K_2 > K_3$, then $A_1 > 0$ and $A_2 < 0$. Hence,

$$(\mathrm{d}L_2/\mathrm{d}X_2) > 0 \quad \text{and} \quad (\mathrm{d}L_3/\mathrm{d}X_2) < 0\,.$$

Jadavpur University

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