CHAPTER-5

TRADE LIBERALIZATION, ENVIRONMENTAL POLLUTION AND INFORMAL SECTOR: A THEORETICAL ANALYSIS

5.1 INTRODUCTION

5.2 THE MODEL

5.2.1 ASSUMPTIONS OF THE MODEL

5.2.2 NOTATIONS USED IN THE MODEL

5.2.3 THE EQUATIONAL STRUCTURE OF THE MODEL

5.3 IMPACT OF FALL IN TARIFF RATE OF THE IMPORT COMPETING MANUFACTURING SECTOR ON THE LEVEL OF OVERALL POLLUTION AND WELFARE OF THE ECONOMY

5.4 CONCLUDING REMARKS

APPENDICES
CHAPTER-5

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AND INFORMAL SECTOR: A THEORETICAL ANALYSIS#

5.1 INTRODUCTION

In the earlier two chapters we have linked two emerging problems of developing economies with that of informal sector. In chapter 3 we have linked informal sector with skilled-unskilled wage gap. In chapter 4 we have considered the problem of child labour which is highly linked with the existence of informal sector. The present chapter considers another important issue of developing economy that can be linked with the existence of informal sector. It focuses on the importance of informal sector in the context of the impact of trade liberalization on domestic environmental pollution.

Pollution control is one of the most important issues of concern among all the policy makers of developing economies in recent years. The environmentalists are very much concerned about the state of natural environment in developing economies under the trade liberalization regime. As trade liberalization leads to economic growth of the economy which again leads to increase in consumption demand, population size (due to a lower death rate) and high standard of living, we find that more environmental discharges are generated causing greater pollution. Thus, the environmentalists have argued that any gains from trade liberalization would be substantially outweighed by the damage it would do to the environment through pollution. In the trade and environment literature, there are many theoretical as well as empirical works that deals with various issues related to emerging problems of developing economies in the context of trade liberalization and environmental pollution. But in most of the works the role of informal sector in the context of trade liberalization and environmental pollution has been ignored. It is to be

# The present chapter has been modified on the basis of suggestions of an anonymous referee on a paper related to this chapter submitted by me to an International Journal. The paper is at present under revision.
noted that in developing economies the persistence of informal sector is quite extensive and moreover empirical evidences suggest that a major part of total pollution in a developing economy occurs in the informal sector of the economy\textsuperscript{61}, which produces intermediate product for the formal sector of the economy on a subcontracting basis\textsuperscript{62}.

The main motivation behind this chapter is to provide a theoretical structure in the context of developing economies which can explain the role of trade liberalization on economy's environmental pollution in the presence of informal sector. The presence of informal sector influences the conventional outcome of trade liberalization, according to which the level of welfare of the economy improves while the level of pollution increases due to trade liberalization. However, the results are also affected by the nature of liberalization policies which are adopted by the economy. Thus, it can be said that World Trade Organization (WTO) prescription, according to which trade liberalization leads to welfare improvement, may not always hold good.

In the literature we find most of the works regarding informal sector have been carried out in a HT framework\textsuperscript{63}. But in recent years the HT (1970) framework has been criticized, which have been already mentioned in the earlier chapters and so in order to overcome the limitations, few studies have been carried out in a neo-classical full-employment framework. Important works in this line are by Marjit, Broll and Sengupta (1997), Acharyya and Marjit (2000), Chaudhuri and Mukherjee (2002) etc. Among the above mentioned works Chaudhuri and Mukherjee (2002) have introduced the wage efficiency function, where the efficiency of a worker is a positive function of the wage rate (and therefore the level of consumption) he receives. They have borrowed this idea from Wage Efficiency Hypothesis \textsuperscript{64}(WEH) which has been developed by

\textsuperscript{61} See for example Joshi and Joshi (1976), Bose (1978), Papola (1981) and Romatet (1983).
\textsuperscript{62} The formal sector firms in the developing countries actually subcontract the informal sector firms to undertake a number of processes and activities that are 'dirty' from the environment point of view.
\textsuperscript{63} See the work of Harris and Todaro (1970).
\textsuperscript{64} The validity of the Wage Efficiency Hypothesis (WEH) in a static general equilibrium set up is subject to a lot of criticisms, since it assumes an instantaneous relationship between wage income (and hence consumption) and the efficiency of workers. But in a developing economy where the majority of the workforce lives below the poverty line, and earns close to minimum subsistence level, there must be some impact of changes in labour income on their efficiency in the same time period. So in such a situation, WEH remain valid.
Leibenstein (1957) and Mirrless (1975).

In this chapter, we have further extended the WEH in an otherwise simple general equilibrium framework, which is basically an extension of the work of Jones (1965). Instead of wage efficiency we have considered nutritional efficiency of workers in this chapter. We have considered that the nutritional efficiency level of a worker is affected by the level of pollution prevailing in the economy. This is because pollution has an adverse effect on the health of a worker which in turn affects his efficiency level. In other words, the environmental aspect has been linked with the nutritional efficiency function in our work, which was missing in Chaudhuri and Mukherjee's (2002) work. Moreover our model differs from that of Chaudhuri and Mukherjee (2002) in many other aspects also. We have considered a four- sector model without any specific primary factor while Chaudhuri and Mukherjee (2002) have considered a three-sector model with specific as well as mobile factors. In our model, the informal sector produces an intermediate product while in Chaudhuri and Mukherjee (2002) model the informal sector produces only a final product.

Within this framework we have tried to analyze the impact of liberalization i.e. by reducing the tariff imposed on the import-competing formal manufacturing sector, on the level of output of the informal sector as well as on the level of overall pollution of the economy. We also try to examine the impact of this tariff reduction on the level of national income of the economy.

The important results of this chapter can be summarized in the following manner: In this model, we find that trade liberalization in the form of reduction of tariff rate of the import-competing formal manufacturing sector leads to a decrease in the level of output of the informal sector and also the level of overall pollution of the economy, under some reasonable assumptions. However, in the presence of negligible wage inequality among

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65 Empirical evidence suggests that the informal sector units mostly produce intermediate inputs for the formal sector. See, for example, Joshi and Joshi (1976), Papola (1981) and Romatet (1983).
all the sectors of the economy and also under some reasonable assumptions, the level of 
NI of the economy increases due to trade liberalization policy.

The layout of the chapter is as follows: The model is developed in Section 5.2 of the 
chapter. Section 5.3 examines the comparative static results. Finally, the concluding 
remarks are made in Section 5.4.

5.2 THE MODEL

5.2.1 ASSUMPTIONS OF THE MODEL

A small open economy has been considered which is basically classified into the 
aricultural (rural) sector ‘x’, the formal manufacturing sector ‘y’ and the informal sector 
‘z’. The formal manufacturing sector is further subdivided into two sub sectors- ‘y1’ and 
‘y2’. The formal manufacturing sectors and the agricultural sector produces final product 
but the informal sector produces an intermediate good for the formal manufacturing 
sector ‘y2’ on a sub contracting basis. Sector ‘y2’ is the import-competing sector and so is 
protected by tariff, whereas the formal manufacturing sector ‘y1’ and the agricultural 
sector ‘x’ produce exportable products. The formal manufacturing sectors ‘y1’ 
and ‘y2’ have access to formal capital market. Thus formal capital is perfectly mobile 
between sectors ‘y1’ and ‘y2’ while informal capital is perfectly mobile between the other 
two sectors ‘x’ and ‘z’. Sector ‘y1’, thus uses formal capital and labour to produce its 
product whereas sector ‘y2’, apart from capital and labour, uses the product of informal 
sector as an intermediate input to produce its product. As the product of sector ‘z’ is fully 
utilized as an intermediate product by sector ‘y2’, it is internationally non- traded and its 
price is determined within the economy. Sector ‘y2’ uses the product of sector ‘z’ on the 
basis of a fixed input-output ratio, otherwise for all the other input use by various

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66 It is quite relevant in developing economies like India, which export software or other highly capital-intensive manufacturing products on the one hand and also exports agricultural products on the other hand. It shows the diversification of the export basket of developing economies.

67 It implies that the input output coefficient a_{202} is fixed. It has already been explained in footnote no 37.
sectors we have a variable-coefficient type of technology. Both sector ‘x’ and sector ‘z’ use informal capital and labour to produce their respective products.

The wage rate of the workers of sectors ‘x’ and ‘z’ is given by $W$, which is referred as the wage rate for the poorer section of the work force and can be referred to as the economy’s basic wage rate. As the sectors ‘$y_1$’ and ‘$y_2$’ are the formal sectors of the economy, there exists effective wage legislation and unionization of labour due to which the wage rate of the workers of this sector, $\bar{W}$, is given exogenously and is much higher than the wage rate of the workers employed in the other two sectors of the economy, $W$.

In a developing economy like India where majority of the labour force lives below the poverty line, the role of nutritional efficiency of the work force is very important. Here in this model, we have considered that the nutritional efficiency of the worker is a decreasing function of the economy’s environmental pollution. In fact for such an economy, one can assume that all the workers possess identical efficiency function so that the labour endowment can be measured in efficiency unit.

We have the usual assumptions of a neo-classical general equilibrium model like CRS production function for each sector and competitive market conditions. The small open economy assumption implies that the prices of the traded goods of the formal manufacturing sectors and the agricultural sector are given internationally. Since the informal sector product is a non-traded good, its price is endogenously determined by the demand supply mechanism. The product of the agricultural sector is considered as the numeraire and its price is set equal to unity.

5.2.2 NOTATIONS USED IN THE MODEL

Let $x$ and $z$ stand for the agricultural sector and the informal sector of the economy respectively. The formal manufacturing sector of the economy is subdivided into two sub sectors $y_1$ and $y_2$ respectively. Other notations can be stated as follows for $i=x, y_1, y_2$ and $z$. 
\[ P_i \] - world price for the product of the \( i^{th} \) sector, \( i-x, y_1 \) and \( y_2 \).

\[ p_z \] - domestically determined price for the sector \( z \).

\[ t_z \] - ad-valorem tariff rate on the product of sector \( y_2 \).

\[ P_{y2}(1+t_z) \] - domestic (tariff inclusive) price of the product of sector \( y_2 \).

\[ a_{ij} \] - quantity of the \( i^{th} \) input required for the production of one unit of output of the \( j^{th} \) sector, \( i-L, K \) and \( z \) and \( j-x, y_1, y_2 \) and \( z \), where \( K \) implies capital, formal or informal and \( Z \) implies the intermediate product produced by informal sector.

\[ W \] - wage rate of the workers in sectors \( x \) and \( z \).

\[ \bar{W} \] - wage rate of the workers in sectors \( y_1 \) and \( y_2 \).

\[ r \] - rate of return on formal capital.

\[ r_i \] - rate of return on informal capital.

\[ L \] - total labour endowment in physical units.

\[ K \] - total formal capital endowment.

\[ K_i \] - total informal capital endowment.

\[ \Omega \] - maximum allowable level of pollution of the economy.

\[ Q \] - total pollution of the economy.

\[ \alpha_j \] - emission coefficient of the \( j^{th} \) sector, for \( i-x, y_1, y_2 \) and \( z \).

\[ \Omega_w \] - pollution generated from the combined wastes of sectors \( y_1 \) and \( y_2 \).

\[ h(.) \] - nutritional efficiency function of a representative worker.

### 5.2.3 THE EQUATIONAL STRUCTURE OF THE MODEL

The competitive equilibrium conditions for the four sectors are given by the following equations:

\[ l = a_{Lx} W + a_{Kx} r_i \] \hspace{2cm} (5.1)

\[ P_{y_1} = a_{L_{y1}} \bar{W} + a_{K_{y1}} r \] \hspace{2cm} (5.2)

\[ P_{y_2}(1+t_2) = a_{L_{y2}} \bar{W} + a_{K_{y2}} r + a_{z_{y2}} P_z \] \hspace{2cm} (5.3)

\[ P_z = a_{Lz} W + a_{Kz} r_i \] \hspace{2cm} (5.4)
Mobility of formal capital between the two formal sectors is given by
\[ a_{K1}Y_1 + a_{K2}Y_2 = K \] (5.5)

Mobility of informal capital between the agricultural sector and the informal sector is given by
\[ a_{Kix}X + a_{Kiz}Z = K_i \] (5.6)

Equations (5.5) and (5.6) imply that there exists full employment in the formal and informal capital markets.

The fact that the informal sector's product is fully utilized to produce the product of sector 'y2' is given by
\[ Z = a_{z2}Y_2 \] (5.7)

We now focus on the pollution part of our model. For simplicity we have assumed in this chapter that the environmental pollution occurs only through production of goods of the various sectors. Thus the pollution emission by each sector is assumed to be proportional to the output of the particular sector. Let \( Q \) be the level of pollution generated in the economy and let \( \Omega \) (exogenously given) be the maximum permissible level of pollution generated by the pollutants for any formal manufacturing sector producing unit in the economy. We assume that, in order to avoid penalties the formal sector industries will never exceed their levels of pollution emission beyond the maximum allowable level. We thus write
\[ \alpha_{x1}Y_1 + \alpha_{x2}Y_2 + \Omega_w = \Omega \] (5.8)

where, as mentioned earlier, \( \Omega_w \) is the pollution generated from the combined wastes of the two formal manufacturing sectors. This is of course other than the direct emission of pollutants by each of the two formal manufacturing sectors. Empirically we find that the formal manufacturing sectors are normally located in the urban area, so \( \Omega_w \) can be interpreted as the pollution from urban sewage generated from the combined effect of the polluting activities of the two formal manufacturing sectors.
It is to be noted in this connection that it is not possible to control the pollution emission generated from both the agricultural sector and the informal sector. Thus, the level of total pollution in the economy is

\[
Q = \alpha_{y_1} Y_1 + \alpha_{y_2} Y_2 + \Omega_w + \alpha_x X + \alpha_z Z
\]

or, \( Q = \Omega + \alpha_x X + \alpha_z Z \) (5.9)

This is because the total emission generated by sectors \( 'y_1' \) and \( 'y_2' \) sum up to \( \Omega \). It is to be noted that, as also mentioned earlier, \( \alpha_x \) and \( \alpha_z \) are the emission coefficients of sectors \( 'x' \) and \( 'z' \).

The nutritional efficiency function of the representative worker is given by

\[
h = h(Q) \quad (5.10)
\]

where \((\delta h/ \delta Q) < 0\)

We know that pollution affects the nutritional efficiency of the worker by affecting his/her physical and mental health. Thus the level of nutritional efficiency is a decreasing function of pollution.

Allocation of the work force among the four sectors (when labour endowment is expressed in efficiency unit) can be expressed as follows

\[
a_{L_1} Y_1 + a_{L_2} Y_2 + a_{L_X} X + a_{L_Z} Z = L h \quad (5.11)
\]

In this model, we have eleven equations with eleven endogenous variables: \( w, r, r_1, P_2, X, Y_1, Y_2, Z, h, \Omega_w \) and \( Q \). Thus the system is determinable.

The working of the model is simple. From equation (5.2), we can solve for \( r \), when \( P_{y_1} \) is given due to small open economy assumption and as \( \overline{W} \) is given exogenously. Once \( r \) is known, we can solve for \( P_z \) from equation (5.3), given \( P_{y_2} \). From equations (5.1) and (5.4), thus \( r_1 \) and \( W \) can be determined, once the value of \( P_z \) is known. Using equation (5.5) we can express \( Y_1 \) in terms of \( Y_2 \). Again using equation (5.7) we can express \( Y_2 \) in terms of \( Z \). Thus the LHS of equation (5.11) can be expressed only in terms of \( X \) and \( Z \).
The RHS of equation (5.11) is a function of $Q$ which in turn is a function of $X$ and $Z$. Thus, the modified form of equation (5.11) is a function of only $X$ and $Z$. Using equation (5.6) and the modified form of equation (5.11), we can solve for $X$ and $Z$ simultaneously. Once the value of $Z$ is known, we can solve for $Y_2$ with the help of equation (5.7) and then we can solve for $Y_1$ with the help of equation (5.5). Using the values of $Y_1$ and $Y_2$, we can solve for $\Omega_{k_t}$ from equation (5.8). Again, using the values of $X$ and $Z$, the value of $Q$ can be determined from equation (5.9). Finally, using the value of $Q$, $h$ can be determined with the help of equation (5.10).

5.3 THE COMPARATIVE STATIC EFFECTS

In this section we want to examine the impact of trade liberalization, in the form of reduction of protection of the import-competing formal manufacturing sector, on the level of output of the informal sector and also on the level of urban pollution of the economy as a whole. We also examine the impact of liberalization on the level of national income of the economy.

Differentiating equations (5.6) and (5.11) with respect to $t_2$, after some mathematical manipulation (for detailed derivation see the subsection 5.1 in appendix 5), we get

$$a_{KX}(dX/dt_2)+a_{KZ}(dZ/dt_2)=-X(da_{KX}/dt_2)+Z(da_{KZ}/dt_2)$$

and

$$A=(a_{LY1}/a_{KX1})$$

$$B=\left(\left(\frac{a_{LY2}}{a_{KY2}}\right)-\left(\frac{a_{LY1}}{a_{KY1}}\right)\right)\frac{a_{KX2}}{a_{Z2}}+a_{LX}$$

where $A= (a_{LY1}/a_{KX1})$ and

$$B=\left(\left(\frac{a_{LY2}}{a_{KY2}}\right)-\left(\frac{a_{LY1}}{a_{KY1}}\right)\right)\frac{a_{KX2}}{a_{Z2}}+a_{LX}$$

Since all the input-output coefficients are positive and under the sufficient condition we get $(a_{KX1}/a_{LY1})>(a_{KX2}/a_{LY2})$, therefore we get $A>0$ and $B>0$. The condition $(a_{KX1}/a_{LY1})>(a_{KX2}/a_{LY2})$ implies that sector ‘$Y_1$’ is more capital-intensive than sector ‘$Y_2$’.

68 This may be due to the fact that sector ‘$Y_2$’ depends on intermediate products (produced by informal sector) apart from capital and labour as inputs whereas sector ‘$Y_1$’ depends on capital and labour as inputs.
Solving equations (5.6.1) and (5.11.2) by Cramer’s rule we get

\[
\frac{dX}{dt} = \frac{\{H (B-h' L a_x) - G (a_{K1z})\}}{\Delta}
\]

and

\[
\frac{dZ}{dt} = \frac{\{a_{K1x} G - H a_{Lx} + L h' a_x H\}}{\Delta}
\]

where

\[
H = - \{X (da_{K1x}/dt_d) + Z (da_{K1z}/dt_d)\}, \quad G = - \{K (dA/dt_d) + Z (dB/dt_d) + X (da_{Ld}/dt_d)\}
\]

\[
\Delta = a_{K1x} (B-h'L a_x) - a_{K1z} (a_{Lx} - h' L a_x)
\]

\[
= \left[ \frac{a_{K1x}}{a_{K1y}} \left( a_{Ly2} / a_{Zy2} \right) - \frac{a_{K1y}}{a_{K1z}} (a_{K1z} a_{Ly2} / a_{Zy2} + a_{Lz}) - a_{K1x} h'L a_x - a_{K1z} a_{Lx} + a_{K1z} h' L a_x \right]
\]

\[
= \frac{\left( a_{K1x} / a_{Lx} \right) \left( a_{K1z} / a_{Lz} \right) + \left( a_{Kx} / a_{Zy2} \right) (a_{Ly2} / a_{K1y}) \left( a_{K1y} / a_{Lz} \right) - \left( a_{K1z} / a_{Lz} \right) \right) + h' \left( a_{K1z} / a_{K1x} \right) \left( a_{K1x} / a_{Lx} \right)
\]

Under sufficient conditions, \(a_{K1y} / a_{Ly1} > a_{K1y} / a_{Ly2}, a_{K1x} / a_{Lx} < a_{K1z} / a_{Lz}\) and
\(a_{K1z} / a_{K1x} < a_{K1x} / a_{Lx}\), we find that \(\Delta > 0\) (see the appendix 5, subsection 5.1 for details).

The first two conditions imply respectively that sector ‘y1’ is more capital intensive as compared to that of sector ‘y2’ and on the other hand sector ‘x’ is more capital intensive as compared to sector ‘z’. The last conditions may seem a bit counter intuitive. This assumption seems plausible in a developing economy like India where the agricultural sector is highly mechanized\(^{69}\) whereas the informal sector plays the role of labour absorbing sector. So we would expect \(a_{K1z} / a_{Ld} < a_{K1x} / a_{Lx}\) and also the value of \(a_{K1z} / a_{K1x}\) to be very low. Again in such an economy, where the informal sector product is used by formal sector on a subcontracting basis, the formal sector tries to shift the hazards of environmental ‘dirty’ activities in the production process to the informal sector. As a result the pollution emission coefficient of the informal sector, \(a_z\), is expected to be very high as compared to the pollution emission coefficient of the agricultural sector which carries out only agricultural activities, \(a_x\). It implies that the value of \(a_z / a_x\) is expected to be quite high. Under this situation the third condition also seems plausible.

\(^{69}\)In the Punjab area of India, where the agricultural sector has already experienced mechanization in the form of Green Revolution, this assumption is quite reasonable. It has also been assumed in chapters 3 and 4 of this thesis.
A fall in the tariff rate, $t_2$, causes the price of the informal sector product, $P_z$, to decrease (from equation (5.3)), to maintain zero profit condition, as $P_{y2}$ and $\bar{W}$ are given exogenously and $r$ is predetermined from equation (5.2). Again, the fall in $P_z$ creates a Stolper-Samuelson effect\textsuperscript{70}, due to which the $W$ decreases and $r_1$ increases, as it has been already assumed that the rural sector is more capital intensive as compared to that of the informal sector. Decrease in $W$ and an increase in $r_1$ causes $a_{l_x}$ and $a_{l_z}$ to increase, i.e. $(da_{l_x}/dt_2)<0$ and $(da_{l_z}/dt_2)<0$, whereas $a_{K_{l_x}}$ and $a_{K_{l_z}}$ to decrease, which implies $(da_{K_{l_x}}/dt_2)>0$ and $(da_{K_{l_z}}/dt_2)>0$
\[\therefore H<0\]

As $r$ remains unchanged and $P_z$ decreases\textsuperscript{71}, we get
\[ (da_{K_{y_1}}/dt_2)=0, (da_{K_{y_2}}/dt_2)>0, (da_{l_{y_1}}/dt_2)=0 \text{ and } (da_{l_{y_2}}/dt_2)<0 \]
Moreover, we already know that $(da_{l_x}/dt_2)<0$.
Therefore, we get $(dA/dt_2)=0$, $(dB/dt_2)<0$ (the fact that $(dB/dt_2)<0$ is shown in appendix 5, subsection 5.1)
\[ \therefore G>0 \]

Since $H<0$, $G>0$ and $\Delta>0$, we can conclude that $(dX/dt_2)<0$ and $(dZ/dt_2)>0$.

An increase in the levels of $a_{l_x}$ and $a_{l_z}$ implies an increase in unit demand for labour whereas a decrease in the levels of $a_{K_{l_x}}$ and $a_{K_{l_z}}$ implies a decrease in unit demand for informal capital, at the initial equilibrium levels of $X$ and $Z$. Hence effectively there is a shortage of labour and an excess supply of informal capital in the economy, which leads

\textsuperscript{70} Stolper-Samuelson effect can be analyzed for sectors even for a closed economy. Here our economy is not closed but the price of informal sector's product is determined domestically. Hence the Stolper-Samuelson effect can be analyzed. It can also be checked mathematically. See Batra (1973).

\textsuperscript{71} We know that the unit demand functions are as $a_{K_{y_1}} = a_{K_{y_1}}(\bar{W}/r)$ and $a_{K_{y_2}} = a_{K_{y_2}}(1, \bar{W}/r, P_z/r)$.

As $r$ remain unchanged and $P_z$ decreases, $(\bar{W}/r)$ remains constant and $(P_z/r)$ decreases. So the demand for capital for the producers of sector ‘$y_1$’ does not change. But in case of sector ‘$y_2$’, as $(P_z/r)$ decreases, the demand for intermediate good increases. Due to the assumption of fixed input-output coefficient $a_{y_2b}$, the unit demand for intermediate product by sector ‘$y_2$’ remains unchanged. This in turn decreases the unit demand for capital in sector ‘$y_2$’ as $(P_z/r)$ falls means $(r/P_z)$ increases.
to the 'Rybczynski type effect'\textsuperscript{72}. Under the assumption that the rural sector is more capital intensive than the informal sector, we find that the level of output of sector 'z' decreases whereas the level of output of sector 'x' increases. Again, with decrease in output of the informal sector, 'z', the level of output of sector 'y\textsubscript{2}' decreases\textsuperscript{73}.

It is already seen that with the fall in \( t\textsubscript{2} \), \((dK\textsubscript{y\textsubscript{2}}/dt\textsubscript{2})>0\), \((dK\textsubscript{y\textsubscript{1}}/dt\textsubscript{2})=0\). Thus, \((dY\textsubscript{2}/dt\textsubscript{2})>0\) (from equation (5.7)), therefore from equation (5.5), it can be concluded that \((dY\textsubscript{1}/dt\textsubscript{2})<0\) (as formal capital endowment is given exogenously) in order to maintain formal capital market equilibrium condition.

We now consider the impact of change in \( t\textsubscript{2} \) on the level of pollution generated by the informal sector of the economy, which is given by

\[
(\alpha\textsubscript{z} (dZ/dh))
\]

where \( \alpha\textsubscript{z} \) is the pollution emission coefficient of the informal sector.

\[
\therefore (dZ/dt\textsubscript{2})>0, \text{ therefore } \alpha\textsubscript{z} (dZ/dt\textsubscript{2})>0.
\]

This establishes the following proposition.

\textbf{Proposition 5.1:} Trade liberalization in the form of reduction of protection of the import-competing formal manufacturing sector 'y\textsubscript{2}' leads to a decrease in the level of output of the informal sector of the economy, under some reasonable conditions. It also reduces the amount of pollution generated by this sector of the economy.

We now consider the impact of change in \( t\textsubscript{2} \) on the level of overall pollution of the economy, which is given as

\[
(dQ/dt\textsubscript{2})=(d\Omega/dt\textsubscript{2})+\alpha\textsubscript{x}(dX/dt\textsubscript{2})+\alpha\textsubscript{z}(dZ/dt\textsubscript{2})
\]

(5.9.1)

Since the maximum allowable level of pollution of the economy is fixed exogenously, we find \((d\Omega/dt\textsubscript{2}) = 0\).

\textsuperscript{72} It is not the Rybczynski effect in the true sense because there is no change in factor endowments. However effectively the effects are similar to that of Rybczynski effect. For example, excess supply of labour has the effects that are similar to that of an increase in labour endowment. See Chaudhuri and Mukherjee (2002) in this context.

\textsuperscript{73} Since \( a\textsubscript{z\textsubscript{2}} \) is fixed, therefore decrease in \( Z \) implies an decrease in \( Y\textsubscript{2} \).
In today's world, social planners are mainly concerned with urban pollution i.e. the pollutants causing air pollution, heavy metals, toxic intensity etc. which is more prevalent in informal sectors of the economy, where the 'dirty activities' of the production process are carried out. Empirically it is observed that most of the informal manufacturing units are located in the urban area. Thus in case of urban pollution, one may expect the emission coefficient of informal sector is much higher compared to that of rural sector. In other words, one can expect the emission coefficient of rural sector is negligible, when one is mainly concerned with air pollution i.e. \( \alpha_x \approx 0 \)

\[ \therefore \alpha_x \left( \frac{dX}{dt_2} \right) \approx 0 \]

Taking this into consideration, equation (5.9.1) can be rewritten as

\[ (\frac{dQ}{dt_2}) = \alpha_z \left( \frac{dZ}{dt_2} \right) \]

\[ \therefore \left( \frac{dZ}{dt_2} \right) > 0 \]

\[ \therefore (\frac{dQ}{dt_2}) > 0 \] (detailed derivations are available in section 5.2 of appendix 5)

We now turn to the economic interpretation of the results. We have already explained earlier that as a result of a reduction in the protection to the import-competing formal manufacturing sector \( \gamma_2 \), the informal sector \( z \) contracts and the agricultural sector, \( x \) expands due to 'Rybczynski type effect'. This in turn causes the pollution emitted by the informal sector to decrease and the pollution emitted by the agricultural sector to increase. If we focus mainly on air pollution (or any other type of urban pollution) the emission rate of the agricultural sector, \( \alpha_x \), is negligible, as compared to that of the informal sector, \( \alpha_z \), and the overall impact of fall in \( t_2 \) on the level of pollution of the economy is positive implying that it falls due to fall in \( t_2 \). However, this effect is the primary effect which generates another secondary effect. The decreased level of overall pollution of the economy has a positive impact on the nutritional efficiency of workers. Thus, the effective labour endowment (measured in efficiency units) of the economy

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74 However in case of the water pollution, one may expect that the emission coefficient of rural sector is much higher in comparison to that of the informal sector.
increases which again creates a secondary 'Rybczynski effect' on the level of output of sectors ‘x’ and ‘z’. As the informal sector, ‘z’ is more labour intensive as compared to that of the agricultural (rural) sector, ‘x’, sector ‘z’ expands while sector ‘x’ contracts due to increase in effective labour endowment. Thus, the secondary ‘Rybczynski effect’ creates an opposite impact on the level of pollution of the economy. However, here we find that ultimately the former effect dominates the latter under some reasonable conditions, so that the level of output of sector ‘z’ falls and that of the sector ‘x’ increases. These conditions are given by \((a_{K_{y1}}/a_{L_{y1}}) > (a_{K_{y2}}/a_{L_{y2}}), (a_{K_{z}}/a_{L_{z}}) < (a_{K_{x}}/a_{L_{x}})\) and \((a_{K_{z}}/a_{K_{x}}) < (\alpha_z/ \alpha_x)\) and as we have already interpreted them we are not repeating the interpretations here.

Thus, in case of urban pollution when \(\alpha_x\) is close to zero and \(\alpha_z\) is high, for given \(\Omega\), we find that the decrease in output and hence decrease in emission of sector ‘z’, given by \(\alpha_z Z\), leads to a decrease in overall pollution of the economy.

We thus have the following proposition

**Proposition 5.2:** Trade liberalization in the form of reduction of tariff imposed on the import-competing formal manufacturing sector ‘\(Y_2\)’ leads to a reduction in the level of overall urban pollution of the economy, if one takes various forms of urban pollution into consideration and if the primary effect of fall in \(t_2\) is much stronger than the secondary effect of it.

Finally, we would like to examine the impact of fall in \(t_2\) on the level of NI of the economy. For this we write NI as

\[
U = \bar{W} (\{h(Q)L - (a_{L_x}X + a_{L_z}Z)\} + (W)(a_{L_x}X + a_{L_z}Z) + rK + r_1K_1 - P_{y2}t_2 Y_2
\]

or
\[
U = \bar{W} L h(Q) + (W - \bar{W})(a_{L_x}X + a_{L_z}Z) + rK + r_1K_1 - P_{y2}t_2 Y_2
\]

(5.12)

In equation (5.12) \(P_{y2}t_2 Y_2\) implies the distortionary effect of cost of tariff protection to the import-competing formal manufacturing sector.
Differentiating equation (5.12) with respect to $t_2$ we get

$$
\begin{align*}
\frac{dU}{dt_2} &= \bar{W} L h' \left( \frac{dQ}{dt_2} \right) + \left( \frac{dW}{dt_2} \right) \left( aLx + aLz \right) + \left( \frac{dr}{dt_2} \right) K + \left( \frac{dK}{dt_2} \right) + \left( \frac{dr}{dt_2} \right) K + \left( \frac{dK}{dt_2} \right) + \left( \frac{dr}{dt_2} \right) K + \left( \frac{dK}{dt_2} \right) + \left( \frac{dr}{dt_2} \right) K + \left( \frac{dK}{dt_2} \right) + \left( \frac{dr}{dt_2} \right) K + \left( \frac{dK}{dt_2} \right) + \left( \frac{dr}{dt_2} \right) K + \left( \frac{dK}{dt_2} \right) + \left( \frac{dr}{dt_2} \right) K + \left( \frac{dK}{dt_2} \right) + \left( \frac{dr}{dt_2} \right) K + \left( \frac{dK}{dt_2} \right) + \left( \frac{dr}{dt_2} \right) K + \left( \frac{dK}{dt_2} \right) + \left( \frac{dr}{dt_2} \right) K + \left( \frac{dK}{dt_2} \right) + \left( \frac{dr}{dt_2} \right) K + \left( \frac{dK}{dt_2} \right) + \left( \frac{dr}{dt_2} \right) K + \left( \frac{dK}{dt_2} \right) + \left( \frac{dr}{dt_2} \right) K + \left( \frac{dK}{dt_2} \right) + \left( \frac{dr}{dt_2} \right) K + \left( \frac{dK}{dt_2} \right) + \left( \frac{dr}{dt_2} \right) K + \left( \frac{dK}{dt_2} \right) + \left( \frac{dr}{dt_2} \right) K + \left( \frac{dK}{dt_2} \right) + \left( \frac{dr}{dt_2} \right) K + \left( \frac{dK}{dt_2} \right) \right] - P_{y_2} Y_2 \left( 1 + \epsilon_2 \right)
\end{align*}
$$

(5.12.1)

where $\epsilon$ is the elasticity of output of sector ‘$y_2$’ with respect to $t_2$.

Thus the impact of a fall in $t_2$ on NI can be divided into four different effects- (i) nutritional effect (ii) factor income effect (iii) labour allocation effect valued in terms of the wage differential and (iv) distortionary effect of tariff protection.

The first term of equation (5.12.1) denotes the nutritional effect. It shows that with a fall in $t_2$, NI increases. A fall in $t_2$ leads to a decrease in the level of output produced and the level of employment generated by the informal sector, which in turn decreases the emission of pollutant from the informal sector. Thus the overall level of pollution of the economy reduces. As a result the nutritional efficiency of workers increases leading to an increase in wage income, given $\bar{W}$. This in turn increases the level of NI. Thus, the sign of the nutritional effect is negative.

The second term of equation (5.12.1) denotes the ‘factor income effect’, which affects NI in two different ways. Firstly, by affecting the total wage bill of the economy and secondly by affecting the total capital income of the economy. We have already shown that with the fall in $t_2$, $W$ decreases. Thus the total wage bill of the economy falls at initial levels of employment. This in turn pulls down the level of NI of the economy. In other words, it implies that the sign of this effect is positive. With a fall in $t_2$, $r$ remains constant but $r_1$ increases. As a result the total capital income of the economy increases which in turn pulls up the NI of the economy. Thus the sign of the ‘capital income effect’ of a fall in $t_2$ is negative. However, the sign of the ‘factor income effect’ is ambiguous.

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75 Since $\bar{W}$ is fixed, therefore with the fall in $W$, the total wage bill of the economy reduces.
The third term of equation (5.12.1) is the labour allocation effect valued in terms of the wage differential. The exact sign of this effect is difficult to determine. However, in the presence of negligible wage inequality, this effect is negligible.

The fourth term of equation (5.12.1) is the distortionary effect of tariff protection. It shows distortionary effect on sector ‘y2’ due to tariff reduction t2. As $E > 0$ it has a negative sign so far as the impact on NI is concerned.

Thus, to conclude, the overall impact of fall in $t_2$ on NI of the economy is indeterminate. It depends on the relative strength of the four different effects as discussed above. But, if we again consider that in the presence of negligible wage inequality, the combined impact of nutritional efficiency effect and capital income effect due to tariff protection dominates over the wage bill effect, we find that a tariff reduction of sector ‘y2’ increases NI of the economy.

The above observation can be summarized in the form of following proposition

**Proposition 5.3:** The impact of trade liberalization in the form of reduction of tariff imposed on import-competing formal manufacturing sector, on the level of national income of the economy is ambiguous. Only under some special situations like (i) the negligible wage inequality among sectors and (ii) the sum of nutritional effect, capital income effect and distortionary effect due to tariff protection dominates over wage bill effect, we find that the tariff reduction increase national income.

5.4 **CONCLUDING REMARKS**

This chapter has analyzed some theoretical issues related to trade liberalization in the presence of an intermediate good producing informal sector. It shows that a reduction of a tariff rate on the product of the import-competing formal manufacturing sector decreases the level of output of the informal sector and also the level of pollution of the
economy but its impact on the level of NI of the economy is ambiguous. It is only under some special conditions we can say that NI increases as a result of trade liberalization.

In this chapter the nutritional efficiency function of the labourers has been introduced and it has been linked with the environmental factor, which is something new in the literature on informal sector and environment. For the sake of simplicity we have considered that efficiency function of a worker depends only on the amount of overall pollution of the economy, but in reality, we know that efficiency of a worker depends not only on the level of overall pollution of the economy, but also on many other factors like the amount of education/skill he has acquired, age of the worker etc. These issues can be considered as an extension of the present version of the chapter. Our model is a theoretical stylization of the empirical facts and figures that we find for a developing economy like India. In our future research agenda we would like to examine empirically the impact of various policy prescriptions as mentioned in the chapter. Such an analysis would make our research more relevant to the policy makers of developing countries.
APPENDICES

APPENDIX 5

5.1. Impact of fall in \( t_2 \) on the levels of \( X \) and \( Z \)

Differentiating with respect to \( t_2 \) and rearranging equation (5.6) we get

\[
a_{KX_1}(dX/dt_2) + a_{KX_2}(dZ/dt_2) = - \{X(da_{KX}/dt_2) + Z(da_{KZ}/d t_2)\}
\]

(5.6.1)

Using equation (5.7), equation (5.5) can be rewritten

\[
a_{KY_1}Y_1 + a_{KY_2}(Z/az_{Y_2}) = K
\]

\[
Y_1 = (1/a_{KY_1}) \{K - a_{KY_2}(Z/az_{Y_2})\}
\]

Putting the value of \( Y_1 \) \{as derived from equation (5.5)\} and \( Y_2 = (Z/az_{Y_2}) \) in equation (5.11) we get

\[
(a_{LY_1}/a_{KY_1})K - \{(a_{LY_1}/a_{KY_1})(a_{KY_2}/az_{Y_2})\}Z + (a_{LY_2}/az_{Y_2})Z + a_{LX}X + a_{LZ}Z = Lh(\Omega + \alpha_X + \alpha_Z) \]

\[
\Rightarrow (a_{LY_1}/a_{KY_1})K + Z [(a_{LY_2}/az_{Y_2}) (a_{LY_1}/a_{KY_1})(a_{KY_2}/az_{Y_2}) + a_{LZ}] + a_{LR}X + a_{LZ} = Lh(\Omega + \alpha_X + \alpha_Z)
\]

\[
\Rightarrow AK + BZ + a_{LX}X = Lh(\Omega + \alpha_X + \alpha_Z)
\]

(5.11.1)

where

\[
A = (a_{LY_1}/a_{KY_1})
\]

and

\[
B = [(a_{LY_2}/az_{Y_2}) (a_{LY_1}/a_{KY_1})(a_{KY_2}/az_{Y_2}) + a_{LZ}]
\]

\[
= [(a_{KY_2}/az_{Y_2})(a_{LY_2}/a_{KY_1})(a_{LY_1}/a_{KY_1})(a_{KY_2}/a_{LY_2}) + a_{LZ}]
\]

Since all the input-output coefficients are positive and as under sufficient condition we get

\[
(a_{KY_1}/a_{LY_1}) > (a_{KY_2}/a_{LY_2}), \text{ therefore } A > 0 \text{ and } B > 0
\]

Differentiating equation (5.11.1) with respect to \( t_2 \) we get

\[
K(dA/dt_2) + B (dZ/dt_2) + Z(dB/dt_2) + a_{LX}(dX/dt_2) + X(da_{LX}/d t_2) = L(dh/dt_2) + h (dL/dt_2)
\]
\[ \Rightarrow K(dA/dt) + B(dZ/dt) + Z(dB/dt) + a_{lx}(dX/dt) + X(da_{lx}/dt) = h'L[a_x(dX/dt) + a_z(dZ/dt)] \]

\[ := (dL/dt) = 0 \text{ and } (dh/dt) = h' [a_x(dX/dt) + a_z(dZ/dt)] \text{ where } (dΩ/dt) = 0 \]

\[ \Rightarrow (a_{lx} - hh'a_x)(dX/dt) + (B - hh'a_z)(dZ/dt) = -\{K(dA/dt) + Z(dB/dt) + X(da_{lx}/dt)\} \quad (5.11.2) \]

Rearranging equations (5.6.1) and (5.11.2) in matrix form we get

\[
\begin{pmatrix}
a_{Klx} & a_{Klz} \\
(a_{lx} - hh'a_x) & (B - hh'Lα_z)
\end{pmatrix}
\begin{pmatrix}
(dX/dt) \\
(dZ/dt)
\end{pmatrix}
=
\begin{pmatrix}
-\{X (da_{Klx}/dt) + Z(da_{Klz}/dt)\} \\
-\{K (dA/dt) + Z(dB/dt) + X(da_{lx}/dt)\}
\end{pmatrix}
\]

The value of determinant matrix is given by

\[ \Delta = a_{Klx} (B - hh'Lα_z) - a_{Klz} (a_{lx} - hh'Lα_x) \]

\[ = a_{Klx} \{(a_{l,y2}/a_{2,y2})(a_{K,y2}/a_{2,y2}) + a_{l,z}\} - a_{Klz} \{h'Lα_z - a_{lx} a_{K,z} + h'Lα_x\} \]

\[ = \{(a_{Klx}/a_{lx})-(a_{Klz}/a_{lz})\} + \{(a_{Klx}/a_{lx})-(a_{Klz}/a_{lz})\} \{((a_{K,y1}/a_{l,y1})-(a_{K,y2}/a_{l,y2})) + h'L\{(a_{K,y2}/a_{Klx})-(a_{l,y2}/a_{Klx})\}\} \]

It has already assumed that the rural sector is more capital intensive than the informal sector and the formal sector ‘\(y_1\)’ is more capital intensive than the formal sector ‘\(y_2\)’

i.e. (\(a_{Klx}/a_{lx}\)) > (\(a_{Klz}/a_{lz}\)) and (\(a_{K,y1}/a_{l,y1}\)) > (\(a_{K,y2}/a_{l,y2}\))

It has also been assumed that (\(a_{Klz}/a_{Klx}\)) < (\(α_2/α_1\))

\[ \therefore \Delta > 0. \]
By Cramer’s rule we have

\[
(dX/\text{d}t_2) = \left\{\left\lfloor \{X(\text{da}_{Kx}/\text{d}t_2)+Z(\text{da}_{Kz}/\text{d}t_2)\} \{B-h'\alpha_x\}\right\rfloor \{-\{\text{K(dA/dt}_2)+Z(\text{dB/dt}_2)+X(\text{da}_{Lx}/\text{d}t_2)\}\{a_{Kz}\}\}\right\} / \Delta \\
\{H(B-h' \alpha_z) - G(a_{Kz})\} / \Delta
\]

and

\[
(dZ/\text{d}t_2) = \left\{\left\lfloor (a_{Kx}) \{\{-\{\text{K(dA/dt}_2)+Z(\text{dB/dt}_2)+X(\text{da}_{Lx}/\text{d}t_2)\}\} - \{-\{\text{K(dA/dt}_2)+Z(\text{dB/dt}_2)+X(\text{da}_{Lx}/\text{d}t_2)\}\} \{a_{Lx}\} - \{-\{\text{K(dA/dt}_2)+Z(\text{dB/dt}_2)+X(\text{da}_{Lx}/\text{d}t_2)\}\} \{a_{Kz}\}\right\rfloor / \Delta
\]

where

\[
H=\{-\{X(\text{da}_{Kx}/\text{d}t_2)+Z(\text{da}_{Kz}/\text{d}t_2)\}\}, \quad G=\{-\{\text{K(dA/dt}_2)+Z(\text{dB/dt}_2)+X(\text{da}_{Lx}/\text{d}t_2)\}\}
\]

As r remain constant and W decreases due to a decrease in t2,

Therefore, we get (\text{da}_{Kx}/\text{d}t_2) > 0 and (\text{da}_{Kz}/\text{d}t_2) > 0

\[\therefore H < 0\]

We know that B=[((a_{Lx} a_{Ly2}/a_{zy2})a_{Ky2})(\{a_{Ky1}/a_{ly1}\}-(a_{Ky2}/a_{Ly2})}]+a_{Lz}\]

Differentiating B with respect to t2 we get, (as we know that with the fall in t2, W decreases and as r remains constant, so we get (\text{da}_{Ky1}/\text{d} t_2)=0, (\text{da}_{Ky2}/\text{d} t_2)=0, (\text{da}_{Lx}/\text{d} t_2)=0, (\text{da}_{Ly2}/\text{d} t_2)=0 and (\text{da}_{zy2}/\text{d} t_2)=0)

\[
(dB/\text{d}t_2) = [\{(a_{Lx}/a_{zy2}a_{Ky1})(\text{da}_{Ly2}/\text{d}t_2)\} \{\{a_{Ky1}/a_{ly1}\}-(a_{Ky2}/a_{Ly2})\}+a_{Lz}\} + (\text{da}_{Lz}/\text{d}t_2)
\]

Thus, (dB/\text{d}t_2)<0

Since, (\text{dA/dt}_2) =0, (dB/\text{d}t_2)<0 and (\text{da}_{Lz}/\text{d}t_2)<0

Therefore G>0.

Thus we get

\[(dX/\text{d}t_2) < 0.\]
and

\( \frac{dZ}{dt_2} > 0. \)

Again, as \( \frac{a_{K1}}{dt_2} = 0 \) and \( \frac{a_{K2}}{dt_2} > 0 \) and \( \frac{dY_2}{dt_2} > 0 \) (as \( a_{Z2} \) is fixed, so when \( \frac{dZ}{dt_2} > 0 \), then \( \frac{dY_2}{dt_2} > 0 \))

Thus, from equation (5.5), we get

\( \frac{dY_1}{dt_2} < 0 \)

5.2 Impact of change in \( t_2 \) on the level of Domestic Pollution of the Economy

Impact of change in \( t_2 \) on \( Q \) is given by

\[
\frac{dQ}{dt_2} = \frac{dQ}{dt_2} + a_x \frac{dX}{dt_2} + a_z \frac{dZ}{dt_2}
\]

(5.9.1)

We know that \( \frac{dQ}{dt_2} = 0 \)

Since \( a_x \approx 0 \)

\( \therefore a_x \frac{dX}{dt_2} \approx 0 \)

Taking this into consideration, equation (5.9.1) can be rewritten as

\( \frac{dQ}{dt_2} = a_z \frac{dZ}{dt_2} \)

\( \therefore \frac{dZ}{dt_2} > 0 \)

\( \therefore \frac{dQ}{dt_2} > 0 \)

5.3 Impact of change in \( t_2 \) on the level of NI of the economy

The NI of the economy is given by

\[
U = W L h(Q) + (W - \overline{W}) (a_{lx} X + a_{lz} Z) + r K + r_1 K_1 - t_2 P_{y2} Y_2.
\]

(5.12)

Impact of change in \( t_2 \) on NI is given by

\[
\frac{dU}{dt_2} = \overline{W} L h' \left( \frac{dQ}{dt_2} \right) + (dW/dt_2) (a_{lx} X + a_{lz} Z) + (W - \overline{W}) [a_{lx} \left( \frac{dX}{dt_2} \right) + a_{lz} \left( \frac{dZ}{dt_2} \right) + X \left( da_{lx}/dt_2 \right) + Z \left( da_{lz}/dt_2 \right)] + (dr/dt_2) K + (dr_1/dt_2) K_1 - Y_2 P_{y2} (1 + C)
\]
\[ \bar{W} L \ h'(dQ/dt_2)+[ (dW/dt_2) (a_{lx} X+ a_{lz} Z)+ (dr/dt_2) K + (dr_f/dt_2) K_i ] + (W-W)[ a_{lx} (dX/dt_2) + a_{lz}(dZ/dt_2) + X (da_{lx}/dt_2) + Z (da_{lz}/dt_2)] - [ Y_2 P_{y2}(1+ \epsilon)] \]

where \( \epsilon \) is the elasticity of output of sector ‘\( y_2 \)’ with respect to \( t_2 \), \( \epsilon > 0 \) (From subsection 5.1 of this appendix we find that \( dY_2/dt_2 > 0 \))

The first term of the expression \( \bar{W} L \ h'(dQ/dt_2) \) represent the nutritional efficiency effect of change in \( t_2 \) on \( U \)

Since \( h' < 0 \) and \( (dQ/dt_2) > 0 \),

\[ \therefore \bar{W} L \ h'(dQ/dt_2) < 0. \]

The second term within the bracket \( [(dW/dt_2) (a_{lx} X+ a_{lz} Z)+ (dr/dt_2) K + (dr_f/dt_2) K_i ] \) represent the ‘factor income effect’ due to change in \( t_2 \) on \( U \) which is further subdivided into two subdivisions (i) change in total wage bill of the economy due to reduction in tariff i.e. \( (dW/dt_2) (a_{lx} X+ a_{lz} Z) \) and (ii) total capital income of the economy due to fall in tariff i.e. \( ((dr/dt_2) K + (dr_f/dt_2) K_i \). 

Since \( (dW/dt_2) > 0, (dr/dt_2) = 0 \) and \( (dr_f/dt_2) < 0. \)

\[ \therefore (dW/dt_2) (a_{lx} X+a_{lz} Z) > 0 \text{ and } ((dr/dt_2) K + (dr_f/dt_2) K_i ) < 0. \]

The third term \( (W-W)[ a_{lx} (dX/dt_2) + a_{lz}(dZ/dt_2) + X (da_{lx}/dt_2) + Z (da_{lz}/dt_2)] \) represent the labour reallocation effect valued in terms of wage differential effect on \( U \).

We know that \( (W-W) < 0, (dX/dt_2) < 0, (dZ/dt_2) > 0, (da_{lx}/dt_2) < 0 \text{ and } (da_{lz}/dt_2) < 0. \)

\[ \therefore \text{The sign of } (W-W)[ a_{lx} (dX/dt_2) + a_{lz}(dZ/dt_2) + X (da_{lx}/dt_2) + Z (da_{lz}/dt_2)] \text{ is indeterminant.} \]

The fourth term \(-[ Y_2 P_{y2}(1+ \epsilon)] \) is the distortionary effect of tariff protection.

We know that \( \epsilon > 0 \), therefore the term \(- Y_2 P_{y2}(1+ \epsilon) < 0. \)

Therefore the effect on \( U \) due to change in tariff is considered as the net effect of four effects :- (i) nutritional effect (ii) labour reallocation effect valued in terms of wage
differential (iii) factor income effect and the (iv) distortionary effect due to tariff protection.

Here in this chapter it has been assumed that \((W - \overline{W}) \approx 0\).

\[
\therefore \text{Effect on } U \text{ depends on the relative force resulting in wage income and distortionary effect due to tariff protection compared to capital income effect and nutritional efficiency effect.}
\]