

CHILD LABOUR AND TRADE LIBERALIZATION IN A DEVELOPING ECONOMY*

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ABSTRACT: The paper analyzes the implications of trade liberalization on the incidence of child labour in a two-sector general equilibrium framework. The supply function of child labour has been derived from the utility maximizing behaviour of the working families. The paper finds that the effect of trade liberalization on the incidence of child labour crucially hinges on the relative factor intensities of the two sectors.

Keywords: Child labour, general equilibrium, trade liberalization.

JEL classification: J10, J13, I28, F10.

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1. Introduction:

The incidence of child labour is a slur on the fair face of the globalized world. Although, child labour has been prevalent from as early as eighteenth century (mainly in rural farming) and gained a boost during the industrial revolution in the last century, the problem has drawn serious cognizance, only after the process of globalization has been initiated and calls for different policy measures to curb the evil. In the past 50 years, the magnitude of child labour has been declining throughout the world. Child labour is presently a phenomenon pervasive mostly in the transitional societies of the developing economies where multi-class social structures exist and a complex of traditional and pre-capitalist production relations are operative in an articulated capitalist mode of production and exploitation. India is one among these countries where the concentration of child labour is the highest in the world.

An accurate measure of working children is difficult to obtain since there is no single, clear-cut definition of child labour under international law. Usually most of the empirical surveys classify as 'child labour' those children under 12 years of age, who work on a regular basis for which they are paid or that results in output destined for the market (Basu, 1999). According to the Bureau of Statistics of the ILO, in 1995 at least 120 million of the world's children between the ages of 5 and 14 did full-time paid work. The participation rates for children aged between 10 to 14 years in 1995 was 13.02 for the world as a whole, and 14.37 for India, in particular (Source: ILO, 1996). Although the estimates are satisfactory if compared with the 1950 estimates of 27.57 and 35.43 respectively, the magnitude of child labour in absolute terms is quite alarming. If the invisible workers who perform unpaid and household jobs are included, the estimates are likely to shoot up significantly.

In the conventional literature, the supply of child labour has been attributed to factors such as failure of the educational system, the objectives of households to maximize present income, a dualistic economy characteristic of developing countries with the co-existence of formal and informal sectors, etc. However, it is beyond any doubt that the root cause is abject poverty, which compels people to have large families and children to go out in the job market and earn their own means of livelihood. To eradicate the incidence of child labour, *World Development Report 1995* called for a multifaceted approach with programs that increase income security, reduce costs of education, and improve the quality schooling.

There have been many groundbreaking changes in the global scenario over the last two decades. The multilateral agreement and the formation of the World Trade Organization (WTO), resultant of the Uruguay round of discussions, have brought about revolutionary changes in liberalizing international trade across countries whether developed or developing. Radical measures for reducing tariff barriers and completely doing away with non-tariff barriers to ensure freer global trade have already been undertaken in manufacturing commodities that are intensive in the use of capital or skilled labour. During this period the problem of child labour has drawn serious cognizance and calls for different policy measures to curb the evil. It was believed that liberalized trade policies would take the developing countries into higher growth orbits, the benefits of which would definitely percolate down to the bottom of the society, thereby leading to reduction of poverty and poverty-driven child labour incidence. Despite most of the developing economies choosing free trade as their development strategies, empirical evidence suggests that in many of the transition economies the incidence of child labour has been on the rise. For example, a recent study of child labour by Swaminathan (1998) in a city in western India concluded: “The prevalence and absolute expansion of child labor in a period and region of relatively high growth of aggregate output indicates that the nature of economic growth is flawed”. Why liberalized trade policies have not so far been successful in eradicating the problem is quite puzzling.

In the recent theoretical literature on child labour the notable contributors are Eswaran (1996), Basu and Van (1998), Basu (1999, 2002), Ranjan (1999), Baland and Robinson (2000), Jafarey and Lahiri (2000) and Dessy (2000). Eswaran (1996) has found an explanation in the need for old age security of the parents behind the incidence of high fertility rate and lower investment on the education of their offspring (and hence the high incidence of child labour) in a backward society where the child mortality rate is quite high. Thus he has suggested improvement in healthcare services and legislation of compulsory education to eradicate child labour from the system. Basu and Van (1998) have shown that if child labour and adult labour are substitutes (substitution axiom) and if child labour is a luxury commodity to the poor households (luxury axiom), unfavourable adult labour markets, responsible for low adult wage rate, is the driving force behind the incidence of child labour. According to the luxury axiom, there exists a critical level of adult wage rate, and any adult worker earning below this wage rate, considers himself as poor and does not have the luxury to send his offspring to schools. He is forced to send his children to the job market to supplement low family income out of sheer poverty. What follows from the Basu and Van (1998) paper is that labour market interventions that raise adults' wages are expected to mitigate the problem of child labour. There are some papers in the literature focusing on capital market failure. Ranjan (1999), Baland and Robinson (2000) and Jafarey and Lahiri (2002) emphasize the importance of capital-market imperfection as a contributing factor to inefficient child labor. On the other hand, Dessy (2000) has advocated in favour of imposition of compulsory education as a means to combat the incidence of child labour. Dessy (2000) has shown that in an economy where the benefits of having children are outweighed by rearing costs, a policy of free education with no compulsory education laws, may lead the economy to an underdevelopment trap with high fertility rate and higher incidence of child labour. On the contrary, a compulsory education policy is expected to eradicate the existence of the evil from the system.

Unfortunately, the existing theoretical literature on child labour does not deal adequately¹ with issues like the supply of child labour and its linkages with the adult labour markets in a multi-sector general equilibrium framework, which is especially crucial when child labour and adult labour are substitutes² in different informal sectors of a developing economy. One cannot get the overall effect of a policy on the incidence of child labour in a partial equilibrium framework. This is because, as the recent Bangladeshi experience³ has shown, a policy designed to mitigate the problem of child labour in a targeted sector may drive the children into other sectors of the economy and undertake illegal and more hazardous activities. So, one cannot evaluate the success of a particular policy unless one takes into account its effect on the aggregate number of child workers, spread over different sectors of an economy. Also no attempt has so far been made to analyze the implications of the liberalized trade policies on the problem of child labour. This attempt should have been made earlier, especially when trade liberalization was expected to exert downward pressures on the poverty-driven child labour incidence.

The present paper is purported to examine the implications of trade liberalization policy on the child labour incidence in a general equilibrium set-up. We consider a two-sector full-employment model with child labour. It is assumed that different economic activities are perfectly substitutable⁴ between adult and child labour (see Basu (1999)). Also all

¹ The Basu and Van (1998) model, of course, can be easily embedded in a general equilibrium framework. Basu (2002) also focuses on the analysis of multiple general equilibria with child labour.

² See footnote 5 in this context.

³ Owing to the possibility of introduction of the US Harkins Bill, which calls for complete ban on imports of any good that were manufactured wholly or partly by child workers, the employers in the booming garments industry in Bangladesh that had employed a large number of child labourers began removing the child workers drastically. The consequence was a chaotic process that left many children worse off than they had before.

⁴ In the developing economies child workers are mostly found in the production of carpets, glass, bangles, leather bags, shoes, garments, matchbox and fireworks and cattle feeding. It is sensible to assume that adults can perform all these tasks. First, all these industries exist in countries where there is no child labour. Secondly, not all the firms producing these goods in countries where child labour exists actually use child labour— after all, this is the justification for ‘social labelling’. The ‘nimble fingers’ argument, which once has been put forward, especially to carpet weaving, is an excuse given by employers and fails to convince researchers (see Burra (1995) and

types of labour are perfectly mobile between the two sectors. So wage rates are equal across the two sectors. The supply function for child labour has been derived from the utility maximizing behaviour⁵ of the working families. We have analyzed how a reduction of the tariff rate affects the supply of child labour and found that the effect of tariff reform crucially hinges on the relative factor intensities of the two sectors and the parameter values of the system.

The paper is organized in the following way. Section 2 describes the model. Sub-section 2.1 analyzes the behaviour of the representative adult worker and hence derives the supply function of child labour. Section 2.2 describes the working of the general equilibrium model of the economy. The effect of trade liberalization on the incidence of child labour has been analyzed in section 2.3. Concluding remarks are made in the final section.

2. The Model:

We consider a small open economy with two sectors producing an exportable commodity X and an importables, Z using labour and capital. There are two types of labour in the model: adult labour and child labour. Following Basu and Van (1998), we assume that adult labour is a perfect substitute for child labour. It is assumed that an adult worker is equivalent to β number of child workers, where $\beta > 1$. Each adult worker earns a wage of W. The child wage rate, W_C , must be (W/β) when the adult wage rate is W.

Complete mobility of both types of labour and capital between the two sectors is assumed and this ensures that the wage rates and rental on capital must be the same across these sectors.

Weiner (1991)). Even if present technologies required the use of child labour and not adult labour in certain production activities, major changes in economic conditions coupled with the mobility of capital across sectors, would certainly result in the adoption of different technologies allowing the substitution of adult for child labour.

⁵ This model is not applicable to the problems of street-children in urban areas where child labourers, themselves, are decision-makers.

Sector 2 is the tariff protected import-competing sector producing a commodity, Z . Production functions in sectors X and Z satisfy constant returns to scale with positive but diminishing returns to each factor. Markets are perfectly competitive and all factors of production are fully employed. Each firm maximizes profit. Owing to the small open economy assumption commodity prices are given internationally. At this moment we do not make any assumption regarding the relative factor intensities of the two sectors.

The following symbols will be used in the formal presentation of the model.

a_{Li} : labour-output ratio in the i -th sector, $i = X, Z$;

a_{Ki} : capital-output ratio in the i -th sector, $i = X, Z$;

θ_{ji} : distributive share of the j^{th} input in the i^{th} industry, $j = L, K$; and, $i = X, Z$;

λ_{ji} : proportion of the j^{th} input employed in the i^{th} sector, $j = L, K$ and $i = X, Z$;

P_i : world price of the i -th good, $i = X, Z$;

t : ad-valorem tariff rate on the import of Z ;

T : total tariff revenue of the government;

M : volume of imports of commodity Z ;

W : adult wage rate;

$W_C (=W/\beta)$: child wage rate;

R : rate of return to capital;

C_X : consumption of commodity X by each working family;

C_Z : consumption of commodity Z by each working family;

L : adult labour endowment;

L_C : aggregate supply of child labour;

K : domestic capital stock of the economy;

$\hat{}$: proportional change.

2.1 Supply Function of Child Labour

In this section we want to derive the supply function of child labour from the utility maximizing behaviour of the representative adult worker who sends his children to work.

The utility function of the representative adult worker is given by

$$U = W(C_X, C_Z) - V(L_C)$$

The worker derives utility from the consumption of the final goods and disutility from child labour. For analytical simplicity let us consider the following specific algebraic form of the utility function.

$$U = (C_X)^\alpha + (C_Z)^\alpha - (L_C)^\alpha \text{ with } 0 < \alpha < 1 \quad (1)$$

It satisfies all the standard properties. Also it is additive and symmetric. It is homogeneous of degree α and has the constant elasticity of substitution between any two arguments.

He maximizes this utility function subject to the budget constraint

$$P_X.C_X + P_Z.(1+t).C_Z = [\{(W/\beta).L_C + Y\}/L] \quad (2)$$

where (Y/L) is the own income of the adult worker and is given by

$$(Y/L) = [(W.L + R.K + T)/L] \quad (3)$$

Here it is assumed that workers are the owners of capital. So the income from capital is equally distributed among the workers. Besides each worker receives a fraction of the tariff revenue as income transfer from the government.

Following first-order conditions are satisfied in equilibrium.

$$(C_X/C_Z)^{(\alpha-1)} = (P_X/P_Z(1+t)) \quad (4)$$

$$(C_X/L_C)^{(\alpha-1)} = (P_X/(W/\beta)) \quad (5)$$

and,

$$(C_Z/L_C)^{(\alpha-1)} = \{(P_Z(1+t)/(W/\beta)\} \quad (6)$$

Using equations (5) and (6) we have

$$P_X.C_X + P_Z.C_Z.(1+t) = [P_X^{(\alpha/\alpha-1)} + (P_Z.(1+t))^{(\alpha/\alpha-1)}].(\beta/W)^{(1/\alpha-1)}.L_C \quad (7)$$

This means that in equilibrium, total expenditure on final goods is proportional to the supply of child labour given the product prices, wage rate and the tariff rate.

Using equations (2), (3) and (7) we have

$$L_C = [\{L + (R/W).K + (T/W)\} / \{(P_X)^{\alpha/\alpha-1} + (P_Z(1+t))^{\alpha/\alpha-1}\} . \{(\beta)^{1/\alpha-1} . (W)^{\alpha/1-\alpha}\} - (1/\beta)] \quad \dots\dots\dots (8)$$

This is the aggregate supply function of child labour. We now analyze its properties. First, the supply of child labour varies positively with rental rate on capital, R , capital stock, K , adult labour endowment, L . L_C also varies positively with the tariff revenue, T ; and, T in turn varies positively with the tariff rate, t , if the import-demand is inelastic. Here income effect on child labour supply is positive. Given the product prices, equilibrium consumption of either commodity is proportional to the supply of child labour. Since both commodities are non-inferior, supply of child labour varies positively with the adult workers' aggregate income, Y . Secondly, L_C varies negatively with the wage rate, W . Note that here adult labour and child labour are perfect substitutes. So (W/β) is the child wage rate. Hence a rise in W produces a negative price effect. Finally, L_C varies positively with the tariff rate, t . An increase in t lowers $(P_Z(1+t)^{(\alpha/\alpha-1)})$ because $(\alpha/\alpha-1) < 0$. So L_C rises given the other parameters. The increase in the tariff rate raises the domestic price of Z commodity. So consumption of Z commodity is substituted by the consumption of X commodity. Since the relative consumption of X with respect to child labour, (C_X/L_C) , remains unchanged, L_C also rises.

In the subsequent sections of the paper the following general form of the aggregate child labour function will be used for analytical purpose. However, all the properties satisfied by the specific functional form given by equation (8) will be retained.

$$L_C = f(W, R, t, L, K, T) \quad (8.1)$$

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2.2 The General Equilibrium Analysis

Given the assumption of perfectly competitive markets the usual price-unit cost equality conditions relating to the two sectors of the economy are given by the following two equations.

$$a_{LX}.W + a_{KX}.R = P_X \quad (9)$$

$$a_{LZ}.W + a_{KZ}.R = P_Z.(1+t) \quad (10)$$

The capital endowment equation, which shows capital market equilibrium, is given by

$$a_{KX}.X + a_{KZ}.Z = K \quad (11)$$

There are L numbers of homogenous working families, each consisting of one adult member and certain number of children. The number of children going to the job market from each family is decided by the adult member of the family. Actually, it is determined from the utility maximizing behaviour of the family. The aggregate supply function of child labour in general form is the following.

$$L_C = f(W, R, t, L, K, T) \quad (8.1)$$

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The effective labour endowment of the economy consists of both adult and child labour; and the labour market equilibrium is given by the following equation.

$$a_{LX}.X + a_{LZ}.Z = L + (L_C/\beta) \quad (12)$$

In this model there are five endogenous variables (namely, W , R , X , Z , and L_C) and five independent equations. The parameters in the system are: P_X , P_Z , β , L , K , and t . Equations (9) and (10) constitute the price system and equations (8.1), (11) and (12) form the output system. We should note that the system possesses the decomposition property since the two unknown input prices, W and R , can be determined from the price system alone, independent of the output system. Once the factor prices are known the factor coefficients, a_{ij} s, are also known. Also the amount of child labour, L_C , is obtained from equations (8.1). Finally, X and Z are solved from equations (11) and (12).

2.3 Comparative Static Exercises

It is believed that liberalized trade policies would take the developing countries into higher growth orbits, the benefits of which would percolate down to the poor people, thereby lowering the extent of poverty. Thus these policies are expected to exert downward pressures on the incidence of poverty-induced child labour. In this section of the paper, we shall examine the impact of trade liberalization on the incidence of child labour. In the present set-up trade liberalization means a reduction in the import tariff on commodity Z .

Totally differentiating equations (9) and (10) and solving by Cramer's rule the following expressions can be obtained.

$$\hat{W} = - (1/|\theta|) \cdot \theta_{KX} \cdot S \cdot \hat{t} \quad (13)$$

and

$$\hat{R} = (1/|\theta|) \cdot \theta_{LX} \cdot S \cdot \hat{t} \quad (14)$$

where $|\theta| = \theta_{LX}\theta_{KZ} - \theta_{KX}\theta_{LZ}$, and $S = (t/(1+t)) > 0$.

Differentiating equation (8.1) with respect to t , the following expression is obtained.

$$(dL_C/dt) = (\partial L_C/\partial W) \cdot (dW/dt) + (\partial L_C/\partial R) \cdot (dR/dt) + (\partial L_C/\partial t) + (\partial L_C/\partial T) \cdot (dT/dt) \quad (15)$$

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Here $(\partial L_C/\partial t)$ represents the price effect of the change in the tariff rate, taking place through the change in the relative price of the importables. However, a change in the tariff rate causes a change in the tariff revenue and $(\partial L_C/\partial T) \cdot (dT/dt)$ represents the effect resulting from the change in tariff revenue. The combined effect is positive if $(dT/dt) \geq 0$, i.e. if the import demand is not elastic.⁶ This is negative if $(dT/dt) < 0$; and, $|((\partial L_C/\partial T) \cdot (dT/dt))| > (\partial L_C/\partial t)$. The sign and magnitude of (dT/dt) depend on the values of the parameters of the system.⁷

Depending on the relative factor intensities between the sectors, the following two cases arise.

Case I: $|\theta| = \theta_{LX}\theta_{KZ} - \theta_{KX}\theta_{LZ} > 0$. This means that the import competing sector is more capital-intensive vis-à-vis the export sector. From (13) and (14) it follows that $\hat{W} > 0$ and $\hat{R} < 0$ when $\hat{t} < 0$. So $(dW/dt) < 0$ and $(dR/dt) > 0$. Therefore from (15) it follows that $(dL_C/dt) > 0$ if $(dT/dt) \geq 0$.⁸

⁶ It is only a sufficient condition not a necessary one.

⁷ See appendix for derivation of the expression for (dT/dt) .

⁸ This is only a sufficient condition for (dL_C/dt) to be positive. However, (dL_C/dt) can be positive even when (dT/dt) is negative.

Case II: $|\theta| = \theta_{LX}\theta_{KZ} - \theta_{KX}\theta_{LZ} < 0$. In other words, the import-competing sector is more labour intensive than the export sector. This may be the trade pattern for a newly industrialized economy⁹. From (13) and (14) it follows that $\hat{W} < 0$ and $\hat{R} > 0$ when $\hat{t} < 0$. So when $|\theta| < 0$, $(dW/dt) > 0$ and $(dR/dt) < 0$. Therefore from (15) it follows that (dL_C/dt) can be negative i.e. a reduction in t may be counterproductive if the direct effect of a reduction in t is outweighed by indirect income effects via changes in W and R and by the tariff revenue effect.¹⁰ Combining the effects in the above two cases we get the following proposition.

PROPOSITION: A reduction in import tariff may have an adverse effect on the incidence of child labour if the tariff protected import-competing sector is less capital-intensive than the export sector. However, it may reduce the pervasiveness of child labour when the import-competing sector is more capital-intensive.

Trade liberalization, in the form of reduction of tariff rates, has two types of effect on the supply of child labour. One is the price effect, which lowers the effective price of the

⁹ In case I, we have considered a small open economy, which exports its labour-intensive commodity and imports the commodity that is intensive in the use of capital. In the traditional literature on trade and development, a developing economy has been depicted with this pattern of trade. However, of late the situation has changed a lot. There are many developing economies today that have adopted an export-oriented growth strategy where the alternative pattern of trade is equally plausible. According to the World Development Report (1991), most less developed countries are net importers of food, while some of these are net exporters in specific food items. For example, Erstwhile Soviet Union, Egypt, Nigeria, Iran, Iraq, South Korea, Brazil, Cuba, Mexico etc. are major importers of wheat and have so far operated under a tariff-quota-subsidy system of trade restrictions. See also Raghavan (1991) and Marjit and Gupta (1995) in this context. At the same time there are many newly industrializing economies, which have grown to be large manufacturing exporters. See Beladi and Marjit (1996), page 932. India is a typical example in this context. In the present case we would like to investigate the robustness of the result of case I under the alternative trade pattern for a developing economy.

¹⁰ The tariff revenue effect is also a part of the income effect. As tariff revenue of the government is distributed among the working families as lump-sum payments, it is also a part of the aggregate income of each family. Any change in the tariff rate, t , affects the aggregate tariff revenue of the government (unless the import demand is unitary elastic) and hence the transfer payments made to the working families. As a consequence, the supply of child labour by each family and hence the aggregate supply would be affected. This we may call the tariff revenue effect to distinguish it from other components of the income effect, which arise due to changes in factor incomes resulting from a change in the tariff rate.

importables. The other is the income effect, which takes place through changes in factor prices (and hence through changes in factor incomes of the household) and through a change in tariff revenue, which is transferred to the households by the government. When the import-competing sector is more capital intensive than the export sector, aggregate income of each household decreases if $(dT/dt) \geq 0$ i.e. the import demand is not elastic. Thus, under the sufficient condition that the demand for importables is not elastic, both price and income effects of trade liberalization move in the same direction, thereby reducing the child labour incidence in the economy. However, it should be noted that this result might hold for elastic import demand function as well if the elasticity is not sufficiently high. On the contrary, a reduction in t lowers W and raises R when the import-competing sector is more labour intensive. The price and the income effects of trade liberalization move in the opposite directions in this case. The supply of child labour is increased if the direct price effect is outweighed by the indirect income effect including the tariff revenue effect.

3. Concluding Remarks:

Abject poverty and lack of educational facilities are often cited in the literature as the primary factors responsible for the incidence of child labour in the developing economies. Liberalized trade and investment policies were often recommended as remedial measures. Trade and investment liberalization programs are supposed to reduce poverty by raising the growth rates of these economies, thereby putting a brake on the incidence of poverty-induced child labour. Over the last two decades, the developing economies have gone in for trade liberalization in a big way. Several drastic measures have been implemented to ensure a freer international trade. However, what empirical evidence from several countries in transition reveals is not quite encouraging. The incidence of child labour has decreased over the last few decades but not at the expected rate. Even in some high growth-prone areas, the incidence has been on the rise. Why trade liberalization has not so far been able to produce the desired results is quite puzzling. The present paper has made an attempt to analyze the effect of trade liberalization in terms of a simple two-sector general equilibrium model.

The paper has shown that the effect of trade liberalization on the incidence of child labour crucially depends on the relative factor intensities of the two sectors and the values of parameters of the system. If the tariff-protected import-competing sector is capital-intensive, a reduction of import tariff may lower the supply of child labour in the given set-up. On the contrary, if the import-competing sector is more labour-intensive vis-à-vis the export sector removal of the protectionist policy may increase the incidence of child labour.

Finally, it should be mentioned that this paper concentrates only on poverty-driven child labour. While poverty has often been assumed to be the cause for paid child labour, other types of child labour are also likely to arise depending on other factors, such as capital and labour market imperfections, trade-offs between returns to general human capital acquired through education and to specific human capital acquired through (for example, working on the family farm), or deficiencies of the schooling opportunities. On the whole, the recent theoretical literature including the present one tends to neglect the different types of child work and to focus on just one of its causes. Empirical papers like, Bhalotra (2000), Bhalotra and Heady (2000), Bommier and Lambert (2000), Jensen (1999) etc. have pointed out that there is a need for more analyses distinguishing between different types of child work. Future theoretical research on child labour should address this aspect.

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APPENDIX:

The aggregate tariff revenue of the government is given by

$$T = tP_Z M = \{tP_Z(C_Z L - Z)\} = \{tP_Z L(C_Z - Z/L)\}$$

From (4) and (6) we respectively get

$$C_X = \{C_Z [P_X / P_Z (1+t)]^{(1/\alpha-1)}\}; \text{ and,} \quad (\text{A.1})$$

$$L_C = \{C_Z [W / \beta P_Z (1+t)]^{(1/\alpha-1)}\} \quad (\text{A.2})$$

Now the budget constraint of each working family is given by

$$P_X C_X + P_Z (1+t) C_Z = (1/L)[(W/\beta)L_C + WL + RK + T]$$

Using (A.1) and (A.2) we get

$$\begin{aligned} \{P_X C_Z [P_X / P_Z (1+t)]^{(1/\alpha-1)} + P_Z (1+t) C_Z\} &= \{(W/\beta L) C_Z [W / \beta P_Z (1+t)]^{(1/\alpha-1)} \\ &+ W + R(K/L) + tP_Z (C_Z - Z/L)\} \end{aligned}$$

$$\text{or, } C_Z = \left\{ \frac{(1/L)[WL + RK - tP_Z Z]}{[P_X [P_X / P_Z (1+t)]^{(1/\alpha-1)} + P_Z - (W/\beta L)[W / \beta P_Z (1+t)]^{(1/\alpha-1)}]} \right\} \quad (\text{A.3})$$

Now

$T = tP_Z L(C_Z - Z/L)$. Using (A.3) it becomes

$$\begin{aligned} T = \left\{ \left[\frac{tP_Z (WL + RK - tP_Z Z)}{[P_X (P_X / P_Z)^{(1/\alpha-1)} (1+t)^{(1/1-\alpha)} + P_Z - (1/\beta L)(\beta P_Z)^{(1/1-\alpha)} (W)^{(\alpha/\alpha-1)} (1+t)^{(1/1-\alpha)}]} \right] \right. \\ \left. - tP_Z Z \right\} \quad (\text{A.4}) \end{aligned}$$

Differentiating equation (A.4) with respect to t we get

$$\begin{aligned}
(dT / dt) = & \{(P_Z / B)[(WL + RK - tP_Z Z) + t(L \frac{dW}{dt} + K \frac{dR}{dt} - P_Z(Z + t \frac{dZ}{dt}))] - P_Z(Z + t \frac{dZ}{dt}) \\
& - (\frac{tP_Z}{(1-\alpha)B^2})(WL + RK - tP_Z Z)(1+t)^{\frac{\alpha}{1-\alpha}} [P_X (P_X / P_Z)^{\frac{1}{\alpha-1}} \\
& - (1/\beta L)(\beta P_Z)^{\frac{1}{1-\alpha}} (W)^{\frac{\alpha}{\alpha-1}} + (\alpha/\beta L)(\beta P_Z)^{\frac{1}{1-\alpha}} (1+t)(W)^{\frac{1}{\alpha-1}} (\frac{dW}{dt})]\} \quad (A.5)
\end{aligned}$$

where $B = [P_X (P_X / P_Z)^{(1/\alpha-1)} (1+t)^{(1/1-\alpha)} + P_Z - (1/\beta L)(\beta P_Z)^{(1/1-\alpha)} (W)^{(\alpha/\alpha-1)} (1+t)^{(1/1-\alpha)}]$.

The expression for (dZ / dt) is obtained after totally differentiating equations (11) and (12) and solving by Cramer's rule. As t decreases the domestic price of Z i.e. $P_Z(1+t)$ decreases, which in turn causes the factor prices to change. The input-output coefficients i.e. a_{ji} s would also change as these are functions of the factor price ratios. Given the product-mix there would be a shortage of capital (labour) if the Z sector is more capital (labour) intensive relative to sector X . In both cases sector Z contracts following Rybczynski type effects. However, the sign of (dT / dt) is ambiguous. It depends on the values of parameters like $\alpha, L, P_X, P_Z, \beta$ and t .