Technical Progress and the North–South Terms of Trade

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Abstract

In a classical world where prices of both northern manufactures and southern raw materials are determined by market demand and supply, technical progress in one region leads to a terms-of-trade improvement of the other region irrespective of whether technical progress is labor-saving or raw-material saving. But in a neo-Kaleckian framework characterized by surplus capacity, and an effective demand problem in the North and a capacity constraint in the South, the terms of trade would turn against the South even if the North experienced a higher rate of technical progress than that of the South.

1. Introduction

The essence of the controversial Prebisch–Singer thesis is that the terms of trade have a long-term tendency to turn against the South vis-à-vis the North. The phenomenon of terms-of-trade decline has been sought to be explained in various ways.

One explanation that can be traced in the early writings of Prebisch (1950) and Singer (1950) is the asymmetry in the mechanism of distribution of the fruits of technical progress among the producers and the consumers in the North and the South. In the words of Singer (1950, p. 479): “technical progress in manufacturing industries showed in a rise in incomes while technical progress in the production of food and raw materials in underdeveloped countries showed in a fall of prices.” So while the prices of southern exports declined with improvements in productivity, the export prices of the North did not decline through the same process. As a result, the terms of trade turned against the South in the process of technical progress and growth of the world economy.

As evidence, Prebisch (1950) cited the case of the USA where during the 40 years preceding World War II, manufacturing production costs declined regularly but the movement of prices did not follow this pattern at all.

Another contributing factor mentioned by Singer (1987) is the raw-material-saving technical progress in the North.

The purpose of this paper is to examine the connection between technical progress and the terms of trade of the industrialized North vis-à-vis the raw-material-producing South with the help of a number of North–South long-term growth models developed on Kaldorian lines (Kaldor, 1976, 1979).

The models discount the importance of raw-material-saving technical progress in the North as a factor contributing towards the secular decline in the terms of trade of the South. One model demonstrates the different mechanisms of distribution of the fruits of technical progress between the North and the South, and its impact on the terms of trade in the process of growth as visualized by Prebisch and Singer.

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Apart from the Prebisch–Singer thesis, the present analysis has implications for the recent catching-up debate centered around the new growth theory propagated by Romer (1986) and Lucas (1988).

2. North–South Growth Models of the World Economy

Model 1: Competitive North–South

The world economy is divided into two regions, the South and the North. The South produces a composite commodity \( Y_1 \) using domestic labor and imported machines; it is used as a consumption good in the South and as a raw material in the North. In exchange for raw materials, the South buys machines from the North. The composite commodity \( Y_2 \) produced by the North, using domestic labor and machines and imported raw materials, is consumed only in the North and used as machines in both the regions.

Following Kaldor (1979) it is assumed that in each region, any amount of labor can be hired at a given real wage rate. The same assumption is also made by Conway and Darity (1991) and Dutt (1996). Following the tradition of Kalecki, it is assumed that all wages are consumed and all profits are saved.

Abstracting from the neo-Kaleckian tradition of introducing surplus capacity and an effective demand problem in the North (Taylor, 1983; Dutt, 1988; Sarkar, 1994b, 1997, 1998a), it is assumed that the constraint to growth in both the North and the South is availability of savings. All profits are not only saved but also invested.

Given the labor requirement per unit of output in the South, \( b_1 \), and the wage rate in terms of southern goods, \( w_1 \), the share of profit in total southern output, which is equivalent to the saving rate, \( s_1 \), is given by the following (assuming away depreciation of fixed capital):

\[
s_1 = (1 - b_1 w_1).
\]  

Real income of the southern capitalists (in terms of southern goods), \( Y_{1k} = s_1 Y_1 \), is equal to total real saving, \( S_1 \), and it constitutes the southern export supply to procure northern machines. If \( P \) is the price of northern machines in terms of southern raw materials (the North–South terms of trade), the level of southern investment, \( I_1 = Y_{1k}/P \), is given by the following:

\[
I_1 = \frac{Y_{1k}}{P} = \frac{s_1 Y_1}{P}.
\]

Hence given the productivity of capital, \( q_1 \), the rate of growth of southern output, \( G_1 \), is inversely related to the North–South terms of trade:

\[
G_1 = \frac{s_1 q_1}{P}.
\]

The inverse relationship between the southern growth rate and the North–South terms of trade is shown by the \( G_1 \) line in Figure 1.

Assuming away depreciation of capital, the northern profit income (in terms of northern goods), \( Y_{2k} \), which is equivalent to northern real savings, \( S_2 \), is given by the following:

\[
Y_{2k} = (1 - b_2 w_2 - a_2/P)Y_2,
\]  

where \( b_2 \) and \( a_2 \) are the labor and raw material coefficients (respectively) fixed by technology, and \( w_2 \) is the wage rate fixed in terms of northern goods.

Since all profits are saved and invested, the northern growth rate is given by the following:
Equation (4) shows that the higher the price of northern goods in terms of southern raw materials ($P$), the higher is the northern growth rate due to increased profit and capital accumulation. This is shown by the $G_2$ line in Figure 1.

The macro-balance in the two regions requires $Y_i = E_i (i = 1, 2)$, where $E_i$ is the aggregate demand for output of the $i$th region. The aggregate demand for southern output, $E_1$, has two components, total real income of the southern workers, $w_1 b_1 Y_1$ (as it is fully spent on southern goods), and total raw-material procurement by the northern producers, $a_2 Y_2$. The aggregate demand for output of the North, $E_2$, consists of the northern real wage income, $w_2 b_2 Y_2$ (as the northern workers are assumed to spend the whole of their income on northern goods), and the total profit income of the northern and southern capitalists measured in terms of northern goods (as it is assumed that the whole of profit income in each region is saved and invested to procure machines produced in the North), $Y_{1k} / P + Y_{2k} = s_1 Y_1 / P + Y_{2k} = I_1 + I_2$.

The conditions of macro-balance in the two regions are

\[
Y_1 = E_1 = w_1 b_1 Y_1 + a_2 Y_2, \tag{5}
\]

\[
Y_2 = E_2 = w_2 b_2 Y_2 + (I_1 + I_2), \tag{6}
\]

From (5), it follows that the export supply of the South to the North must match the export demand for southern goods in the North:

\[
(1 - w_1 b_1) Y_1 = a_2 Y_2. \tag{7}
\]

The left-hand side of (7) shows total imports of the South from the North (measured in terms of southern goods), $M_1$, and the right-hand side gives total exports of southern goods to the North, $X_1$. 

\[
G_2 = s_2 q_2, \tag{4}
\]

where $q_2$ is the given productivity of capital and $s_2$ is the saving rate $= Y_{2k} / Y_2 = (1 - b_2 w_2 - a_2 / P)$.
The same condition follows from (6). Equation (6) can be written as

\[ Y_2 - w_2 b_2 Y_2 - I_2 = I_1, \]

where \( I_1 = s_1 Y_1 / P \) and \( I_2 = Y_2 k = (1 - b_2 w_2 - a_2 / P) Y_2 \). Hence follows equation (7).

Granted an initial equilibrium, the global macro-balance can be maintained if the Southern export demand, \( X_1 = a_2 Y_2 \), grows at the rate of growth of southern export supply, \( M_1 = (1 - b_1 w_1) Y_1 \). This requires the two regions to grow at the same rate.\(^5\) This is shown by the point of intersection between the \( G_1 \) and \( G_2 \) lines in Figure 1. The equilibrium terms of trade is shown by the point \( P_e \). Thus, in essence, we have a Kaldorian model (Kaldor, 1975, 1976, 1979; see also Targetti, 1985; Thirlwall, 1986; Molana and Vines, 1989; Sarkar, 1994b; Dutt, 1996).

Algebraically, the equilibrium condition can be written from equations (2) and (4):

\[ (G_1) = s_1 q_1 / p = s_2 q_2 \quad (= G_2). \]  

(8)

From (1), (4), and (8), the solution for the North–South terms of trade can be derived:

\[ P = (s_1 q_1 + a_2 q_2) / (1 - b_2 w_2) q_2, \]  

(9)

where \( s_1 = (1 - b_1 w_1) \).

Now introduce technical progress. For simplicity, technical progress is viewed as some kind of exogenous change in technological parameters, the input coefficients. One can visualize a learning-by-doing process: in the process of growth and capital accumulation, labor productivity improves; the efficient way of using raw materials in the production process becomes gradually known, and so on. Instead of taking this type of technical progress as continuous, it is better to consider it as a discrete progress and consider parametric changes in input coefficients.

Consider first a raw-material-saving technical progress (implying a fall in \( a_2 \)). This leads to a rise in northern profit income, at a given level of output, \( Y_2 \) (equation (3)), and steps up the rate of capital accumulation and growth in the North (equation (4)). This is shown by a rightward shift in the \( G_2 \) line in Figure 1. As a result, the terms of trade turn in favor of the raw-material-producing South (\( P_e \) declines to \( P'_e \) in Figure 1). This is the essence of the argument of Dutt (1996).

The same result holds good if technical progress in the North is labor-saving so that \( b_2 \) falls.

Similarly, the North will face a terms-of-trade improvement if the South faces a labor-saving technical progress so that \( b_1 \) falls and \( s_1 \) rises.

The fact is that we are in a competitive classical world where the fruits of technical progress in one region are transmitted to the other region through free trade and flexible terms of trade. What is important is that the classical mechanism operates even when the nature of technical progress is raw-material-saving and one of the regions is fully dependent on raw material exports. The world visualized by Prebisch (1950) and Singer (1950), however, is not of this type.

**Model 2: Mark-up Pricing and Fixed Money Wage Rate**

Following Kalecki (1971), consider a semi-monopolistic price formation in northern manufacturing. Assume that the price of Northern goods (\( P_2 \)) is set by applying a fixed mark-up (\( m_2 \)) on unit variable cost (ignoring depreciation of capital).

Instead of assuming a constant real wage, it is assumed that any amount of labor can be hired at a money wage rate fixed by wage contracts. The money wage rate is
expected to rise with the rise in the cost of living. Perfect indexation implies a constant real wage as in the earlier model. The constancy of real wage rate coupled with a fixed mark-up specifies the value of the terms of trade which may ensure an equilibrium only by a fluke. To allow for flexible terms of trade, an imperfect indexation of money wage has to be assumed. The simplest way is to take money wage as parametrically given by wage contracts.

The price of northern output is given by the following:

\[ P_2 = (b_2 W_2 + a_2 P_1)(1 + m_2), \quad (10) \]

where \( W_2 \) is the money wage rate fixed by wage contracts and \( P_1 \) is the price of raw materials (measured in a common currency under a fixed exchange rate regime).

Real income of the northern capitalists (profit income measured in terms of northern goods) is

\[ Y_{2k} = k_2 Y_2, \quad (11) \]

where \( k_2 = m_2/(1 + m_2) \), the share of profit in total output (\( Y_2 \)), gives a measure of the degree of monopoly power of the northern capitalists à la Kalecki (1971).

If the whole of profit is saved and invested as assumed in the earlier model, the northern growth rate (\( G_2 \)) will be given by the following:

\[ G_2 = k_2 q_2. \quad (12) \]

Equation (12) shows that the northern growth rate is independent of the terms of trade as shown by the vertical line \( G_2 \) in Figure 2. The rate of growth of southern output is given by equation (2). It is shown by the \( G_1 \) line. The point of intersection between the two lines determines the terms of trade.

Algebraically, the equilibrium solution of the terms of trade can be derived from the equality of the two growth rates given by equations (2) and (12):
The raw-material coefficient $a_2$ does not appear in the expressions for the northern growth rate given by (12) and the equilibrium terms of trade given in (13). That means a decline in raw-material requirements per unit of output has no impact on the northern growth rate, nor does it have an effect on the terms of trade. That is to say, the fruits of raw-material-saving technical progress in the North are not passed on to the South in the form of better terms of trade. This is also true for a labor-saving technical progress (a decline in the per-unit labor requirements, $b_2$).

On the contrary, a decline in the per-unit labor requirements in the South for a given real wage rate will step up the rate of capital accumulation and growth of southern output as shown by equations (1) and (2). Graphically this is shown by a rightward shift in the $G_1$ line to $G_1'$ in Figure 2. This higher rate of growth of southern output pushes up the relative price of northern machines to $P_e'$ and consequently the southern growth rate comes back to the level of initial equilibrium, $G_e$.

Critics, however, may question the fixity of mark-up in the face of technical progress. It may be argued that as raw-material-saving or labor-saving technical progress takes place, the mark-up rate is raised. In our framework, this pushes up the rate of saving and capital accumulation as shown by a shift in the $G_2$ line to $G_2'$ in Figure 2. Hence, the conclusion of model 1 will hold good: technical progress in the North will lead to an improvement in the terms of trade of the South ($P_e$ falls to $P_e'$).

**Model 3: Mark-up Pricing of Southern Raw Materials**

Assume that the price of northern goods is determined in the market as in model 1 while the South can fix the price of raw materials (the so-called OPEC phenomenon). Consider that the price of raw materials ($P_1$) is set by applying a fixed mark-up ($m_1$) on unit labor cost:

$$P_1 = b_1 W_1 (1 + m_1),$$  \hspace{1cm} (14)

where $W_1$ is the money wage rate fixed by wage contracts. Southern profit income is

$$Y_{1k} = k_1 Y_1,$$  \hspace{1cm} (15)

where $k_1 = m_1/(1 + m_1)$, a measure of monopoly power of the raw-material-producing South.

Given (15), equation (2) showing the rate of growth of southern output is to be modified:

$$G_1 = k_1 q_1 / P.$$  \hspace{1cm} (16)

Equalizing the growth rates of the South and the North ($G_1 = G_2$) and using (4) and (16), the equilibrium terms of trade can be solved:

$$P = (a_2 q_2 + k_1 q_1) / (1 - b_2 w_2) q_2.$$  \hspace{1cm} (17)

The solution in equation (17) is similar to that of model 1 in equation (9), the only difference being that $s_1$ is replaced by $k_1$. As in model 1, the fruits of technical progress in the North are passed on to the trading partner, the South, in the form of better terms of trade irrespective of whether technical progress is raw-material-saving or labor-saving.
Technical progress in the South, on the contrary, does not lead to any improvement in the terms of trade of the North at a given mark-up. If, however, the mark-up rate rises with technical progress in the South, the North will face a terms-of-trade improvement.

Model 4: Surplus Capacity and Effective Demand Problem in the North

In the structure of model 2, the neo-Kaleckian (or “structuralist”) feature is introduced. It is assumed that all profits in the North are saved but not necessarily invested, because of surplus capacity.

The relationship between capital ($K_2$) and output ($Y_2$) in the North is given by

$$Y_2 = u_2 q_2 K_2,$$

where $u_2$ is the rate of capacity utilization <1 (by assumption) and $q_2$ is the given productivity of capital.

The desired rate of capital accumulation ($I_2/K_2$) is assumed to be a linear function of the rate of profit, $r_2$:

$$I_2/K_2 = d_2 + e_2 r_2,$$

where $d_2$ and $e_2$ are positive parameters and $r_2 = Y_{2k}/K_2$ is the rate of profit.

Given (10) and (11) due to mark-up pricing, the rate of profit is a rising function of capacity utilization (using (18)):

$$r_2 = k_2 q_2 u_2,$$

where $k_2 = m_2/(1 + m_2)$.

In this model, the macro-balance condition (7) is no longer sufficient; it ensures equilibrium in the market for raw materials. Granted (7), the equilibrium in the market for northern goods requires a balance between saving and investment: $S_2 = I_2$. Dividing both sides by the capital stock, $K_2$, we have

$$I_2/K_2 = S_2/K_2,$$

where $S_2 = Y_{2k} = k_2 Y_2$.

This equilibrium is achieved through output adjustment and changes in capacity utilization. From (18)–(21), the equilibrium rate of capacity utilization can be solved:

$$u_2 = d_2/k_2 q_2 (1 - e_2),$$

where it is to be assumed that $e_2 < 1$ for a meaningful solution of capacity utilization, $u_2$.

From (19), (20), and (22), the equilibrium rate of capital accumulation and growth can be derived (this is also the equilibrium rate of profit):

$$G_2 = d_2/(1 - e_2).$$

The solution of the terms of trade can be derived by equalizing the two growth rates ($G_1 = G_2$) and using equations (2) and (23):

$$P = s_1 q_1/G_2,$$

where $G_2$ is given by (23).
In essence, this is model 2 and Figure 2 is applicable. The interesting conclusion that follows from this model is that a rise in the mark-up rate has no effect on the northern rate of capital accumulation and growth. That means, even if technical progress in the North is accompanied by a rise in the mark-up rate (and growth of monopoly power), the North–South terms of trade remain unaffected.

In the earlier models, technical progress and higher profit margin leads to a higher rate of capital accumulation as both the North and the South face “exhilarationist” regimes of profit-led growth (Bhaduri and Marglin, 1990; Taylor, 1991; Sarkar, 1993). In the present model, the South faces an “exhilarationist” regime while the North faces an indifferent regime experiencing neither a profit-led growth nor a wage-led expansion (of a “stagnationist” regime).  

Dutt (1988) presented a “stagnationist” North–South model and tried to explain the phenomenon of secular decline in the terms of trade of the South through growth of northern monopoly power and rising mark-up which leads to a deceleration of northern growth. Darity (1990), on the other hand, had an “exhilarationist” model where a rise in the northern mark-up leads to a fall in the terms of trade of the North (Sarkar, 1997). The conclusion of Darity (1990) can be derived from model 2 as shown by equations (11)–(13). All these point to the ambiguities in the relationship between growth of northern monopoly power and the long-term behavior of the North–South terms of trade.

An alternative explanation of the phenomenon of secular decline in the terms of trade of the South can be found in the present model. This comes very close to the original ideas of Prebisch (1950) and Singer (1950). Technical progress in the North (a reduction in $b_2$ and/or $a_2$) leads to a rise in the real wage rate of the northern workers, $W_2/P_2$; profit can also rise through a rise in the mark-up. But there is no effect on the terms of trade.

Technical progress in the South (leading to a fall in $b_1$ or $q_1$), on the other hand, leads to a fall in the terms of trade of the South ($P$ rises as shown by (1) and (24)). In the process of long-term growth and development, both the North and the South have undoubtedly experienced a steady technical progress. Given the present structure, this process of growth and technical progress implies a secular decline in both the barter and factorial terms of trade of the South (given the fact that the South did not experience a sufficiently higher rate of technical progress than the North).

Recently, Sarkar (1998a) presented a North–South model of endogenous technical progress and showed the phenomenon of secular decline in the process of long-term growth and technical progress.

Consumer goods trade between the North and the South can be introduced into the present structure. This gives an additional factor behind the secular decline stressed by Sarkar (1997): export of older goods from the South for imports of newer goods from the North in a product-cycle scenario so that southern exports have a lower income elasticity than that of the northern exports. Given this factor, the South will face a secular decline in the terms of trade if it does not grow at a sufficiently lower rate than the North.

The foregoing analysis can be connected with the catching-up debate (for details of the history of the debate, see Sarkar (1998b)) rejuvenated recently by the new growth theory of Romer (1986) and Lucas (1988). In none of the models presented here does the South experience a consistently higher rate of growth than what is experienced by the North, so that the wide gap in the standards of living between the North and the
South will remain. Any attempt to grow at a higher rate to catch up would lead to a regular terms-of-trade loss. That means it would have to make more and more real resource transfers to pay for a given amount of machine requirements. If the raw-material exports constitute exhaustible resources (such as petroleum), the impact of the terms-of-trade loss would be more damaging to the long-term welfare of the South.

3. Concluding Observations

In a classical world where prices of both northern manufactures and southern raw materials are determined by market demand and supply, technical progress in one region leads to a terms-of-trade improvement of the other region irrespective of whether technical progress is labor-saving or raw-material-saving. Such technical progress promotes growth in both the regions.

Even under mark-up pricing, this result will hold good if it is expected that the mark-up can be raised in the event of technical progress so that the increased profit margin will step up saving and investment rates.

But in a neo-Kaleckian dual-economy framework characterized by surplus capacity, and an effective demand problem in the North and a capacity constraint in the South, this result does not hold. In this type of framework, the terms of trade turn against the South even if the North experiences a higher rate of technical progress. This happens because the mechanisms of distribution of the fruits of technical progress in the two regions are different. The fruits of technical progress in the North are distributed in the form of higher incomes to the northern workers and capitalists; in the South, these are distributed in the form of lower prices to the consumers. As a result, in the process of growth and technical progress, the standard of living of the northern people improves while the South faces a secular decline in the terms of trade. This is the world visualized by Prebisch (1950) and Singer (1950).

References


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Notes

1. There is a great debate concerning the statistical validity of the Prebisch–Singer thesis. For details of the controversy and strong support of the thesis, see Spraos (1983), Thirlwall et al. (1985), Sarkar (1986a,b, 1994a), Sarkar and Singer (1991, 1993) etc.
2. Historically, the South was a raw-material-exporting region. Today manufactures dominate the export structure of the South as a whole (see Sarkar, 1986b). Of course, the number of southern countries that are primarily manufacturing-goods exporters still remains quite small.
3. The goods produced by the South can be taken as coarse goods directly consumed by the southern workers, whereas these are processed in northern factories in order to be consumed in the North (e.g., tealeaves and teabags, raw coffee and instant coffee, simple rice and non-sticky quick-cook rice).
4. This is the contention of Kaldor (1975, p. 354): “For over longer periods Ricardo’s presumption that manufacturers and traders only save in order to invest, so that the amount or the proportion of savings or both would adapt to changes in the opportunities for, or profitability of, investment, seems to me more relevant than the Keynesian assumption for explaining the true constraints on the growth of production and employment in the ‘capitalist’ industrial sector.”
5. Granted the balance of trade equilibrium, \( X_1 = a_2 Y_2 = M_1 = (1 - b \omega_1) Y_1 \), it follows that \( Y_2/Y_1 = (1 - b \omega_1)/a_2 \). That is to say, the ratio of output of the two regions is fixed and their growth rates are equal in equilibrium.
6. A rise in real wages and a change in income distribution in favor of the workers reduces the rate of profit and dampens the rate of capital accumulation. This is the “profit squeeze” force. If this force dominates the scene, stimulation of investment requires reductions in the real wages and consequent increases in the rate of profit. This is the case of an “exhilarationist” economy characterized by profit-led growth.

In contrast, a fall in real wages and a change in income distribution against the workers reduces effective demand and creates the problem for the capitalists of realizing production plans. This is the “realization crisis” of a capitalist system. The realization factor reduces the rate of capacity utilization, which in turn dampens the inducement to invest. If this factor dominates the scene, investment and output can be stimulated by a redistribution of income toward wages (Sarkar, 1993, pp. 787–88). An output increase “in response to redistribution toward labor may be called ‘stagnationist’ or ‘wage led’—redistribution favoring workers activates an otherwise stagnant system” (Taylor, 1991, p. 72).
7. This was also observed by Findlay (1980, 1981) in a model of Solow-type North and Lewis-type South.