

1970

The Terms of Trade and Economic Growth: A Theoretical and Empirical Analysis

Raveendra Batra

Gerald W. Scully

Follow this and additional works at: <https://ir.lib.uwo.ca/economicsresrpt>

 Part of the [Economics Commons](#)

Citation of this paper:

Batra, Raveendra, Gerald W. Scully. "The Terms of Trade and Economic Growth: A Theoretical and Empirical Analysis." Department of Economics Research Reports, 7026. London, ON: Department of Economics, University of Western Ontario (1970).

RESEARCH REPORT 7026

THE TERMS OF TRADE AND ECONOMIC GROWTH:
A THEORETICAL AND EMPIRICAL ANALYSIS*

by

Raveendra Batra

and

Gerald W. Scully

* Paper to be presented at the Econometric Society Meetings, Detroit, December, 1970.

The Terms of Trade and Economic Growth:
A Theoretical and Empirical Analysis

by Raveendra Batra and Gerald W. Scully*

Widespread controversy has existed concerning the question of whether there is a secular tendency for the terms of trade in the 'peripheral' or less developed countries to deteriorate. The controversy is of some importance, since it is generally believed that the economic growth and welfare of a country are directly connected with its terms of trade. Any evidence of a secular deterioration in the terms of trade is viewed with alarm, because of its implications for economic development and for economic policies designed to foster economic growth. The view that the terms of trade of the less developed countries have deteriorated over time is most frequently associated with the writings of R. Prebisch [17, 23], H. Singer [22], W. A. Lewis [14, 15], among others. A contrasting position has been taken by G. Haberler [11] and M. J. Flanders [8], among others. The two positions are worth reviewing briefly.

Prebisch argues that "historically, the spread of technical progress has been uneven, and this has contributed to the division of the world economy into industrial centers and peripheral countries engaged in primary production, with consequent differences in growth" [14, p. 251]. The higher rate of growth in the developed (center) countries did not lead, contrary to the predictions of classical trade theory, to a lowering of the price of industrial output, but resulted instead in higher wages or profits to the domestic factors of production. It was alleged that this was due to monopoly in industrial factor or product markets. On the other hand, the fruits of technical progress in the

less developed (peripheral) countries were transmitted to the developed countries in the form of lower product prices. In addition, because of Engels law, the demand for the primary output from the less developed countries has declined relative to the income growth in the developed countries. Because of the monopoly in the factor and product markets of the developed countries the prices of the industrial imports to the less developed countries have risen secularly. Because of the competitive nature of primary production and the operation of Engels law, the export prices of less developed countries have fallen secularly. Correspondingly, the operation of these two phenomena has produced a deterioration of the terms of trade of less developed countries, which can be inferred empirically from an examination of the terms of trade of the United Kingdom over the period 1876-1938. The deterioration in the terms of trade in turn represents a considerable barrier to the economic development of the periphery. Accordingly, in the interests of economic growth some protectionist policy designed to favorably alter the terms of trade of the less developed countries should be pursued.

While Haberler [11] tacitly concedes the direct connection between the terms of trade and economic growth he has systematically criticized Prebisch's views on both empirical and conceptual grounds.¹ Haberler argues that inferences about the terms of trade of less developed countries drawn from the inverse of the United Kingdom's terms of trade during the period 1876-1938 suffer from a number of weaknesses. First, the commodity or net barter terms of trade for the United Kingdom are likely to be biased due to changes in the commodity mix making up the index. Over this period a variety of new commodities appear and significant quality changes in industrial output occur and these changes are not taken into account in the indexes. Additionally, the index of the terms of trade leaves out services and changing transportation costs are ignored.

Even in a country to country comparison of the terms of trade it is inappropriate to treat the terms of trade of one partner as an index of the terms of trade of the other partner when there is a change in transportation costs. Furthermore, the results are sensitive to the extent that the United Kingdom is representative of the pattern in the terms of trade of the developed nations. Kindleberger [13] and Morgan [16] have obtained different results in the terms of trade for different industrial countries. Finally, Haberler believes that the Prebisch argument suffers from a statistical fallacy of generalization in that it is argued that all of the primary producing countries, no matter what the characteristics of their economic structure, are believed to suffer from the same secular deterioration in their terms of trade. He concludes that

"the support which these findings provide for the thesis under consideration is, however, very weak. For the underlying indices suffer from all the defects mentioned above. . . . We may conclude that it has not been established that the terms of trade have deteriorated for underdeveloped countries over the stated period."
[11, p. 283]

In addition to these empirical criticisms, Haberler takes issue with the reasons Prebisch gives for the secular deterioration in the terms of trade of the less developed countries. He points out that while it is true that the fruits of technical progress have been passed on in the form of higher factor incomes rather than lower industrial prices; this phenomenon has no particular relationship to the world prices of industrial commodities and, hence, the terms of trade. Haberler accuses Prebisch of confusing "movements in the absolute price level with shifts in the relative prices of manufactures and primary products" [11, p. 284]. He observes that, actually, world competition in industrial commodities is more keen today than in the 19th century. Finally, with respect to the explanation of the low income elasticity of demand for primary goods as the source of the declining prices of primary exports, Haberler observes that Engle's law, while valid, after all only applies to food not raw materials and that relative prices depend as much upon supply as upon demand.

However, there is room for honest men to disagree, especially when the argument is essentially empirical in nature and the causes identified are only indirectly connected to the main issue. Thus, despite the criticisms, many believe that Prebisch has correctly identified, if not proved, the problem, if not its causes. However, Prebisch's argument is susceptible to criticism at a far more fundamental level, which makes criticisms of the price indices and causes of the deterioration unnecessary. That is, within the framework of a two-country, two-commodity, two-factor model, if interindustry or interregional wage differentials are assumed to exist, which is certainly the more reasonable assumption², the terms of trade are not directly connected to economic growth. It is the purpose of this paper to show mathematically and graphically that a deterioration (improvement) in the terms of trade does not necessarily imply a decrease (increase) in economic welfare, i.e., that the Prebisch hypothesis can only hold under restricted assumptions.³ Additionally, an empirical test of the Prebisch hypothesis, which relates the terms of trade and the rate of change of money national income, is offered covering some 34 countries over the period 1948-1968.

II. The Model

To derive our results we use a two-country, two-commodity (X_1 and X_2), two-factor (capital, K , and labor, L) model. X_1 is the exportable commodity, while X_2 is importable. Unless relaxed, the following assumptions will be maintained throughout the discussion: (1) production functions are homogeneous of degree one; (2) there is perfect competition in commodity markets; (3) factor markets are characterized by perfect internal mobility and perfect factor-price flexibility; (4) factor supplies are inelastic; (5) there is full employment of factors as long as assumption (3) holds; (6) the foreign trade market is stable and inferior goods are absent.

Commodities X_1 and X_2 are produced with the following production functions:

$$(1) X_1 = F_1(K_1, L_1)$$

and

$$(2) X_2 = F_2(K_2, L_2).$$

Denoting μ_i as the marginal product of labor and v_i as the marginal product of capital in the i th industry, we write

$$\mu_i = \partial F_i / \partial L_i, \text{ and}$$

$$v_i = \partial F_i / \partial K_i, \quad i = 1, 2.$$

Under perfect competition the price of each factor of production is equal to the value of its marginal product. Let p_i be the price of the i th commodity, w_i the wage rate and r_i the rental rate of capital in the i th industry, then

$$(3) w_i = p_i \mu_i, \text{ and}$$

$$(4) r_i = p_i v_i.$$

Assume, now, that the rate of return on capital is the same in both industries, but that there is a stable wage differential between the industries⁴, that is

$$(5) r_1 = r_2 = p_1 v_1 = p_2 v_2, \text{ and}$$

$$(6) \alpha w_1 = w_2 \quad \text{or}$$

$$\alpha p_1 \mu_1 = p_2 \mu_2, \text{ where } \alpha \neq 1.$$

With full employment

$$(7) L_1 + L_2 = \bar{L} \quad \text{and}$$

$$(8) K_1 + K_2 = \bar{K},$$

where the bars indicate that L and K are in inelastic supply.

Let Y equal national income. Then,

$$(9) Y = p_1 X_1 + p_2 X_2, \text{ or}$$

$$Y = p X_1 + X_2,$$

where $p (= p_1/p_2)$ is the price of X_1 in terms of X_2 . Under free trade p equals the international terms of trade.

Differentiating (1) and (2) totally and dividing we obtain a relationship for the marginal rate of transformation:

$$(10) \quad \frac{dX_2}{dX_1} = \frac{\mu_2 dL_2 + v_2 dK_2}{\mu_1 dL_1 + v_1 dK_1} .$$

From (5) and (6) we observe that the international terms of trade may be expressed as the ratio of the factor remunerations between the industries, that is

$$(11) \quad p = p_1/p_2 = v_2/v_1 = \mu_2/\alpha\mu_1 .$$

In view of the assumptions of full employment and inelastic supply of the factors, it is clear that the differentiation of (7) and (8) yields

$$(12) \quad dL_1 = -dL_2 \text{ and}$$

$$(13) \quad dK_1 = -dK_2 ,$$

so that (11) can be written as

$$(14) \quad p = \frac{-v_2 dK_2}{v_1 dK_1} = \frac{-\mu_2 dL_2}{\alpha\mu_1 dL_1} , \text{ or}$$

$$p = \frac{-(v_2 dK_2 + \mu_2 dL_2)}{v_1 dK_1 + \alpha\mu_1 dL_1} , \text{ or}$$

$$(15) \quad \frac{p(v_1 dK_1 + \alpha\mu_1 dL_1)}{v_1 dK_1 + \mu_1 dL_1} = - \frac{v_2 dK_2 + \mu_2 dL_2}{v_1 dK_1 + \mu_1 dL_1} .$$

It is clear from (10) and (15) that

$$(16) \quad \frac{dX_2}{dX_1} = -\beta p ,$$

where $\beta = (v_1 dK_1 + \alpha\mu_1 dL_1)/(v_1 dK_1 + \mu_1 dL_1)$.

If $\alpha = 1$, that is if $w_1 = w_2$ (i.e., no interindustry wage differential exists, then $\beta = 1$, and from (16) we obtain the usual result that the marginal rate of transformation is equal to the negative of the commodity price ratio. However, if a wage differential exists, which is usually the case even in the most developed nations where factor markets are less imperfect, then α and, hence, β cannot be equal to unity. Specifically,

$$\beta > 1, \text{ if } \alpha > 1,$$

that is to say that β is directly related to α . The larger the wage differential the greater will be the divergence between the marginal rate of transformation and the negative of the commodity price ratio.⁵ This is the first important result obtained.

From (16) we can write

$$(17) \quad \beta p \frac{dX_1}{dp} + dX_2/dp = 0.$$

Now, we can show the effect of a change in the terms of trade, p , on national income, Y . Differentiating (9) with respect to p , we have

$$(18) \quad \frac{dY}{dp} = p \frac{dX_1}{dp} + \frac{dX_2}{dp} + X_1.$$

Substituting dX_2/dp from (17) into (18), we obtain

$$(19) \quad \frac{dY}{dp} = p \frac{dX_1}{dp}(1-\beta) + X_1, \text{ or}$$

$$(20) \quad \frac{dY}{dp} = X_1 [1 + \eta_1(1-\beta)],$$

where $\eta (= \frac{p}{X_1} \frac{dX_1}{dp})$ is the elasticity of the production of X_1 with respect to the terms of trade. It can be observed that η_1 is positive.

From expression (20) the following results can be derived.

(1) If $\beta = 1$, that is, if there is no wage differential between the two industries,

$$\frac{dY}{dp} = X_1 > 0.$$

Since X_1 is the exportable commodity, a rise in p means that there is an improvement in the domestic country's terms of trade and a fall in p means that there has been a deterioration. It is clear that an improvement (deterioration) in the terms of trade, in the absence of an inter-industry wage differential, results in an increase (decrease) in national income. This is the premise on which the Prebisch hypothesis is based.⁶

(2) If $\beta < 1$, since the elasticity of the production of X_1 with respect to the terms of trade, η , is positive the improvement (deterioration) in the terms

of trade still yields an increase (decrease) in national income. In fact the rise (fall) in national income is even greater than in the case where no inter-industry wage differential existed at all. If $\beta < 1$, then $\alpha < 1$, meaning that $w_1 > w_2$. In other words, if the wage differential works against X_1 , the exportable commodity, and if X_1 continues to be exported, the conventional result, that an improvement (deterioration) in the terms of trade results in an increase (decrease) in welfare, continues to hold.⁷

(3) If $\beta > 1$, i.e., if $\alpha > 1$ or $w_1 < w_2$, that is, if the wage differential works against X_2 , the importable commodity⁸, it is possible that $dY/dp < 0$.

This will occur if

$$(21) \quad 1 + \frac{1}{\eta} < \beta.$$

In other words, if β is greater than unity plus the inverse of the elasticity of export production, then an improvement in the terms of trade will lead to a decline in national income. Symmetrically, a deterioration in the terms of trade will lead to a rise in national income. Therefore, the unique relationship between the terms of trade and national income breaks down in the presence of an inter-industry wage differential, provided $\beta > 1$.

Now, a change in the terms of trade may result from economic growth. The Prebisch theory implies that a deterioration in a country's terms of trade will lower its economic growth. Suppose G stands for the growth agent. Then, the actual change in national income, denoted dY^* , as a result of growth can be written as:

$$(22) \quad \frac{dY^*}{dG} = \frac{dY}{dG} + \frac{dY}{dp} \cdot \frac{dp}{dG},$$

where dY/dG denotes the rise in national income as a result of economic growth at constant commodity prices. Substituting dY/dp from (20) into (22), we have

$$(23) \quad \frac{dY^*}{dG} = \frac{dY}{dG} + \frac{dp}{dG} [X_1 \{1 + \eta_1(1 - \beta)\}].$$

From (23), the following results can be deduced.

(1) If there is no inter-industry wage differential, i.e., $\beta = 1$, then an improvement in the terms of trade raises the rate of economic growth above that which would result at constant commodity prices. Conversely, a deterioration in the terms of trade will cause the rate of economic growth to be slower than would result at constant commodity prices--the Prebisch case. Thus, Prebisch's hypothesis that the secular deterioration in the terms of trade of the underdeveloped countries historically lowered their growth rates is valid if there is no inter-industry wage differential.

(2) If $\beta < 1$, i.e., $\alpha < 1$ or $w_1 > w_2$, that is, if the wage differential works against X_1 , the exportable commodity, then an improvement in the terms of trade raises the rate of economic growth above that which would result at constant commodity prices, but this increase in the growth rate will be even greater than was the case when $\beta = 1$. Conversely, a deterioration in the terms of trade will result in a rate of growth slower than that which would prevail under constant commodity prices and this rate will be even slower than that which would occur if $\beta = 1$. Again, Prebisch's hypothesis is valid, only the magnitude of the effect is changed.

(3) However, if $\beta > 1$, i.e., $\alpha > 1$ or $w_1 < w_2$, that is, if the wage differential works against X_2 , the importable commodity, then an improvement in the terms of trade will result in a rate of economic growth lower than that which would have occurred at constant commodity prices. The necessary condition for this result to occur is again given by (20). Furthermore, if $dY/dG < -dp/dG[X_1\{1+\eta_1(1-\beta)\}]$, then $dY^*/dG < 0$, that is, Bhagwati's [4] case of immerring growth will occur. On the other hand, quite contrary to the Prebisch hypothesis, a deterioration in the terms of trade will result in a rate of economic growth higher than that which would have resulted in the presence of constant commodity prices. In other words, the traditional results that an improvement in the terms of trade must raise a country's growth rate, and a

deterioration must lower it, may not hold in the presence of an inter-industry wage differential such that $\beta > 1$. Thus, the relationship between the rate of economic growth and the terms of trade is not unique.

III. A Diagrammatic Explanation of the Theorems

That an improvement in the terms of trade results in an increase in the rate of growth of national income when the inter-industry wage differential is absent is shown in Figure 1. Observe in the diagram that TT' is the transformation curve before growth takes place, that the slope of AB furnishes the price of X_1 relative to X_2 ($p_1/p_2 = p$), that P is the production point and C the consumption point under free trade with the level of welfare given by U_1 . As a result of economic growth, the transformation curve shifts from TT' to GG' , the production point moves from P to P' , the consumption point rises from C to C' , and the level of welfare improves from U_1 to U_2 , with the commodity price-ratio remaining constant (now given by the slope of EF parallel to AB). Suppose as a result of growth, the terms of trade improve from the slope of EF to that of DN . As a result of the improvement in the terms of trade, the production point shifts to P'' , the consumption point shifts to C'' , and welfare improves further to U_3 . Therefore, an improvement in the terms of trade arising from growth increases the rate of increase in economic welfare in the absence of an inter-industry wage differential (reflected by the fact that the price lines AB , EF and ND are tangent to the transformation curves.)

We have also demonstrated mathematically the opposite case, that a deterioration in the terms of trade due to economic growth lowers the rate of increase in economic welfare, the Prebisch case, and this theorem is proved diagrammatically in Figure 2. As before, growth at the constant commodity price ratio moves the production point from P to P' and the consumption point from

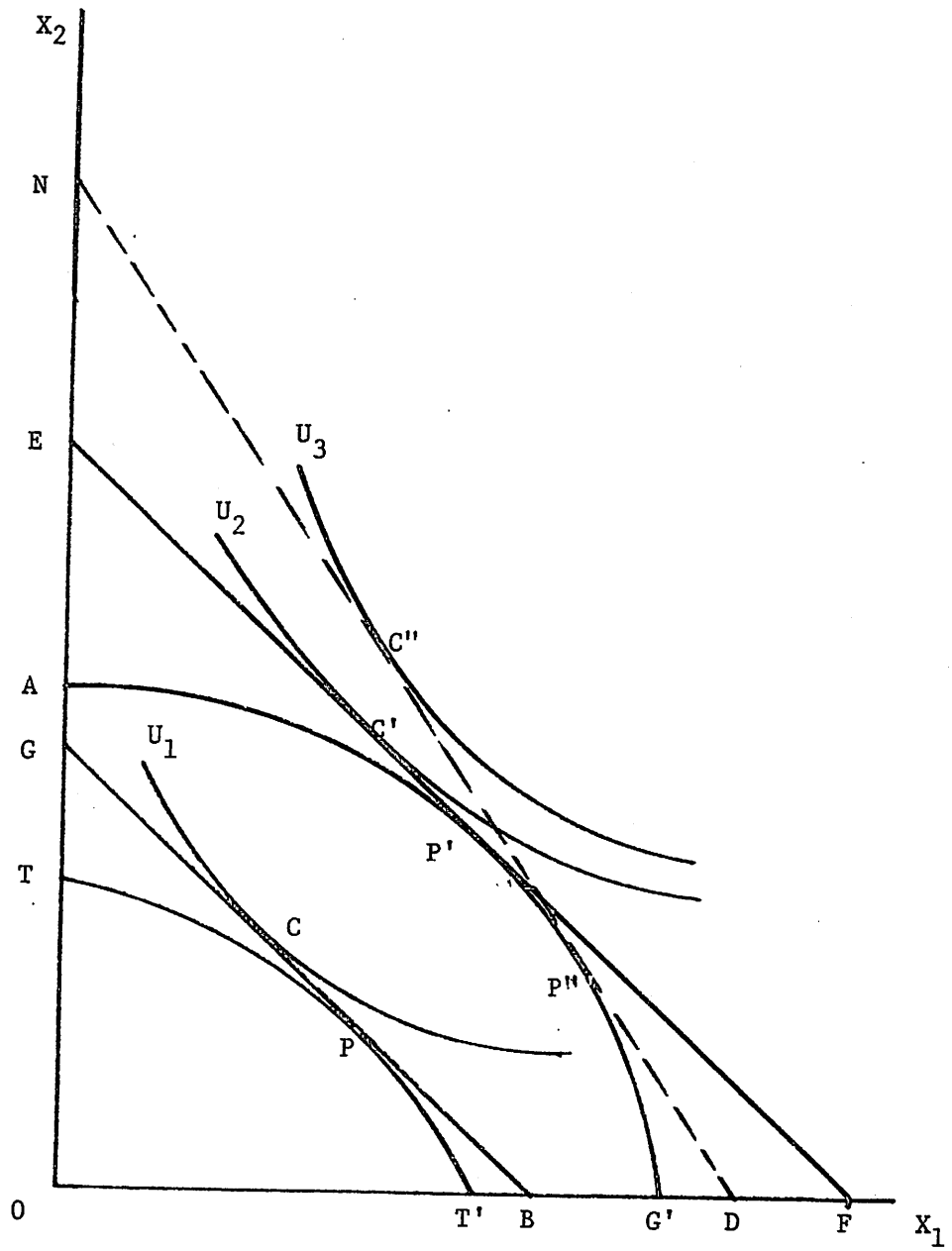


Figure 1

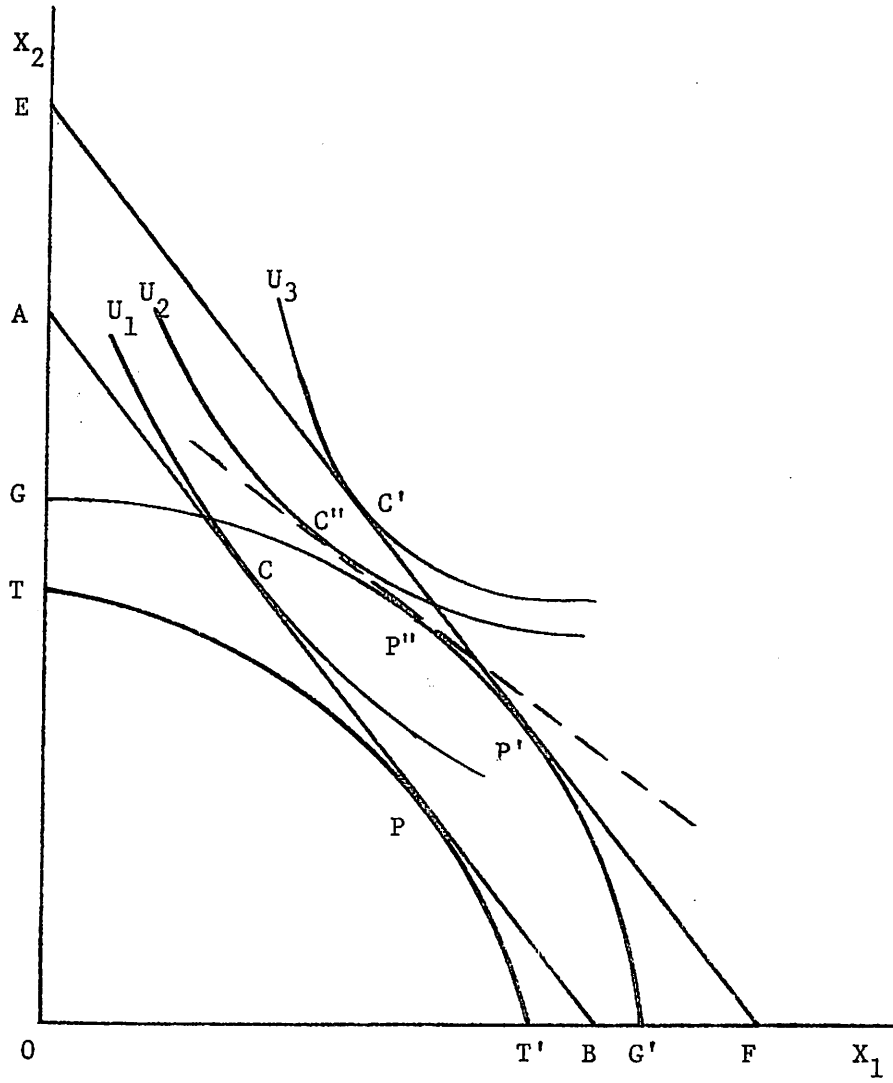


Figure 2

C to C' and improves welfare from U_1 to U_3 . A deterioration in the terms of trade due to growth shifts the production point to P'', lowers the consumption point from C' to C'', and reduces welfare from U_3 to U_2 . Thus, a deterioration in the terms of trade, in the absence of an inter-industry wage differential, adversely affects the rate of increase in welfare (again, observe that the price lines are all tangent to the transformation curves). Indeed, if the deterioration is very large, economic growth may be immiserizing. (See Bhagwati [5]).

We have shown that in the presence of an inter-industry wage differential the relationship between the terms of trade and the rate of increase in economic welfare is no longer direct. Specifically, the existence of an inter-industry wage differential causes the transformation curve to shrink-in and the equality between the commodity-price ratio and the marginal rate of transformation is disrupted. In Figure 3, we posit that the wage differential works against X_1 , the exportable commodity, and this fact is represented schematically by drawing the price lines steeper than the slope of the transformation curve at the intersection points.⁹ With TT' being the transformation curve in the absence of growth, P is the production point and C is the consumption point on the commodity-price ratio, given by the slope of AB, yielding a welfare level of U_1 . Growth shifts the transformation curve outward to GG', the production point at constant commodity prices moves to P' and the consumption point to C', so that the level of welfare improves to U_2 .¹⁰ An improvement in the terms of trade, from EF to ND, resulting from growth, shifts the production point to P'' and the consumption point to C'', so that the level of welfare improves further to U_3 . The traditional result, then, relating the improvement in the terms of trade due to growth to a rise in the rate of increase in economic welfare holds in the presence of an inter-industry wage differential, providing the wage differential works against the exportable commodity.

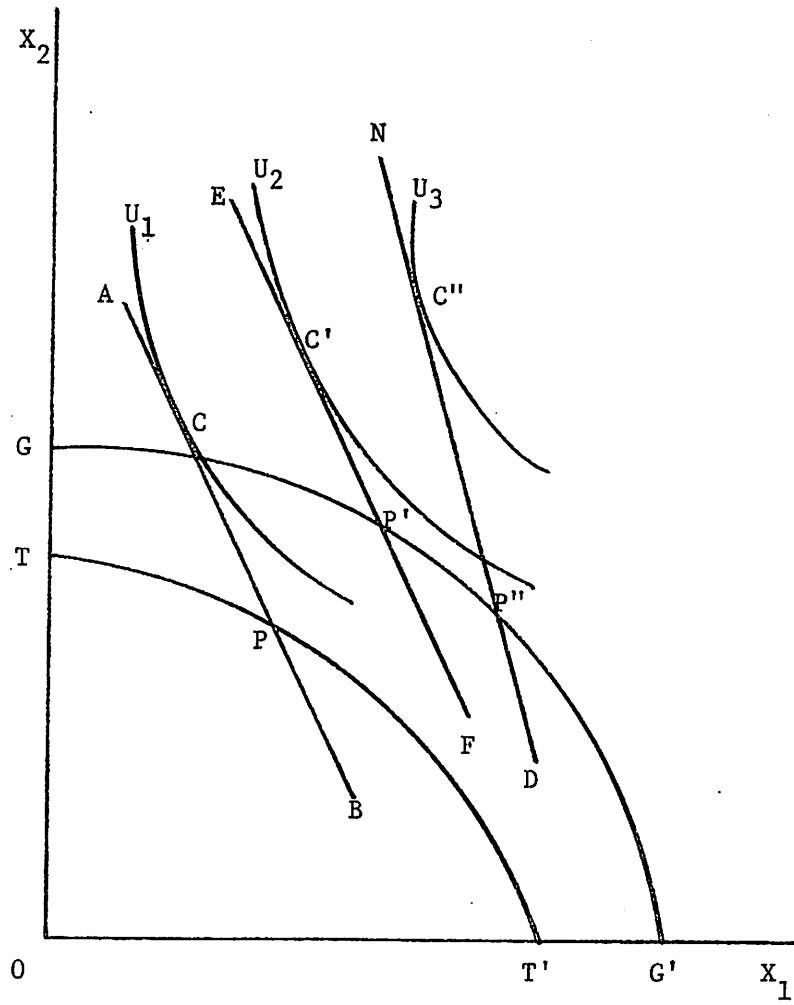


Figure 3

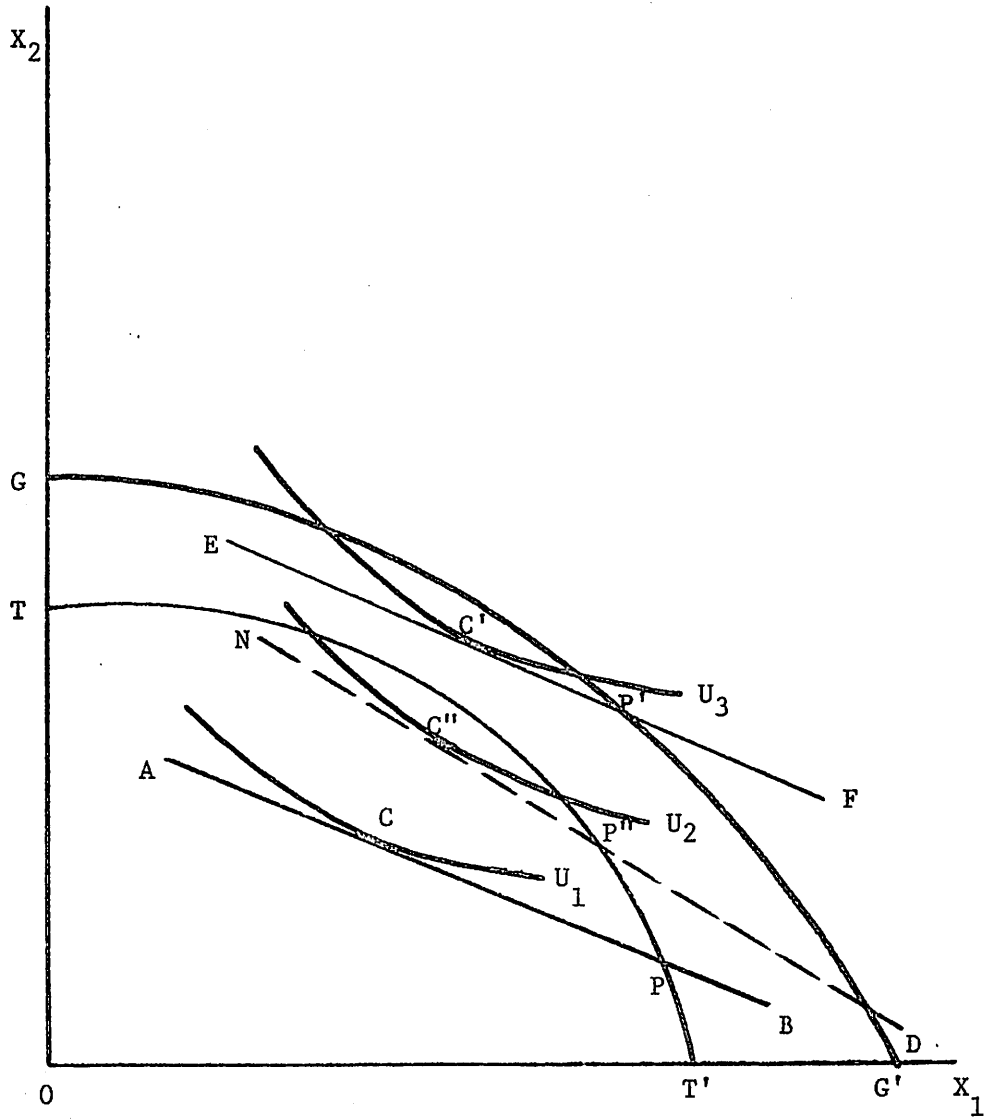


Figure 4

However, as is likely to be the more common case in underdeveloped countries, where the wage differential works against the importable commodity, an improvement in the terms of trade may result in a rate of increase in economic welfare less than that which would have occurred at constant commodity prices. This is shown in Figure 4, where the price lines, AB, EF, and ND, are shown to be less steep than the slopes of the transformation curves at the respective intersection points, showing that the wage-differential works against X_2 , the importable commodity. Economic growth improves welfare from U_1 to U_3 if commodity prices are constant (as AB is parallel to EF). However, a resultant improvement in the terms of trade, which increases the steepness of the price line EF to ND, lowers the level of welfare to U_2 , showing that there may be no unique relationship between the improvement in the terms of trade and the rate of increase in welfare. This disproves the Prebisch hypothesis.

IV. Empirical Results

The theoretical analysis provided above led to the conclusion that when a wage differential is present there may be no direct relationship between the terms of trade and economic growth. Some empirical verification of this theorem would seem useful. Fortunately, a data series does exist for enough countries to undertake a meaningful and fairly extensive test of the theorem. Specifically, data on national income for a number of countries is available from United Nations [24] and International Monetary Fund [12] sources, covering at most the years 1948 to 1968. A statistical series for this period on prices of exports and of imports by country is also available from International Monetary Fund [12] sources. While the usual criticisms of the accuracy of national income accounts in the non-advanced countries applies, it is felt that a test of the relationship between the terms of trade and economic growth for 34 countries (see Table 1), including 15 underdeveloped countries, should

Table 1

Simple Correlations Relating Terms of Trade and Rate of Change
of Money National Income in 34 Countries

<u>Country</u>	<u>Years</u>	<u>Simple Correlation Coefficient, r^1</u>
Australia	1950-68	.1796
Austria	1950-68	.1713
Belgium	1953-67	.2056
Canada	1948-68	-.2573
Ceylon	1950-66	.3761
Chile	1950-66	-.0625
Colombia	1950-67	-.3476
Costa Rica	1950-68	.1022
Denmark	1948-68	.3897
El Salvador	1958-67	-.5578
Finland	1948-68	.0989
France	1951-68	-.3290
Germany	1950-68	-.6049*
Greece	1951-67	-.2170
Guatemala	1950-67	.1379
Honduras	1948-67	.1040
India	1948-68	.1279
Ireland	1953-68	.4642
Israel	1953-68	.0376
Italy	1950-68	.2542
Japan	1951-68	.3547
Netherlands	1948-68	.2412
New Zealand	1950-67	.1889
Norway	1950-68	.3298
Panama	1951-67	-.4946
Philippines	1948-68	-.4203
South Africa	1953-68	.3540
Spain	1954-68	.1690
Switzerland	1950-68	.2113
Thailand	1956-67	.3982
Turkey	1950-68	-.0831
United Kingdom	1948-67	-.6069*
United States	1951-68	.3767
Venezuela	1950-68	.0919

*Denotes significance at the 1 percent level.

provide an adequate basis on which to evaluate our theorem and the alternative proposition of R. Prebisch. The specific form of the regression equation was

$$(24) \left(\frac{\Delta Y}{Y}\right)_i = a + b \left(\frac{P_1}{P_2}\right)_i, \quad i = 1, 34,$$

where $\Delta Y/Y$ is the rate of growth of money national income in the i th country and p_1/p_2 is the country's commodity terms of trade. If the Prebisch hypothesis holds we should observe a consistently positive and significant relationship between the variables. If our theorem applies then the sign of the regression coefficient should be negative or if positive the relationship between the variables should not be significant.

The results of estimating the relationship given in equation (24) for 34 countries is presented in Table 1. Since concern is primarily with significance, and to a lesser extent with the sign, since the question of whether $\beta \gtrless 1$ is a matter for further empirical investigation, we report only the values of the simple correlation coefficient, r . As can be verified from Table 1, the empirical results offer support to the view that there is no positive relationship between changes in the terms of trade and the rate of economic growth. Out of 34 cases, 11 of the coefficients are negative, while 23 are positive. However, only two cases are significant, but note that the signs are negative, i.e., Germany and the United Kingdom. No other cases are significant at the 5 percent level or above, although the results for Panama and the Phillipines are just short of being significant at that level. Moreover, contrary to Prebisch's view, no positive and significant relationship between changes in a country's terms of trade and its rate of economic growth is revealed.

V. Summary and Conclusions

A controversial question in the theory of international trade and economic development exists concerning the tendency of the terms of trade to deteriorate among underdeveloped countries. This decline is said to be caused by a falling

world demand for primary products and rising prices of manufactured goods. Concern has been expressed, primarily by Prebisch [17, 23] and Singer [22], because of the belief that economic growth is retarded when a country's terms of trade are deteriorating. Critics of the Prebisch hypothesis, such as Haberler [11], have tacitly accepted this implication of the impact on growth of changing terms of trade. They have based their counter arguments on essentially empirical grounds, suggesting that the terms of trade show no long run tendency to deteriorate among underdeveloped countries. We have shown theoretically that, if a wage differential exists between the exportable and importable sectors and that the wage differential favors the exportable commodity, which is usually the case, at least for underdeveloped countries, then, a direct relationship between the terms of trade and economic growth may not exist. This theorem was tested empirically with data on national income and the terms of trade for 34 advanced and underdeveloped countries for the period 1948-1968. The empirical results lent support to our conclusion.

Footnotes

*The authors are respectively Assistant Professors at The University of Western Ontario and Southern Illinois University.

¹For further criticisms of the Prebisch hypothesis along somewhat different lines see M. J. Flanders [8].

²In this study we will treat the case of an inter-industry wage differential, although within the framework of a two commodity model, at least, inter-industry and inter-regional wage differentials are frequently interrelated. For example, primary and industrial production may be located in different geographical regions, and, hence, geographical and inter-industry wage differentials may be indistinguishable. For an analysis identifying productivity differentials, arising from differences in capital-labor ratios and in human capital, and labor market imperfections as a source of observed sustained manufacturing wage differentials within the context of certain U.S. economic regions see Scully [19]. An analysis focusing on regional differences in labor productivity and its relation to regional wage differentials in the U.S. for the period 1869-1919 is given in [21] and a further analysis of the importance of human capital differences to productivity differentials is contained in [20]. Also, there is a fairly wide and accessible literature, which will not be cited here, relating the above mentioned causes specifically to inter-industry wage differentials and indicating their long-run stability over time in the U.S., among other countries. In any event, an inter-industry wage differential, like that between primary and industrial goods production, is likely to be much wider in less developed countries than among developed countries due to more abundant and intensive factors making for less labor mobility.

³Batra and Pattanaik [3] have shown geometrically that in a static model there is no unique relationship between changes in the terms of trade and economic welfare. In the present paper, we extend the argument to a growing economy and also provide rigorous mathematical proofs.

⁴Under these circumstances, the production functions for X_1 and X_2 must differ. Specifically, if $w_1 < w_2$ and $r_1 = r_2$, the production function for X_2 must be more efficient than that for X_1 . Of course, the factor intensities in the production of X_1 and X_2 need not be similar. This view of the wage differential contrasts with the model that assumes similar production functions with differing factor intensities (i.e., $(K/L)_1 < (K/L)_2$) producing $w_1 < w_2$, but $r_1 > r_2$ (see Borts [7] and Gallaway [10], for example). Thus, we trace the wage differential to differences in production functions, while this other view identifies differences in the capital-labor ratios as the source of the wage differential. For reasons which are more fully explored by Batra and Scully [4], within the context of the U.S. regional wage differential problem, but applicable, mutatis mutandis, to the problem of inter-industry wage differentials, we believe the assumption of similar rates of return and differences in production functions between the industries is more consistent with the notion of an equilibrium wage differential than the alternative view.

In part, we are persuaded to this formulation on empirical grounds. Scully [19, 21] has shown, within the context of the U.S. regional wage differential, that the regional convergence of capital-labor ratios has had little effect on the regional wage differential. Certain regional wage differentials in the U.S. can be observed to have remained nearly constant for a century despite the convergence of the capital-labor ratios. Furthermore, in decade to decade estimates of cross-section equations, with states as the unit of measurement, the elasticities relating changes in the capital-labor ratios to changes in the wage rates among the regions converged, indicating similarity in the marginal

products of capital (and, hence, the rate of return on capital) over time, regionally. Additionally, the elasticities were exceedingly small, indicating a very inelastic response in the wage rate to a change in the capital-labor ratio. Most of the regional wage differential is embodied in substantial differences in the constant terms. It can be shown, providing the wage function is completely specified, that the constant term captures the effect of differences in the production functions. Similar empirical findings have been obtained with the focus of attention on inter-industry wage differentials.

However, a more compelling reason for our choice of the formulation of the wage differential is that it is the only one consistent with equilibrium. If production functions are invariant between industries, the conditions $w_1 < w_2$, $r_1 > r_2$, and $(K/L)_1 < (K/L)_2$ exist, and the assumption of capital mobility holds, the existence of a wage differential cannot be an equilibrium condition. In this case, the model would not be stable. However, our assumption of $r_1 = r_2$ and differing production functions yields a stable and equilibrium wage differential (see [4] for a full discussion). Of course, alternatively, one could relax the assumption of capital mobility, but this assumption is certainly among the more reasonable ones in neoclassical theory.

⁵Several authors, such as Fleming [9] and Scitovsky [18] believe external economies exist in underdeveloped countries. Such economies, like the wage differential case, are likely to disrupt the equality between the marginal rate of transformation of the price ratio. Our theoretical arguments can be easily applied to the case of external economies. For a treatment of external economies within the context of international trade theory, among others, see R. Batra [2].

⁶Recently R. Batra [1] has shown that this premise may not hold if there are more than two countries in the model.

⁷The theorem that an improvement in the terms of trade increases welfare even if an inter-industry wage differential exists, providing the wage differential works against the exportable commodity, has been proven geometrically in a previous paper by Batra and Pattanaik [3].

⁸If one will permit a simplification, it may be useful to note that a wage differential favoring the exportable commodity, primary goods, in underdeveloped countries, is the usual case.

⁹Observe that only the "shrunk-in" transformation curves are drawn in Figure 3. The original transformation curves are not shown to avoid the clutter.

¹⁰Bhagwati [6] has shown that economic welfare may actually decline, in the presence of an inter-industry wage differential, as a result of growth even if commodity prices remain constant. However, this case requires that growth be ultra-biased. The case discussed in terms of Figure 3 is not one of ultra-biased growth.

References

1. R. Batra, "Factor Accumulation and the Terms of Trade: A Three Country, Three Commodity, Three Factor Analysis," Econometrica, forthcoming (July, 1970).
2. _____, "Protection and Real Wages under Conditions of Variable Returns to Scale," Oxford Econ. Papers, Nov. 1968, 354-61.
3. _____ and P. Pattanaik, "Domestic Distortions and the Gains from Trade," Economic Journal, forthcoming.
4. _____ and G. W. Scully, "Technical Progress, Economic Growth, and the North-South Wage Differential," paper presented at Regional Science Meetings, Iowa City, March, 1970.
5. J. Bhagwati, "Immiserizing Growth: A Geometrical Note," Review of Economic Studies, June 1958, 25, 201-05.
6. _____, "Distortions and Immiserizing Growth: A Generalization," Rev. Econ. Stud., Oct. 1968, 35, 481-85.
7. G. H. Borts, "The Equalization of Returns and Regional Economic Growth," American Economic Review, June 1960, 50, 319-47.
8. M. J. Flanders, "Prebisch on Protectionism: An Evaluation," Economic Journal, June 1964,
9. J. M. Fleming, "External Economies and the Doctrine of Balanced Growth," in A. N. Agarwala and S. P. Singh, The Economics of Underdevelopment, New York, 1963, 272-94.
10. L. E. Gallaway, "The North-South Wage Differential," Review of Economics and Statistics, Aug. 1963, 45, 264-72.

11. G. Haberler, "Terms of Trade and Economic Development," H. S. Ellis, ed., Economic Development for Latin America, New York 1961, 275-297.
12. International Monetary Fund, International Financial Statistics, various issues.
13. C. P. Kindleberger, The Terms of Trade, A European Case Study, New York, 1956.
14. W. A. Lewis, "Economic Development with Unlimited Supplies of Labour," Manchester School of Economic and Social Studies, May 1954, 22, 139-91.
15. _____, "World Production, Prices and Trade, 1870-1960," Manchester School of Economic and Social Studies, May 1952, 20, 105-38.
16. T. Morgan, "The Long-Run Terms of Trade Between Agriculture and Manufacturing," Economic Development and Cultural Change, October 1959, 8, 1-23.
17. R. Prebisch, "Commercial Policy in Underdeveloped Countries," American Economic Review, Papers and Proceedings, May 1959, 49, 251-73.
18. T. Scitovsky, "Two Concepts of External Economies," in A. N. Agarwala and S. P. Singh, The Economics of Underdevelopment, New York, 1963, 295-308.
19. G. W. Scully, "Interstate Wage Differentials: A Cross Section Analysis," American Economic Review, Dec. 1969, 59, 757-773.
20. _____, "Human Capital and Productivity in U.S. Manufacturing," Western Economic Journal, Dec. 1969, 7, 334-340.
21. _____, "The North-South Manufacturing Wage Differential, 1869-1919," Department of Economics, Southern Illinois University, mimeographed, November, 1969.

22. H. Singer, "The Distribution of Gains Between Investing and Borrowing Countries," American Economic Review, Papers and Proceedings, May, 1950, 40, 473-85.
23. United Nations, The Economic Development of Latin America and its Principal Problems.
24. _____, Yearbook of National Accounts Statistics, various issues.