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NEGATIVE VALUE ADDED AND THE THEORY OF EFFECTIVE PROTECTION

by

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Introduction

A number of studies have appeared recently on the subject of the effective rate of protection afforded by a country's tariff system. In contrast to nominal protection which considers only the impact of tariffs on the value of final goods, effective protection measures the percentage change in the value added per unit of final output for an industry as the economy moves from free trade to protected trade equilibrium. Tariffs on imported goods which compete with domestic goods tend to raise value added per unit while tariffs on imports of intermediate goods tend to reduce value added per unit. If a number of assumptions about the mobility of factors and the non-redundancy of tariffs are satisfied, sets of effective rates of protection will provide an accurate description of the direction and strength of the incentives created by the tariff system.

However, the studies which have actually calculated rates of protection for the developed and the less developed economies have begun with data on tariff protected costs of production and worked backwards to simulate costs of production in a "no-tariff"

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world. One of the more controversial issues arising from the empirical results is the appearance of negative value added when the "no-tariff" value added is calculated. The procedure followed in most empirical studies has been to estimate "no tariff" value added by deducting the value of inputs from the value of outputs when both are measured at observable world prices. Several authors have noticed that in a number of cases, the "world" value of inputs exceeds the "world" value of outputs, hence "negative value added at world prices." This finding has stirred up considerable debate over the validity of negative value added as a meaningful economic concept.[1] Both Basevi and Leith termed results involving negative value added as "absurd"[2] while P. T. Ellsworth has stated that "a negative value added implies a degree of inefficiency that is almost unbelievable."[3] The purpose of this article is to show that negative value added is neither an "absurd" concept nor does its occasional appearance in empirical studies need to be explained by additional assumptions about extreme inefficiency in production or monopoly pricing.

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1. For those favorably disposed see: Soligo, R. and Stern, J., "Tariff Protection, Import Substitution and Investment Efficiency," Pakistan Development Review, Vol. V, No. 2, Summer, 1965, and Lewis, S. R., Jr., and Guisinger, S., "Measuring Protection in a Developing Country: The Case of Pakistan," Journal of Political Economy, forthcoming. For those not favorably disposed, see Basevi, G., "The United States Tariff Structure: Estimates of Effective Rates of Protection of United States Industries and Industrial Labor," The Review of Economics and Statistics, Vol. XLVIII, No. 2, May 1966, and Ellsworth, P. T., "Import Substitution in Pakistan -- Some Comments," Pakistan Development Review, Vol. VI, Autumn 1966, No. 3; and Leith, J. C., "Substitution and Supply Elasticity in Calculating the Effective Protection Rate" Quarterly Journal of Economics, Vol. LXXXII, No. 4, November 1968, pp. 588-601.

2. Basevi, G., op. cit., p. 151; Leith, J. C., op. cit., p. 597.

3. Ellsworth, P. T., op. cit., p. 397.

Section I presents a simple two commodity, geometric model of effective protection where the physical requirements of intermediate products are a fixed proportion of the levels of output. It is shown that after an economy has moved from free trade equilibrium to a protected trade equilibrium, two measures of effective protection are possible owing to an important difference between the two kinds of value added that can be used in the formula: the value added at world prices (hereafter VAWP) and the value added at free trade equilibrium (VAFT). Section II further extends the model of section I by demonstrating that VAWP can take on negative values while VAFT is always greater than or equal to zero. The conclusion is reached that because a negative VAWP signals an industry that could not exist without tariff protection, studies which eliminate rates of effective protection for these industries understate the average level of protection provided by a country's tariff system. In Section III, the assumption of fixed coefficients is relaxed and a CES production function is used to show that the notion of two measures of effective protection becomes even more important when substitution between primary factors and intermediate goods is possible. It is demonstrated that the possibility of negative value added in the case of substitution is as real as it is in the model with fixed coefficients. However, the measurement of effective protection for industries where VAWP is negative raises serious problems and these are discussed in Section IV.

Consider an economy with the following resource endowments and production functions:

1. $x(L_x, K_x) = x$
2. $y(L_y, K_y) = y$
3. $L_x + L_y = \overline{L}$
4. $K_x + K_y = \overline{K}$

where:

x, y are the total physical outputs

L_x, K_x, L_y, K_y are the labor and capital employed in the two industries; and

x(L, K), y(L, K) are production functions

The conventional transformation curve for x and y is depicted by TT' in diagram 1. Now assume that in addition to direct inputs of capital and labor, production of each good requires some input of the other commodity. Jaroslav Vanek[4] has suggested a simple technique for geometrically deriving the transformation curve of final goods, X and Y, from TT' when inter-industry flows exist. Vanek's two transformation curves of total output and final goods can then be used to depict rates of effective

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4. Vanek, J., "Variable Factor Proportions and Inter-Industry Flows in the Theory of International Trade," Quarterly Journal of Economics, February 1963, pp. 129-142.

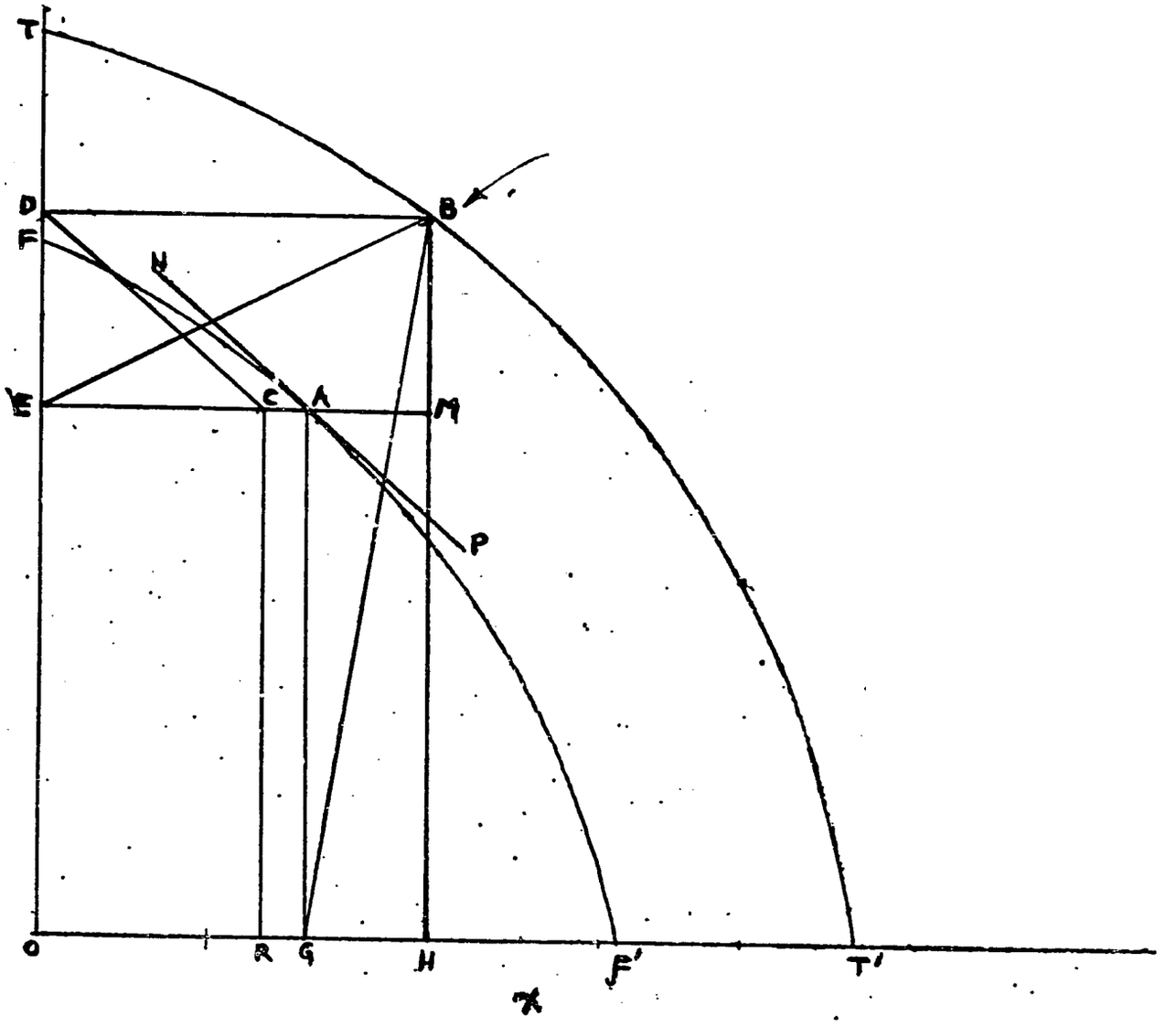

Diagram 1

protection after an adjustment is made in Vanek's original presentation, which is now summarized (for Vanek's own presentation see pp. 132-135).

Let the conditions of production for an economy be defined as follows:

5. $x(L_x, K_x) - a_1 \cdot y(L_y, K_y) = X$
6. $y(L_y, K_y) - a_2 \cdot x(L_x, K_x) = Y$
7. $L_x + L_y = \overline{L}$
8. $K_x + K_y = \overline{K}$

where X and Y are final goods and a_1, a_2 are fixed coefficients representing respectively the physical requirements of x for producing y and of y for producing x. The new transformation curve of X and Y, FF', can be derived from TT' in the following manner. Pick a point, say B, on TT'. Construct a new set of axes BH and BD originating at B. Construct lines BG and BE such that the tangents of the angles DBE and GBH equal the inter-industry coefficients a_2 and a_1. Where BE and BG intersect the ordinate and abscissa erect perpendiculars EA and GA. The point of intersection, A, is on the new transformation curve of X and Y, and the locus of all such points A is the transformation curve itself. If the terms of trade are given by NP (tangent to FF' at A), the competitive economy will settle at A. At this point, a total of OD of y and OH of x will be produced, of which DE of y and GH of x will be used as inputs and OE of y and OG of x will be available for final demand.

From his Figure I on p. 133 and his discussion, Vanek apparently concludes that there is a one-to-one mapping of points on TT' to points on FF' and vice versa. Any combination of final goods is produced by a unique combination of total outputs of x and y, while any pair of output levels

on TT' results in some combination of final goods lying on FF'. The difficulties with this argument can best be seen with the aid of diagrams 2 and 3.

Suppose for the moment that the economy is closed to foreign trade. In diagram 2, it can be shown that segments TZ and LT' (indicated by the dotted lines) are unattainable because the required inputs are not available domestically. At Z, OZ' of y and OS of x are produced. Z'F of y is used as inputs into x (angle Z'ZF constructed equal to angle DBE), leaving OF for final demand. The total output of x, OS, is entirely exhausted by the demands for intermediate inputs into y (angle OZS constructed equal to angle GBH). Clearly, any attempt to increase production of y beyond OZ' would both increase the intermediate demand for x and reduce the total amount of x produced -- an impossible situation given that imports of x are not permitted.

By allowing trade in x and y to take place, which is assumed throughout Vanek's article, points on segments TZ and LT' become feasible output levels, since required inputs can be imported. But in this case, the transformation curve of final goods derived from TT' <u>is</u> <u>not</u> represented by FF'. Considering only segment TZ (a symmetrical argument will apply to LT'), the corresponding final demand curve will have these properties:
1) X will equal zero -- all domestically produced x will join imports of x as inputs into y; and 2) Y will exceed the amount of y available for final demand at Z (i.e. OF).

This final point is made clear by diagram 3 which is an enlarged version of the relevant portion of diagram 2. Consider first a situation where all domestic factors are devoted to the production of y. At point T, production of OT of y would require QO of x. If world terms of trade

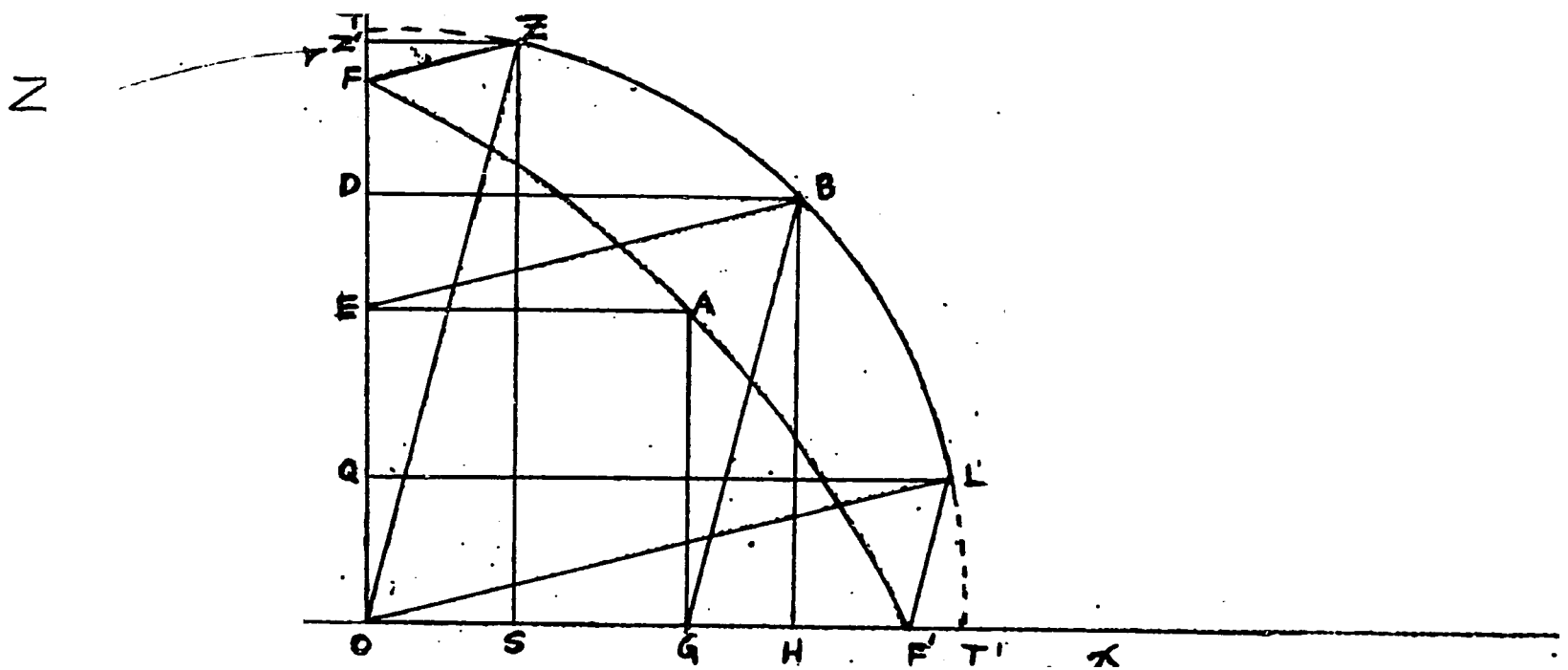

Diagram 2

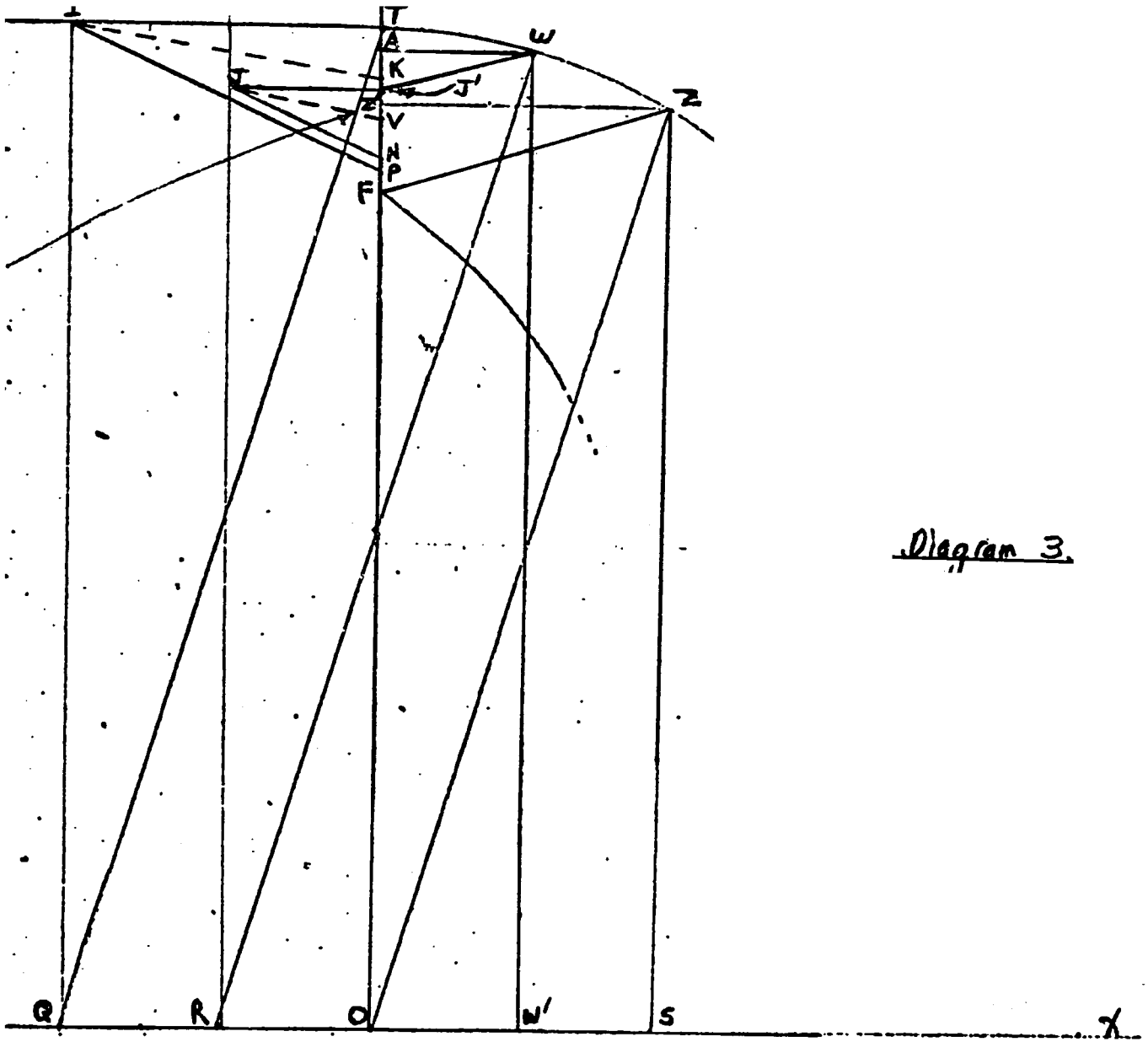

Diagram 3.

equal the slope of the line IP, QO of x can be obtained on the world market for TP of y. This leaves OP of y available for final demand, either to be consumed at home or exported for more x. But it is not clear that OP represents the maximum Y obtainable when X = 0. At point W, RW' of x is required to produce OA of y. OW' is supplied by domestic production, leaving OR to be supplied from foreign production. Now, AJ' of y is used up in the domestic production of AW (equal to OW') of x. J'N of y is used to produce JJ' (equal to RO) of x. Thus RW' of x "costs" a total of AN of y, which, when subtracted from the total y produced, OA, leaves ON for final demand. Note that in this case, the net production of y corresponding to point W on the transformation curve TT' exceeds the net production corresponding to T. This is not always the case as seen by the situation displayed by the dotted lines in diagram 3. Here, the final goods are OK and OV for points T and W respectively, and OK exceeds OV in this case.

For any world terms of trade whose slope is less in absolute value than the tangent at F, the optimal level of output in the x-industry can be derived as follows.

Let the transformation curve TT' be defined by y=T(x). Whenever $a_1 \cdot y$, the intermediate demand for x, exceeds x, the total domestic output of the x-industry, the net production of y is given by:

9. $Y = y - a_2 \cdot x - \frac{1}{p} [a_1 \cdot y - \underline{x}]$

where p is world terms of trade Py/Px.

To determine at what level of x, Y reaches its maximum, dY/dx is set equal to zero and solved for dy/dx. Let dy/dx equal y'.

10. $dY/dx = y' - a_2 - \frac{1}{p} [a_1 \cdot y' - 1] = o$

11. $y' = \frac{p \cdot a_2 - 1}{p - a_1}$

For a given combination of p, a_1, a_2 there is an X_o such that the slope of the transformation curve, y_o', equals the R.H.S. of equation 11. The Y_o, corresponding to X_o, will represent a maximum, provided of course that d^2Y/dx^2 is negative:

12. $d^2Y/dx^2 = y'' \left(1 - \frac{a_1}{p}\right)$

y' is negative for normal, convex transformation curves. Therefore:

13. $\frac{a_1}{p}$ must be < 1.

In summary, wherever the line representing the world terms of trade is tangent to FF', the economy will produce a combination of x and y which lies on TT' between Z and L in diagram 2. Whenever the world terms of trade is smaller (in absolute value) than the slopes of the tangents to FF' at F, the attainable level of final demand, Y, lies somewhere on the y-axis above F. The exact point is determined only by solving equation 11 for X_o and Y_o, subject to the condition specified by 13. A similar argument applies at the other end of the transformation curve.

It is clear that the discontinuities in the transformation curve of final goods only become operative at "corner solutions" -- i.e. whenever there is net production of only one good. From the point of view of the pure theory of international trade, it might be argued that these are exceptional cases, but from the viewpoint of economic development theory, corner solutions are more often the rule than the exception. Infant industry arguments are widely used to justify high tariff protection for goods that would not be manufactured at all under free trade. It will be shown later that negative value added arises precisely from tariff protection in

a situation where free trade would have resulted in a "corner solution."

Given a situation where an economy has moved from a free trade equilibrium to a protected trade equilibrium -- i.e. to any position where tariffs or subsidies have distorted the price ratio facing domestic producers -- three different kinds of value added can be distinguished for each industry. For ease of exposition, these different kinds of value added will be calculated only for the x-industry, allowing the industry subscripts to be dropped. There is no loss of generality from this simplification; the same arguments will apply to the y-industry.

First, consider the economy depicted in diagram 1. Assume that the world terms of trade (equal to the domestic terms of trade) are represented by NP and the economy is in equilibrium at A. The value added in the x-industry can be calculated as follows. Construct DC parallel to NP. Since DE represents the y-inputs, measured in units of y, employed in the production of EM of x, EC measures the value of these same y-inputs but in units of x. By definition value added is the value of total output less the value of intermediate products, so that CM (i.e. EM less EC) is the value added in the x-industry. More specifically, CM represents the value added at free trade, VAFT, because the domestic and world terms of trade are identical.

Now suppose that tariffs are imposed on x, causing domestic terms of trade to shift to N'P' as shown in diagram 4. The economy will come to rest at A' where OH' of x and OD' of y are produced. OG' of x and OE' of y will be available for final demand either for consumption at home or for export at the world terms of trade, NP. Value added at domestic prices, W, can be calculated in the same way as before. E'M' is the x-value of total output while E'C' is the x-value of the y-inputs and the difference

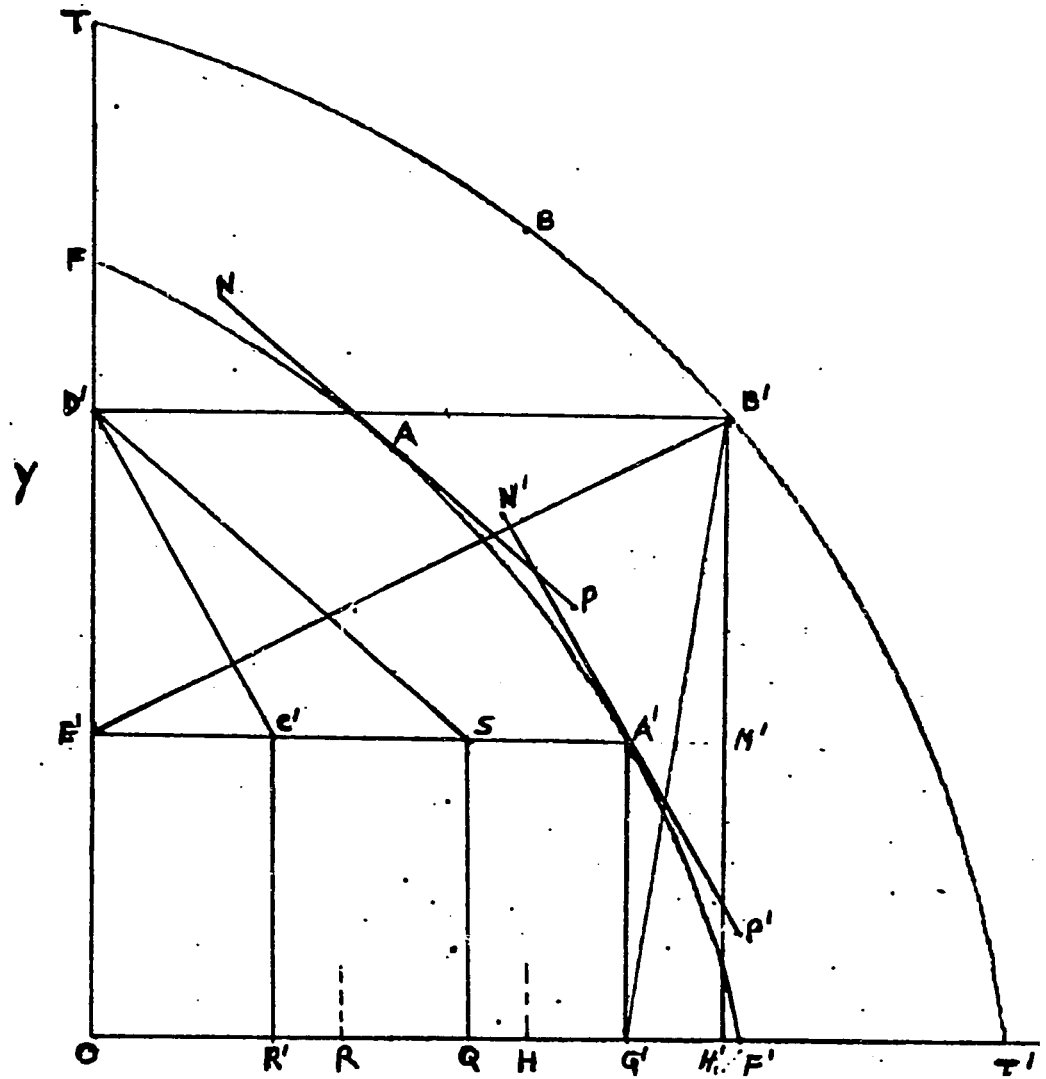

Diagram 4

between E'M' and E'C' is the value added in the x-industry at the new equilibrium level of output.

The recent literature on effective protection has introduced the third kind of value added -- the value added at world prices. In diagram 4, D'E' of y is used in the production of E'M' of x. If these inputs were instead sold on the world market, they could purchase E'S of x (D'S is constructed parallel to world terms of trade, NP). Subtracting the world value of the intermediate inputs from the world value of the output leaves SM' of x or the value added at world prices.

According to Corden, "The effective protective rate is the percentage increase in the value added per unit [of output] in an economic activity which is made possible by the tariff structure <u>relative to the situation in the absence of tariffs</u> but with the same exchange rate."[5] In terms of diagrams 1 and 4 the "situation in the absence of tariffs" is open to two interpretations. The first is the equilibrium at free trade where value added per unit of output is measured by CM/EM. The second is the equilibrium with tariff protection <u>but</u> where value added is measured as if there were no tariffs. Here, value added per unit of output is SM'/E'M'.

Corresponding to these two interpretations of value added per unit of output in the absence of tariffs, there are two measures of effective protection. With value added at domestic prices per unit of output equal to C'M'/E'M', the rate of effective protection for the x-industry under the first interpretation is:

$$14. \quad Z = \frac{\frac{C'M'}{E'M'} - \frac{CM}{EM}}{\frac{CM}{EM}}$$

5. Corden, W.M., "The Structure of a Tariff System and the Effective Protective Rate," <u>Journal of Political Economy</u>, Vol. LXXIV, No. 3, June 1966, p. 222. Italics mine.

15. $Z = \frac{C'M'}{CM} \cdot \frac{EM}{E'M'} - 1$

The second interpretation yields another measure of effective protection:

16. $Z' = \frac{\frac{C'M'}{E'M'} - \frac{SM'}{E'M'}}{\frac{SM'}{EM'}} = \frac{C'M'}{SM'} - 1$

The question now arises: under what conditions is Z equivalent to Z'. The answer becomes clear after the geometric model is reformulated in algebraic terms.

17. $VAFT_x = x - p \cdot a_2 \cdot x$

18. $\frac{VAFT_x}{x} = 1 - p \cdot a_2$

19. $VAWP_x = x' - p \cdot a_2 \cdot x'$

20. $\frac{VAWP_x}{x'} = 1 - p \cdot a_2$

21. $VADP_x = x' - (p/1+t) \cdot a_2 \cdot x'$

22. $\frac{VADP_x}{x'} = 1 - (p/1+t) \cdot a_2$

where:

$VAFT_x$ is the value added at free trade in the x-industry measured in physical units of x.

$VAWP_x$ is the value added at world prices in the x-industry measured in physical units of x.

$VADP_x$ is the value added at domestic prices in the x-industry measured in physical units of x.

x is the level of total output in the x-industry before tariffs.

x' is the level of total output in the x-industry after tariffs

p is the world terms of trade, Py/Px.

a_1, a_2 is the input coefficients (from equations 5 and 6)

the effective rate of protection, Z is calculated as follows:

$$23. \quad Z = \frac{1 - (p/1+t) \cdot a_2 - 1 + p \cdot a_2}{1 - p \cdot a_2}$$

$$= \frac{a_2 \cdot p \cdot \left(\frac{t}{1+t}\right)}{1 - p \cdot a_2}$$

Equations 18 and 20 show that mathematically VAFT per unit and VAWP per unit are equivalent, implying that Z is everywhere equivalent to Z'. This is true, however, only as long as VAWP per unit is greater than zero. If VAWP per unit falls below zero, domestic production of x would simply not be profitable at world prices and VAFT would equal zero. Domestic production in those industries with negative VAWP is possible whenever the tariff system provides a large enough subsidy to the domestic factors through its operation on relative prices. The possibility of a high domestic value added coexisting with a negative value added at world prices is demonstrated in the following section.

II

Suppose that world terms of trade are now represented by the line, WW' (with a slope smaller in absolute value than that of the tangent to FF' at F) as shown in diagram 5. Suppose, also, that the tariff on x has been increased so that the domestic terms of trade, N'P', are the same as in diagram 4. We can calculate the two types of effective protection as before. Domestic value added is C'M' and value added per unit, C'M'/E'M'.

It is clear from diagram 5 that if domestic terms of trade were given by WW', no x would be produced for final demand. This does not imply that no x is produced domestically. Following the argument presented in Section I, it may make economic sense to produce some x at

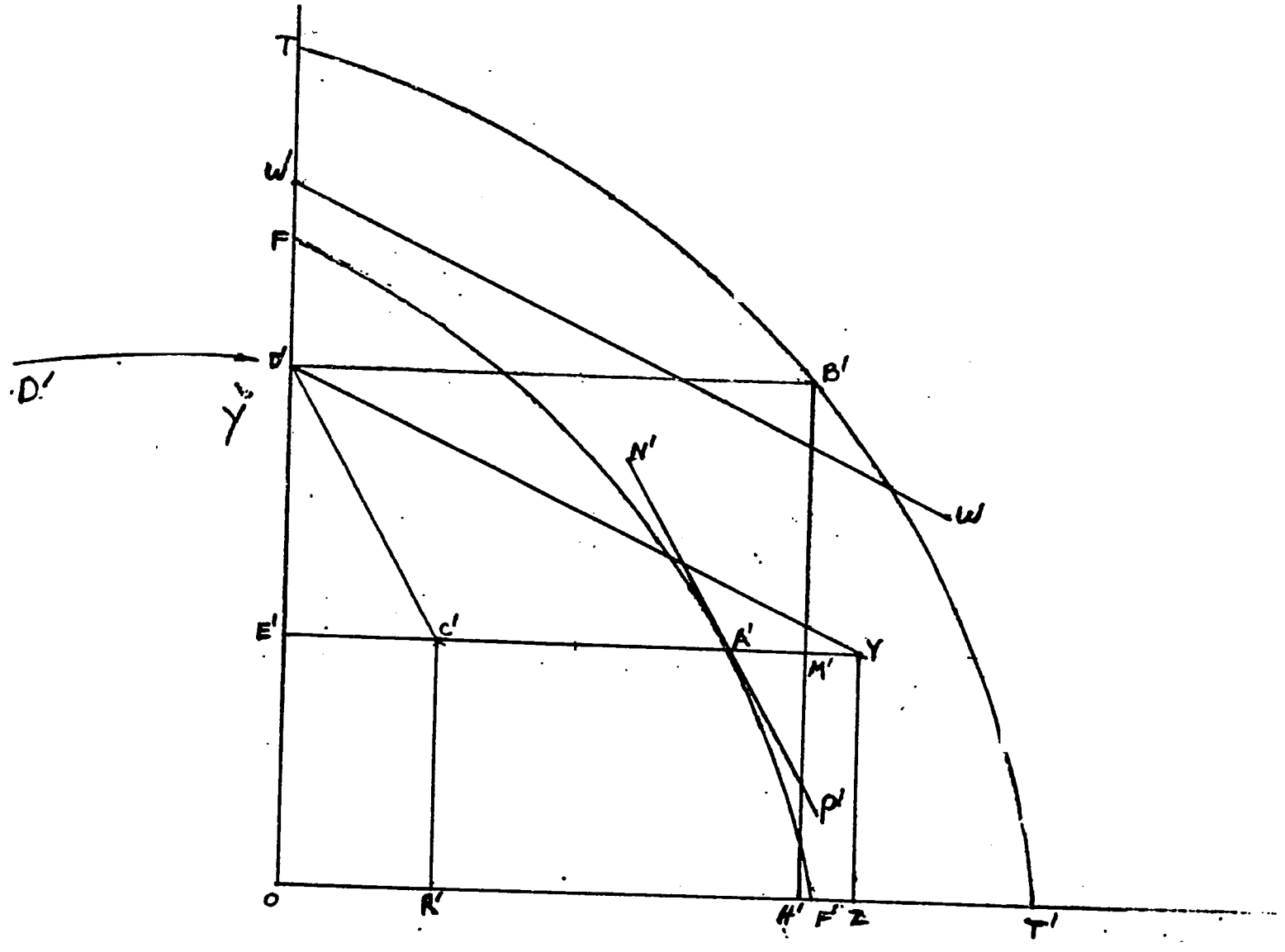

Diagram 5

home for inputs into y. If, however, world terms of trade are extremely favorable to the purchase of x, all factors will be engaged in the production of y with all inputs of x being purchased on world markets. In this situation VAFT in x will be zero and the effective rate will be

$$24. \quad Z = \frac{\frac{C'M'}{E'M'} - 0}{0} \quad \text{or infinity}$$

Calculation of Z' in this situation produces a case of negative value added. Referring again to Diagram 5, /D'E' of y are used in the production of E'M' of x and if sold on the world market, these inputs would be worth E'Y of x. The value of the inputs, E'Y, exceeds the total value of x produced by an amount M'Y. Thus, VAWP is equal to -M'Y and VAWP per unit, -M'Y/E'M'

$$25. \quad Z' = \frac{C'M'/E'M' - (-M'Y/E'M')}{-M'Y/E'M'} = \frac{C'M' + M'Y}{-M'Y}$$

In the algebraic model, negative VAWP occurs when the product of the world terms of trade and the input coefficient exceeds one. Under these circumstances, Z' switches to a negative value while Z becomes undefined (since VAFT equals zero).

Negative value added in this example required no special assumptions about monopoly pricing or an "unbelievable" degree of inefficiency, although either may be sufficient to cause VAWP to become negative. The explanation of negative VAWP in this example rests squarely upon opportunity costs. The "corner solution" at W' in diagram 5 implies that at free trade, the domestic supply curve of net output for the x-industry lies totally above the world supply curve of x. The economy's comparative advantage is clearly in the production of y. When tariffs are imposed and resources drawn into the production of x, the appearance of a negative VAWP simply reflects the net loss in goods available for consumption because of the high opportunity cost of the factors employed in the x-industry.

III

It may seem that the unrealistic assumption of fixed coefficients is at the heart of the problem of negative value added. Yet it can be shown that not only is a negative VAWP as likely to occur where substitution of material inputs for primary factors is possible but also that the distinction between the two types of measures of effective protection, namely Z and Z', becomes even more important.

Suppose that the fixed-coefficient production function for the x-industry is replaced by a CES production function of the following form:[6]

26. $x = (\alpha \cdot L_x^{-\beta} + \gamma \cdot y_x^{-\beta})^{-1/\beta}$

where x is the level of physical output,
α, γ are distribution parameters,
L_x, y_x are the physical inputs of labor and y into the production of x, and
β is a substitution parameter. Note that if σ is the elasticity of substitution, $\sigma = 1/1+\beta$

It can be shown that the demand for an input, such as y_x, under perfectly competitive conditions is represented by the following relationship.

27. $y_x = p^{-\sigma} \cdot x \cdot \gamma^{\sigma}$

If a tariff was levied on imports of x, then the protected trade demand for y as an input would be:

28. $y'_x = (\frac{p}{1+t})^{-\sigma} \cdot x' \cdot \gamma^{\sigma}$

where t is the level of the tariff and the primes indicate the quantities of inputs and outputs under protection.

As before, in the model with fixed coefficients, three types of

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6. A similar model is found in Leith, op. cit., p. 593.

value added per unit of output in the x-industry can be distinguished. In the following equations, value added will be measured in value terms, not in physical units as was done previously. First, the value added at free trade is calculated.

29. $VAFT = p_x \cdot x - p_y \cdot y_x$

substituting from equation 27 above

30. $VAFT = p_x \cdot x - p_y \cdot p^{-\sigma} \cdot x \cdot \gamma^{\sigma}$

31. $\frac{VAFT}{x} = p_x - p_y \cdot p^{-\sigma} \cdot \gamma^{\sigma}$

Second, value added at domestic prices can be determined as follows:

32. $VADP = p_x (1 + t) \cdot x' - p_y \cdot y'_x$

$= p_x (1+t)x' - p_y \cdot (\frac{p}{1+t})^{-\sigma} \cdot x' \cdot \gamma^{\sigma}$ (from equation 28 above)

33. $\frac{VADP}{x'} = p_x (1+t) - p_y (\frac{p}{1+t})^{-\sigma} \cdot \gamma^{\sigma}$

Finally, value added per unit at world prices is calculated as:

34. $VAWP = p_x \cdot x' - p_y \cdot y'$

$= p_x \cdot x' - p_y (\frac{p}{1+t}) \cdot x'$.

35. $\frac{VAWP}{x'} = p_x - p_y (\frac{p}{1+t})^{-\sigma} \cdot \gamma^{\sigma}$

With the three values added per unit of equations 31, 33 and 35, the generalized formulas for Z and Z', in which the elasticity of substitution, σ, becomes a parameter, can be derived as follows:

36. $Z = \frac{\frac{VADP}{x'} - \frac{VAFT}{x}}{\frac{VAFT}{x}}$

$$37.\quad Z = \frac{p_x \cdot t + p_y \cdot p^{-\sigma} \left[1 - \left(\frac{1}{1+t}\right)^{-\sigma}\right]}{p_x - p_y \cdot p^{-\sigma} \cdot \gamma^{\sigma}}$$

dividing the numerator and denominator of the R.H.S. by p_x and rearranging.

$$38.\quad Z = \frac{t + p^{1-\sigma} \cdot \gamma^{\sigma} \left[1 - (1+t)^{\sigma}\right]}{1 - p^{1-\sigma} \cdot \gamma^{\sigma}}$$

recalling the definition of Z' from section 1,

$$39.\quad Z' = \frac{\frac{VADP}{x'} - \frac{VAWP}{x'}}{\frac{VAWP}{x'}}$$

substituting equations 33 and 35 above and simplifying,

$$40.\quad Z' = \frac{p_x \cdot t}{p_x - p_y \cdot p^{-\sigma} \left(\frac{1}{1+t}\right)^{-\sigma} \cdot \gamma^{\sigma}}$$

dividing the top and bottom of the R.H.S. by p_x and rearranging

$$41.\quad Z' = \frac{t}{1 - p^{1-\sigma} \cdot \gamma^{\sigma} \cdot (1+t)^{\sigma}}$$

The denominator of equation 41 is of particular importance because it represents the value added per unit of x measured at world prices, whose "negativity" has generated so much interest. As can be seen from inspection, a number of combinations of values for p, γ, t and σ will succeed in causing VAWP to fall below zero. Indeed, a negative VAWP can occur over a wide range of values of (including zero) so that Leith appears to err in ascribing the negativity of VAWP solely to "either failure to allow for substitution or too high an assumed substitution elasticity."[7] Moreover, and this is the primary conclusion of

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7. Leith, op. cit., p. 597 (footnote 9).

this article, there seems to be no justification for calling "absurd" those rates of effective protection with a negative value added at world prices and therefore eliminating them from comparisons with the effective rates of other industries.

IV

At this point however a dilemma appears. The analysis so far has established the fact that a negative VAWP is possible and is indicative of the high degree of protection that can be provided by a tariff system. Basevi's study, which eliminated any industry having a negative VAWP, is misleading to the extent that the average level of effective protection for the economy is understated and the most highly protected industries are not even included.

Yet, faced with the necessity of dealing with industries exhibiting negative VAWP's, there is no satisfactory way to measure the rate of effective protection for these industries! It can be shown that the standard formula and even one that was designed expressly for the purpose of ranking industries where VAWP is negative, may give incorrect orderings of industries whenever some of the industries show a VAWP that falls below zero.

Consider for a moment an abstract measure of effective protection, call it T. T is a function of W, domestic value added, and VAWP, the value added at world prices. In this case, it makes no difference whether T is a function of value added or value added per unit since both W and VAWP relate to the same total output. If for simplicity VAWP is represented by V, T can be written as $T = T(W,V)$.

T must satisfy certain logical conditions for it to measure the protective effects of a tariff system.

First, if tariffs are raised so that domestic value added is caused to increase, T should also increase -- V being fixed in terms of world prices and constant technology. In mathematical terms this condition becomes,

42. $\frac{\partial T}{\partial W} > 0$

Second, if V were to increase due to a change in either technology or world prices while W was held constant by compensatory adjustments in the tariff system, T should increase.

43. $\frac{\partial T}{\partial V} < 0$

Third, the size of the industry should have no effect on the value of the rate of effective protection.

44. $T = T(\lambda \cdot W, \lambda \cdot V)$ for any $\lambda > 0$

It can now be seen that Z' satisfies only one of these three conditions.

45. $\frac{\partial Z'}{\partial W} = \frac{1}{V}$; since V can take on both positive and negative value, $\frac{\partial Z'}{\partial W}$ is not uniformly > 0.

46. $\frac{\partial Z'}{\partial V} = \frac{-W}{V^2}$

V can be equal to zero, causing $\partial Z/\partial V$ to become undefined and not uniformly < 0.

47. $Z' = \frac{\lambda \cdot W - \lambda \cdot V}{\lambda \cdot V} = \frac{W - V}{V}$

Soligo and Stern[8] propose a new measure, U, as a way of avoiding the problems raised by negative VAWP. It is defined as $U = \frac{W - V}{W}$. The only difference is that W has replaced V in the denominator; effective protection is now the change in value added as a per cent of domestic value added. As W is never negative, U can only be less than zero when W is less than V -- the "export industry" case. U thereby avoids the confusion of having two kinds of negative effective rates of protection. Nevertheless, U satisfies only two of the three conditions that a consistent measure must meet.

48. $\frac{\partial U}{\partial W} = \frac{V}{W^2}$

49. $\frac{\partial U}{\partial V} = \frac{-1}{W}$

50. $U = \frac{\lambda \cdot W - \lambda \cdot V}{\lambda \cdot W} = \frac{W - V}{W}$

$\partial U/\partial W$ is not uniformly positive, since V can assume negative values. This means that when V is negative, an increase in W actually causes U to decrease. Similarly, in a cross-section study, if two industries have an identical negative VAWP, the industry with the <u>highest</u> W would show the <u>lowest</u> effective rate of protection.

As U and Z' are currently the only alternatives for measuring effective protection, some inconsistency is introduced into empirical studies which rank industries according to their effective rates--excepting, of course, studies where negative VAWP does not appear. Corden's suggested treatment of non-traded good inputs[9] -- that the value added part of these non-traded inputs should

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8. Soligo, R. and Stern, J., <u>op. cit.</u>, p. 255.

9. Corden, W. M., <u>op. cit.</u>, p. 227.

be joined with the value added of the user-industry -- may reduce considerably the number of cases where negative VAWP will in actual practice occur. But in at least one study,[10] the application of Corden's method still left 3 of the 32 industry groups studied with a world market value of inputs exceeding the world market value of their output.

Summarizing briefly the points made above:

1. It is possible to derive a transformation curve of final goods from a transformation curve of local outputs once inter-industry coefficients are specified. Vanek's technique is modified to allow for imports of intermediate inputs.

2. The two transformation curves can then be used to represent geometrically the two different effective rates of protection which result from a distinction between the value added at free trade equilibrium (VAFT) and value added measured at world prices (VAWP).

3. The two rates of effective protection are identical when production functions are characterized by fixed coefficients, except in the case where VAWP is negative, but are <u>always</u> different when production functions exhibit non-zero elasticity of substitution between material inputs and primary factors.

4. Negative value added at world prices may occur when protection permits domestic production of a good which would not appear at free trade equilibrium. Negative VAWP is not necessarily caused by an unusual degree of inefficiency, although it can be, but is most likely to occur

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10. Lewis and Guisinger, <u>op</u>. <u>cit</u>. See Table II.

where there is "over" production of goods that are uneconomical from the standpoint of opportunity costs. Note that it is not irrational for a country to choose to invest in an industry where VAWP is initially negative provided it can be shown that productivity gains will, over time, convert this cost into a net benefit and that the discounted value of the stream of benefits will exceed the original capital cost. A negative VAWP indicates that the initial cost to an economy of a particular industry is high but does not pass judgment on the wisdom of the investment as would a complete benefit-cost calculation.

5. Given that empirical studies must resort to using VAWP instead of VAFT in the formula for the rate of effective protection and that VAWP can assume negative values, there is no correct way to rank and compare different rates of effective protection among industries having both positive and negative VAWPs. It is shown that each of the currently used formulas fail to meet one or more of the basic requirements for a meaningful measure of effective protection. It may still be necessary to exclude, or at least set aside, those industries where VAWP is negative from studies of the overall protective effect of an economy's tariff system, but not for the reason that a negative VAWP for an industry is "absurd" but simply because rates of effective protection involving negative VAWP are incommensurable with those of the remaining industries.