INTERNATIONAL TRADE AND ECONOMIC EXPANSION

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The recent literature on the effects of economic expansion on international trade has been concerned with two principal problems: the impact of the expansion on the terms of trade; and the resultant change in the welfare of the trading nations. The solutions offered, however, are not fully satisfactory. Thus H. G. Johnson [5] and W. M. Corden [3], who attempt to tackle the first problem, succeed only in establishing the *direction*, as distinct from the *extent*, of the consequential shift in the terms of trade. In so far as the full impact of the expansion on the terms of trade must be known prior to determining the change in the welfare of the countries involved, it is not surprising that the second problem has received scant attention.[1]

It is intended in this paper to resolve principally the problem of bringing the different factors that affect the terms of trade into a single formula to determine the extent of the shift in the terms of trade consequent upon economic expansion. The analysis is further rendered geometrically by translating the usual textbook back-to-back partial diagram, depicting international trade equilibrium in a single commodity, into a general equilibrium framework. The argument is then extended, in a brief section, to the welfare effects of the expansion. To the gain from growth must be added the gain or loss from the resultant shift, if any, in the terms of trade; conditions are derived to determine whether the growing country will experience a net gain or loss from the expansion. The final section of the paper is concerned with the concept of the "output elasticity of supply" (to be used in the paper) and the analytical methods that can be employed to investigate the output elasticity of supply of different activities under specified varieties of expansion.

I. *Formula to Determine Change in the Terms of Trade*

The model used here is the familiar two-country (I and II), two-commodity (X and Y), "real" model with continuous full employment of all factors. Transport costs and intercountry factor movements are ab-

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[1] It should be mentioned, however, that Johnson [5] has an excellent analysis of this problem in the context of a model of complete specialization, although the concern of the article is principally to evolve a criterion to determine the impact of expansion on the terms of trade.

sent. To simplify the analysis, economic expansion, defined as the country's capacity to produce extra output at constant relative commodity prices, is confined to country I. We wish to determine the consequent impact on I's commodity terms of trade. The analysis is conducted in terms of I's importable good (Y); it is one of the advantages of our two-good model that the analysis can be couched entirely in terms of one good and yet will hold generally.

The total impact on the terms of trade of country I as a result of the expansion is compounded of six effects:

1. *Change in the Output of Y due to Economic Expansion.* The change in the output of importables (Y) in country I, at constant relative commodity prices, as a result of the economic expansion, is given by:

$$\frac{\delta Y}{\delta K} \cdot dK = Y \cdot E_{SY} \cdot \overline{K} \tag{1}$$

where Y is the domestic production of importables in I prior to the expansion; K is I's productive capacity which is assumed to be kept fully employed and is measured by the value, in terms of exportables (X), of the output the country would produce at the initial terms of trade;

$$\overline{K} = \frac{dK}{K}; \text{and } E_{SY} = \frac{K}{Y} \cdot \frac{\delta Y}{\delta K}$$

is the output elasticity of supply of importables at constant relative commodity prices. This represents, therefore, the change in the domestic production of importables directly as a result of expansion, at constant terms of trade. If (1) is positive, the supply of Y is increased; if it is negative, the supply of Y is reduced.[2]

2. *Change in the Demand for Y due to Economic Expansion.* We must now consider the change in the demand for importables, at constant relative commodity prices, as a direct result of the expansion. This is given by:

$$\frac{\delta C}{\delta K} \cdot dK = C \cdot E_{DY} \cdot \overline{K} \tag{2}$$

where C is the pre-expansion consumption of importables (Y) in I and

$$E_{DY} = \frac{K}{C} \cdot \frac{\delta C}{\delta K}$$

is the output elasticity of demand for importables at constant relative

[2] Formula (1) may be negative under certain circumstances. This possibility is outlined again in Section III and is actually demonstrated, in the context of our highly simplified model, in Section IV. Also see Bhagwati [1].

commodity prices.[3] If (2) is positive, there is an increase in the demand for Y; if it is negative, the demand for Y is decreased.

It follows that the net change in the demand for imports, at constant terms of trade, will be given by [(1)−(2)]. If this expression is positive, there is a net decrease in I's demand for imports at the pre-expansion terms of trade and hence the terms of trade will tend to improve for I (unless II's offer curve is infinitely elastic); if the expression is negative, there is a net increase in I's demand for imports and the terms of trade will tend to deteriorate for I.[4] In order to determine the extent of the shift in the terms of trade which will be necessary to restore equilibrium, however, we must introduce the following four factors, three domestic and one foreign. Each of them measures one aspect of the changes in the supply of and demand for importables induced by a shift in the terms of trade.

3. *Change in the Demand for Y due to Price Shift.* The change in the demand for Y due to the shift in the terms of trade may be measured by the following expression:

$$\frac{\delta C}{\delta p}\cdot dp = -\frac{C}{p}\cdot\epsilon\cdot dp \tag{3}$$

where p is the terms of trade, measured as the number of units of exportables required to buy a unit of importables; and

$$\epsilon = -\frac{p}{C}\cdot\frac{\delta C}{\delta p}$$

is the income-compensated or constant-utility demand-elasticity for importables (Y), representing movement *along* the indifference curve in response to the price-shift. If (3) is positive, there is an increase in the demand for Y; if it is negative, there is a reduction in the demand for Y. The demand for Y will be negatively correlated with changes in the price of Y relative to the price of X.[5]

4. *Change in the Supply of Y due to Price Shift.* The change in the domestic supply of Y due to the shift in the terms of trade is:

$$\frac{\delta Y}{\delta p}\cdot dp = \frac{Y}{p}\cdot\sigma\cdot dp \tag{4}$$

where

$$\sigma = \frac{p}{Y}\cdot\frac{\delta Y}{\delta p}$$

[3] Output elasticity of demand is used in preference to income elasticity to describe the behavior of aggregate consumption as aggregate income rises, to include the effects of population changes, growth of per capita incomes, and resultant changes in income distribution.

[4] This is, in effect, Johnson's [5] central argument.

[5] This is so because we normally assume, for well-known reasons, that the substitution effect, with which (3) is concerned, is negative.

is the supply-elasticity of importables based on movement along the transformation curve in response to the price-shift. When (4) is positive, the supply of Y is increased; when it is negative, it is decreased. The supply of Y will normally be positively correlated with changes in the price of Y relative to the price of X.[6]

5. *Change in the Demand for Y due to Change in Real Income resulting from Shift in the Terms of Trade.* A change in the terms of trade leads to a consequent change in real income. This income change is approximated here by the usual method employed widely in the theory of international trade and based on the theory of value, namely, by the difference in the cost of the initial quantity of imports. The resultant change in the demand for Y is:

$$-\frac{\delta C}{\delta K}\cdot M\cdot dp = -\frac{C}{K}\cdot M\cdot E_{DY}'\cdot dp \tag{5}$$

where $M \equiv C - Y$ is the quantity of initial imports; and

$$E_{DY}' = \frac{K}{C}\cdot\frac{\delta C}{\delta K}$$

is the elasticity of demand for Y with respect to a change in income resulting from changed terms of trade. If (5) is positive, there is an increase in the demand for Y; if it is negative, there is a reduction in the demand for Y.

6. *Change in the Supply of Y by Country II due to Price Change.* As a result of the shift in the terms of trade, the supply of Y by II to I changes. This is given by:

$$\frac{\delta S_m}{\delta p}\cdot dp = \frac{M}{p}\cdot r_m\cdot dp \tag{6}$$

where $S_m \equiv M$ and

$$r_m = \frac{p}{M}\cdot\frac{\delta S_m}{\delta p}$$

is the *total* elasticity of II's supply of its exports (commodity Y) to I, in response to a shift in the terms of trade. II's supply of Y to I increases or decreases according as (6) is positive or negative.[7]

The total impact on the terms of trade is then derived from the simple proposition that, in equilibrium, the excess demand for Y should be zero. Thus we can collect all the effects into two groups: those on the

[6] This holds again because we normally assume that the transformation curve is a convex set.

[7] The elasticity r_m will be negative, for instance, when the exports of I are Giffen goods in II; though this is by no means a necessary condition for r_m to be negative.

supply side, [(1)+(4)+(6)]; and those on the demand side, [(2)+(3)+(5)]. We subtract the latter from the former and set the expression equal to zero. Solving for dp, we get the magnitude of the shift in the terms of trade consequent upon economic expansion:

$$dp = \frac{(C \cdot E_{DY} - Y \cdot E_{SY}) \cdot \overline{K}}{\left[\frac{Y}{p} \cdot \sigma + \frac{M}{p} \cdot r_m + \frac{C}{p} \cdot \epsilon + \frac{C}{K} \cdot M \cdot E_{DY}'\right]}, \tag{7}$$

which may be rewirtten as:

$$dp = \frac{p \cdot dM}{M\left[\frac{Y}{M} \cdot \sigma + r_m + \frac{C}{M} \cdot \epsilon + p \cdot \frac{C}{K} \cdot E_{DY}'\right]}, \tag{8}$$

provided it is remembered that dM refers to the income effect of expansion on imports at constant terms of trade.

We have thus succeeded in bringing together into a single formula, and thereby establishing the relative significance of, the different factors (elasticities) which simultaneously determine the impact of expansion on the international commodity terms of trade. The analysis can be readily extended to the case of simultaneous growth in *both* countries. This can be done by replacing

$$\left[\frac{M}{p} \cdot r_m \cdot dp\right]$$

by an elaborate expression derived by extending to country II an analysis exactly analogous to that we have applied to country I.[8]

Some interesting results follow from our analysis. Thus in order for the terms of trade to turn adverse to the growing country it is not sufficient that the income effects of the expansion should be unfavorable and should create an increased demand for imports (that is, $C.E_{DY} > Y.E_{SY}$). It is also necessary that the expression

$$\left[\frac{Y}{M} \cdot \sigma + r_m + \frac{C}{M} \cdot \epsilon + p \cdot \frac{C}{K} \cdot E_{DY}'\right],$$

which constitutes the denominator in (8), should be positive. Since both σ and ϵ are normally positive, and since E_{DY}' is also positive (unless either the commodity Y is an inferior good in the strict Hicksian sense or the expansion is accompanied by a redistribution of income biased strongly against the consumption of Y), it follows that r_m will have to be not merely negative but also sufficiently large in magnitude

[8] Nothing substantive is gained by carrying out this exercise.

in order that the entire expression should be negative. The converse is also true: where the income effects are favorable and lead to a reduction in the demand for imports, the terms of trade may still worsen for the growing country I if the total elasticity of II's supply of its exports (Y) to I is sufficiently large and negative to make the denominator in (8) negative. These conclusions are, no doubt, intuitively plausible, which is perhaps an advantage; what is chiefly claimed is that the precise relation in which the different operative factors stand vis-à-vis one another, which has been attempted here, lends a needed element of rigorousness to these qualitative results. Besides, it enables us to investigate more satisfactorily the related problem of the impact of economic expansion on the welfare of the growing country (Section III).

II. *Geometrical Analysis*

Using the familiar partial equilibrium back-to-back diagram determining the flow of exports of a single commodity from one country to another, we propose now to: (1) show how this partial diagram can be transformed into a general equilibrium diagram; and (2) relate the diagram to, and thereby illustrate, the argument algebraically presented in Section I.

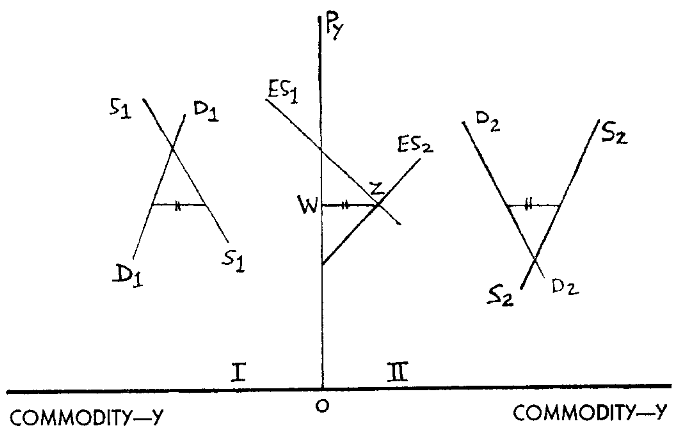

FIGURE 1

Figure 1 shows the usual partial equilibrium diagram for depicting international trade equilibrium in a two-country model. Transport costs are assumed to be zero. D_1D_1, S_1S_1 and D_2D_2, S_2S_2 are the domestic demand and supply curves of countries I and II respectively. ES_1 and ES_2 are the excess-supply functions, as Samuelson [11] calls them, of I and II respectively. Equilibrium is at Z where the exports of Y from II match the imports of Y into I; the equilibrium price of Y is OW.

Now this diagram can be readily converted into a general equilibrium diagram in the following fashion. Relabel the vertical axis $p = p_y/p_x$, the terms of trade, instead of p_y, the price of Y. Further, instead of regarding D_1D_1, D_2D_2, S_1S_1 and S_2S_2 as partial curves,[9] treat them as general equilibrium or total curves. Thus S_1S_1 and S_2S_2 now represent schedules of varying supply of Y as the change in the terms of trade shifts production along the transformation curve. The reinterpretation of D_1D_1 and D_2D_2 is slightly more involved as the schedules are now compounded of two effects: (1) the shift in the demand for Y caused by the real-income change resulting from the change in the terms of trade; and (2) the change in the demand for Y as the change in the terms of trade shifts consumption along the indifference curve (i.e., the substitution effect).

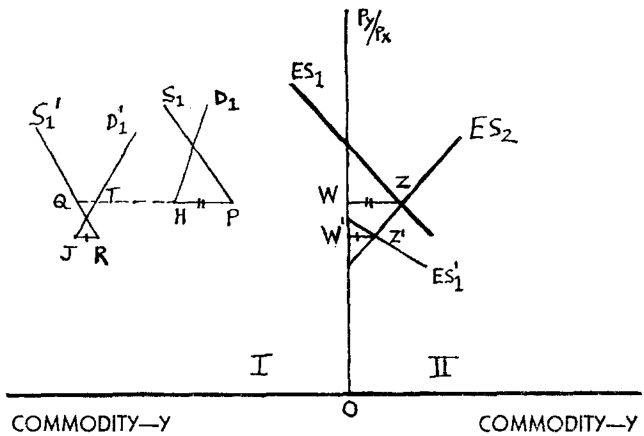

FIGURE 2

The reader may still doubt whether the transformation of the partial into a general equilibrium diagram has been accomplished. Equilibrium in the diagram, as now interpreted, is still in the Y market. What about the X-market? The answer is straightforward. As argued before, it is one of the advantages of a two-good model, such as the one employed here, that the argument can be couched entirely in terms of one good. Equilibrium in the Y-market implies equilibrium in the X-market as well.

We have thus accomplished our first task of transforming the partial into a general equilibrium diagram. We can now proceed to derive geometrically the argument and result of Section I. In Figure 2 we assume that, as a result of economic expansion, S_1S_1 and D_1D_1 shift to $S_1'S_1'$ and $D_1'D_1'$ respectively. ES_1 correspondingly shifts to ES_1' and the new

[9] See an interesting note by Hicks [4] on how the Marshallian supply curve, corresponding to Marshall's demand curve, should be derived.

equilibrium terms of trade are at OW'. Country II now exports $W'Z'$ of Y and I imports JR $(=W'Z')$ of Y. The total impact on imports and exports can then be analyzed as follows:

1. *Total Effect on Demand for Y in I.* (a) The movement from H to T is the income effect of expansion, measured by (2) in Section I. (b) The movement from T to J is compounded of the income effect on consumption of Y due to the shift in the terms of trade and the substitution effect on consumption of Y due to the same shift. It is measured therefore by (5) and (3) in Section I. (c) The movement from H to J, representing the total effect on the demand for Y in I, is thus measured by [(2)+(3)+(5)].

2. *Total Effect on Supply of Y in I.* (a) The movement from P to Q is the income effect on production of the expansion, measured by (1). (b) The movement from Q to R is the substitution effect on production of Y due to the shift in the terms of trade and is measured by (4). (c) The movement from P to R, representing the total effect on the supply of Y in I, is thus measured by [(1)+(4)].

3. *The Net Effect on the Excess Supply of Y in I.* This is then given by: (1)+(4)−[(2)+(3)+(5)]. This corresponds to the difference between HP $(=WZ)$, the old volume of imports, and JR $(=W'Z')$ the new volume of imports. If the expression is positive, there is a net reduction in the demand for imports into I; if it is negative, there is a net increase.

4. *The Net Effect on the Excess Supply of Y in II.* This is similarly given by (6). It corresponds to the difference between WZ and $W'Z'$. If it is positive, there is a net increase in the supply of imports to I; if it is negative, there is a net decrease.

The formula for determining the shift in the terms of trade is now easily derived. In equilibrium, the net changes in the excess supplies of Y in I and II must match each other and also add up to zero:

$$(1) + (4) - [(2) + (3) + (5)] + (6) = 0.$$

Solving the above for dp, we can derive formula (7). The geometrical construction not only represents the transformation of a useful diagram of partial analysis into a general equilibrium framework but also serves the purpose of deriving the results of Section I visually. There is an additional advantage that follows from our transformation; this is a direct result of Samuelson's ingenious use of this diagram (in a partial framework) to convert the international trade problem involved into a maximum problem, thereby enabling the anlayst "to make rigorous predictions as to the qualitative direction in which the variables of the system will change when some change is made in the data of the problem" [11, p. 299] and to derive generalized reciprocity relations.

III. *Expansion and Economic Welfare*

Having derived an expression to measure the precise impact of expansion on the commodity terms of trade, we can now analyze the net effect of expansion on the welfare of the growing country. Economic expansion, while increasing output, might lead to a deterioration in the terms of trade and a corresponding reduction in the growth in real income of the country experiencing the expansion. Where expansion leads to deterioration in the country's commodity terms of trade, there are three possible outcomes for the country's economic welfare:[10] net gain, no gain, or actual loss. We propose now to investigate the conditions under which these possibilities will respectively materialize.

Let dK denote the gain in real income that results from growth of output, at constant relative commodity prices. From this we must subtract the loss of real income that arises from the attendant deterioration in the terms of trade by approximating this loss with the familiar expression: $M.dp$. Using formula (8), we can say that the growing country, I, will, as a result of growth, experience net gain, make neither gain nor loss, or actually suffer immiserizing growth according as:

$$dK \gtreqless \frac{p \cdot dM}{\left[\frac{Y}{M}\cdot\sigma + r_m + \frac{C}{M}\cdot\epsilon + p\cdot\frac{\delta C}{\delta K}\right]}$$

which simplifies to:

$$\left[\frac{Y}{M}\cdot\sigma + \frac{C}{M}\cdot\epsilon + y\right] \gtreqless - r_m \tag{9}$$

where $y=p.(\delta Y/\delta K)$ and it is assumed that $E_{DY}'=E_{DY}$, so that a change in real income due to a reduction of import prices has the same effect on the demand for importables as a change in real income due to growth.[11]

It may be of interest to note that, since ϵ and σ are necessarily positive,[12] the possibility that growth might be immiserizing would arise only if either the demand for the growing country's exports is inelastic (r_m is negative) or growth actually reduces the domestic production of importables at constant relative commodity prices (y is negative). (Neither of these conditions, it should be noticed, is sufficient for im-

[10] The analysis outlined here is subject to all the familiar caveats attending on discussions of social welfare.

[11] For a similar assumption, see Bhagwati [1]. For further observations and an able discussion of related issues, see Johnson [7].

[12] This argument is again based on the assumption of convex indifference and transformation curves, convexity being defined in the strict mathematical sense.

miserizing growth to occur.[13]) Although, as indicated in Section I, y will normally be positive, it is possible to postulate assumptions under which it will be negative; this possibility is demonstrated in Section IV where the concept of the output elasticity of supply is further explored.

IV. *Increased Factor Supply and Output Elasticity of Supply*

Our formulae for determining the change in the terms of trade and the impact of growth on the welfare of the growing country draw upon elasticity concepts that are familiar to economists from the modern theory of value.[14] The concepts of output elasticity of supply and of demand (at constant relative commodity prices), E_{SY} and E_{DY}, however, are fairly recent concepts although they have already been widely used [2] [3] [5] [6]. They would appear far more familiar if they were described as yielding respectively Engel's curves of production and consumption of the commodity in question. Whereas, however, Engel's curves of consumption are respectable in the literature, those for production are still a sufficiently rare phenomenon to justify a sketch of the analytical techniques by which they may be derived. Of the two major sources of economic growth, namely expansion of factor supply and technical progress, the former is analyzed in our simple model, and the output elasticities of supply of the two activities X and Y implied thereby are investigated.

Let a and b be the amounts of the two factors employed in industry X and a', b' the amounts employed in industry Y. The prices, p_x and p_y of X and Y respectively, are assumed to be constant throughout the analysis. $a+a'=A$ and $b+b'=B$ where A and B are the total factor endowment enjoying full employment. It is assumed that B is constant. Therefore, $db+db'=0$. A is assumed to change infinitesimally so that $da+da'=dA$. The production functions are assumed to be linear and homogeneous and remain unchanged throughout the analysis. We can now proceed to analyze the impact of the change in A on the output of Y as follows:

From equilibrium conditions, we have

$$p_x \cdot \frac{\delta X}{\delta a} = p_y \cdot \frac{\delta Y}{\delta a'} = \Pi_a$$

$$p_x \cdot \frac{\delta X}{\delta b} = p_y \cdot \frac{\delta Y}{\delta b'} = \Pi_b$$

[13] This is best seen by rewriting the criterion thus:

$$\left(\frac{Y}{M} \cdot \sigma + \frac{C}{M} \cdot \epsilon + y + r_m \right) < 0$$

For further discussion of the economic implications of this criterion, see Bhagwati [1].

[14] Our substitution elasticities are not identical with, though similar to, the elasticities of substitution in the literature. See Morrissett [8].

Differentiating these, with p_x and p_y constant, and then using the relations $da+da'=dA$ and $db+db'=0$, we get:

$$(10)\quad \left(p_y\cdot\frac{\delta^2 Y}{\delta a'^2}+p_x\cdot\frac{\delta^2 X}{\delta a^2}\right)\cdot da'+\left(p_y\cdot\frac{\delta^2 Y}{\delta a'\delta b'}+p_x\cdot\frac{\delta^2 X}{\delta a\delta b}\right)db'=p_x\cdot\frac{\delta^2 X}{\delta a^2}\cdot dA$$

$$(11)\quad \left(p_y\cdot\frac{\delta^2 Y}{\delta a'\delta b'}+p_x\cdot\frac{\delta^2 X}{\delta a\delta b}\right)\cdot da'+\left(p_y\cdot\frac{\delta^2 Y}{\delta b'^2}+p_x\cdot\frac{\delta^2 X}{\delta b^2}\right)\cdot db'=p_x\cdot\frac{\delta^2 X}{\delta a\delta b}\, dA$$

Using equations (10) and (11) and the identity

$$p_y\cdot\frac{dY}{dA}=\Pi_a\,\frac{da'}{dA}+\Pi_b\,\frac{db'}{dA}$$

and choosing units such that all prices are equal to unity, we arrive at the following formula:[15]

$$(12)\qquad dY=\frac{b\cdot Y}{(a'b-ab')}\cdot dA.$$

Some interesting conclusions emerge from this formula. First, the formula has the property that the output elasticity of supply of Y (as also X) is independent of the scale of the two activities, X and Y, and depends exclusively on the factor proportions in the two activities. This is easily demonstrated by rewriting the formula thus:[16]

[15] Since the change in A is assumed to be infinitesimal, formula (12) can be derived much more readily by using the Samuelson theorem [12] that the relationship between commodity and factor price ratios is unique under the conditions postulated. J. Black informs me that the following alternative proof is available, if the Samuelson theorem is used: Assume, by choice of units, that all prices equal unity.

$$da+da'=dA\cdot\quad da'=\frac{a'}{(a'+b')}\cdot dY.$$

Similarly,

$$dY=\frac{(a'+b')}{b'}\cdot db'=-\frac{(a'+b')}{b'}\cdot\frac{b}{(a+b)}\cdot dX\cdot(db=-db').$$

Therefore,

$$da=\frac{a}{(a+b)}\cdot dX=-\frac{ab'}{b(a'+b')}\cdot dY.$$

Therefore,

$$dA=da+da'=-\frac{ab'}{b(a'+b')}\cdot dY+\frac{a'}{(a'+b')}\cdot dY.$$

Therefore,

$$dY=\frac{b(a'+b')}{(a'b-ab')}\cdot dA=\frac{b\cdot Y}{(a'b-ab')}\cdot dA.$$

The analytical method employed in the text, however, is more general and can be used for other similar problems where nothing comparable to the Samuelson theorem is available.

[16] This property is geometrically demonstrated in a different context by Mundell [9].

$$dY = \frac{1 + \dfrac{a'}{b'}}{\left(\dfrac{a'}{b'} - \dfrac{a}{b}\right)} \cdot dA \tag{13}$$

Further, the familiar Rybczynski [10] proposition that the output of the B-intensive industry will contract, under the assumptions made here, when the supply of A increases, at constant relative commodity prices, follows quite readily from (12). If Y is B-intensive, it follows that

$$\frac{a'}{b'} < \frac{a}{b}$$

and thus $a'b < ab'$. Under our assumptions, therefore, it can be established that dY/dA is negative if Y is B-intensive. It follows then that E_{SY} (and y) may be negative, indicating that the domestic output of importables declines absolutely, at constant terms of trade, as a result of the expansion.

The analytical technique outlined above is perfectly general and can be utilized for determining the output elasticities of supply under other types of expansion as well, such as neutral technical progress in an activity. It would thus be feasible to undertake an interesting taxonomic exercise: to consider different varieties of expansion and investigate the output elasticities of supply (and of demand) implied by them; and to relate them with different values for the substitution elasticities to discover the full impact on the terms of trade of expansion under different circumstances. Such an analysis, however, cannot be attempted here as the task would take us far afield.[17]

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[17] See Johnson [5] for a very able taxonomic exercise of this nature.

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