Trade Restrictions versus Foreign Aid as a Means of Improving a Country's Welfare*

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Introduction

One of the recurring themes in the literature on international trade and economic development is the contention that while free-trade policies will lead to efficient world allocation of resources and a Pareto-optimal distribution of goods and services among countries, they tend to have deleterious effects on the global *distribution* of welfare; rich countries get richer and poor countries poorer. This view has been expressed in various forms by Kindleberger (1943), Balogh (1946, 1948, 1949a, 1949b, 1950), Robinson (1947), Prebisch (1950, 1959), Singer (1950), Williams (1952), Hicks (1953), Robertson (1954), Lewis (1954), Myrdal (1956, 1957), Emmanuel (1972), Amin (1976), and others. The doctrine is usually expressed in the context of technological change and economic growth; it is maintained that the engines of growth are a few industrial countries (such as Great Britain in the nineteenth century and the United States in the 1950s) whose technical progress brings about a deterioration of the terms of trade of the "peripheral" countries and results in chronic "dollar shortage." These countries thus fail to share in the increasing prosperity unless they take remedial measures. Such measures usually take the form of (a) borrowing or procuring aid from abroad, or (b) protectionist policies of various kinds, although—as Haberler (1988, pp. 11–12) notes with his usual perspicacity—such policies are generally described by euphemisms such as "import substitution."

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In the 1980s these doctrines have been revived (cf. Hatsopoulos, Krugman, & Summers 1988), with Japan as the new culprit replacing the United States, and the latter as the new victim replacing the periphery. The situation is described as "declining international competitiveness," and while the remedies proposed include policies to encourage saving and growth of productivity, most of the ones actually resorted to again come under the heading of (a) foreign borrowing to finance massive budget deficits or (b) protectionist policies, although the new euphemisms are "fair trade," "level playing fields," and so forth.[1]

In all these accounts one finds two interrelated analytic problems: (1) If a country experiences unfavorable circumstances which lead to either a loss of welfare or a failure of welfare to achieve expected or target levels, is there a convenient and accurate way to measure this welfare loss as a monetary magnitude? (2) Can this welfare measure usefully provide a ranking of alternative policies to mitigate the welfare losses? In particular, can it evaluate the relative merits of protectionism and foreign financing as means to alleviate a welfare loss?

In this paper my aim is to try and bring some precision to the welfare analysis of countries' adjustments to external events. In particular, following Hicks (1942), it is natural to look for a numerical monetary indicator of welfare loss consequent upon an external disturbance.[2] Let us suppose, for example, that a country experiences a deterioration in its terms of trade. This is analogous to the situation of an individual who experiences a rise in the market price of a commodity he or she consumes. In the latter case, we may consider

[1]For a fuller discussion of these doctrines and their historical development see Chipman (1992).

[2]Hicks (1953, p. 122) himself, rather curiously, did not pursue this approach to explaining why deterioration in a country's terms of trade would lead to "dollar shortage"; rather, he regarded a balance-of-payments deficit as the first but temporary step in a dynamic adjustment to the worsening terms of trade. This could not explain an alleged *chronic* "dollar shortage." Other writers, e.g., Nurkse (1953), have resorted to the explanation that poor countries, via an alleged "demonstration effect," decide to ape the living standards of prosperous ones and therefore dissave. The psychological basis for this effect seems to be quite flimsy, but even if it could be accepted it fails to explain why this demonstration effect would occur precisely when the country experiences a deterioration in its terms of trade. A more reasonable explanation is surely that the country's inhabitants will put pressure on their government to take measures to preserve their previous standard of living, either by (a) dissaving or borrowing and thus (in Haberler's 1948 phrase) living beyond their means, or (b) adopting restrictive trade policies that will reverse the deterioration in the terms of trade and, in effect, increase their means. This provides the positive counterpart to the normative criterion being considered in the text.

(i) a hypothetical rise in income which, following the price increase, would exactly compensate the individual for the rise in price; or (ii) a hypothetical fall in income which, at the original prices, would have led to the same welfare loss as was brought about by the price increase with constant income. The first of these (with opposite sign) is Hicks's Compensating Variation, and the second is his Equivalent Variation. Can a similar analysis be applied to a country?

In the case of a country that is assumed to behave as a rational unit, an analogous procedure is possible provided that on the basis of some ethical postulates we can interpret the utility the country acts as if it maximizes as a measure of the country's "welfare." In place of a consumer's utility function that has amounts consumed as arguments, we may substitute, following Meade (1952), a trade-utility function whose arguments are the amounts traded—specifically the net imports—of the tradable commodities. Analogously to the Marshallian demand function, whose values are amounts consumed and whose arguments are prices and income, the trade-demand function has as its values the country's net imports of tradable commodities (imports and negatives of exports) and as its arguments the prices of tradables and the deficit in the country's balance of payments on goods and services (cf. Chipman 1979).[3] Thus, if a country faces a deterioration in its terms of trade, say a rise in the nominal prices of its imports, we may consider (i) the amount of foreign aid it would have to receive (i.e., the necessary increase it would have to experience in its payments deficit) to compensate for the worsened terms of trade; or (ii) the hypothetical reduction in foreign aid it would have had to undergo—or increase in aid it would have had to provide to other countries (i.e., the necessary fall in its payments deficit or rise in its payments surplus)—at the original external prices, in order to suffer exactly the same loss of welfare as caused by the rise in import prices. The first of these (with opposite sign) we might provisionally take as our measure of Compensating Trade-Variation and the second as the measure of Equivalent Trade-Variation. The negatives of either of these could be taken as a measure of "dollar shortage,"[4] or more

[3]The trade-demand function is also affected by the shape of the country's production-possibility set, which in the context of the usual Heckscher-Ohlin-Lerner-Samuelson (HOLS) model means that it is a function of the country's factor endowments (as well as of any parameters of the production functions representing technical change).

[4]According to Prebisch (1950, p. 19), "the dollar shortage means that the United States does

generally, "shortage of foreign exchange." [5]

However, an important difference between the case of an individual and that of a country makes the above analogies unnatural. If a transfer of income is made to an individual, it is quite reasonable to assume that the prices faced by this individual remain constant; in the case of a country, however, it is in the nature of the case that a transfer generally changes its terms of trade. Of course, there are special assumptions (cf. Samuelson 1952) under which a unilateral transfer from one country to another will leave the terms of trade unaffected; but it would be quite limiting to have to restrict oneself to these assumptions. One could argue that, as in the case of an individual, if a country is very small compared to the rest of the world, a transfer (which, if it is a fraction of its national income, will be a very small fraction of that of the rest of the world) will have a negligible effect on its terms of trade; the analysis would then be of interest in the case of "small countries." However, the literature on dollar shortage is replete with illustrations of tradeoffs between foreign aid and import restrictions, it being assumed that by restricting its imports a country can improve its terms of trade. To find a precise concept of "dollar shortage" that can be usefully employed to analyze the issues dealt with in the literature, it is therefore better to take explicit account of the transfer problem.

A simple example will illustrate the importance of this. Suppose it be granted that import-biased technical change takes place in an advanced country, leading to a deterioration in the terms of trade of a backward country; if the Mill-Taussig-Keynes "orthodox" presumption holds that a transfer will improve the receiving country's terms of trade, then the compensating trade-variation will exaggerate the amount of aid the backward country will need to compensate for its worsened terms of trade, since the aid will itself have the "secondary" effect of improving its terms of trade. That is, the compensating trade-

not purchase merchandise and services, or lend money, in an amount sufficient to cover the needs, justified or not, of other countries." This definition is substantially the same as Kindleberger's (1943, p. 375). It, of course, begs the question of what is meant by "needs," since presumably these could be unlimited. For example, according to this definition the total amount of dollar shortage could easily exceed the entire U.S. gross national product.

[5] A somewhat similar concept is that of a "trade gap" in the "two-gap model" developed by Chenery and his associates. See for instance the interchange between Bruton (1969) and Chenery (1969).

variation will overstate the amount of dollar shortage. Of course, if a transfer should on the contrary have the "anti-orthodox" effect of worsening the receiving country's terms of trade, the compensating trade-variation would understate the amount of dollar shortage. [6]

In Section 1, analogues of the Hicksian concepts of compensating and equivalent variation are developed for application to countries, and the application of such measures to the evaluation of changing terms of trade is discussed. Section 2 provides a self-contained treatment of the effect of technical change on a country's terms of trade in the case of two models: the standard two-commodity HOLS model and a model in which each of two countries specializes in an export good and a nontradable, the latter giving rise to what Samuelson (1952) called the "orthodox presumption" that a transfer will improve the terms of trade of the receiving country.

Section 3 takes up a topic that recurs in Balogh's writings but was first systematically analyzed by Kahn (1950): the question whether a country is better off receiving foreign aid than imposing trade restrictions. This includes the particular problem posed by Kahn of whether the country is better off (in the short run only, of course) losing reserves or resorting to "distress borrowing" than imposing import restrictions. [7]

Of course, from a global point of view a unilateral lump-sum costless transfer from a rich to a poor country (if such a thing is possible) is preferable to restrictive measures imposed by the poor country; for, it follows immediately from the so-called Fundamental Theorem of Welfare Economics that there exists a transfer from the rich country

[6] There is a further problem to which attention has been drawn in Chipman & Moore (1980). If one is comparing two hypothetical price changes faced by an individual, and if the compensating variations are both negative, then while in both cases we can conclude that the individual is made worse off by the price changes, we are not in general entitled to conclude that the price change that leads to the larger (absolute) compensating variation is worse than the price change that leads to the smaller (absolute) compensating variation. Such a conclusion could be drawn only if special assumptions are made about the individual's preferences, unless only one price varies (cf. Chipman & Moore 1980, p. 947n). The equivalent variation, however, does not suffer from this deficiency, because it is a true indirect utility function.

[7] Kahn's formulation was somewhat confusing in that it assumed that both import restrictions and foreign aid were alternatives to currency devaluation. This entails the implicit assumption that the nominal and real exchange rate are proportional to each other and to the terms of trade; this could be true in certain circumstances (cf. Chipman 1989) but is not true in general. Trade restrictions will in general improve a country's terms of trade; a transfer to a country may (but need not) strengthen its real exchange rate (and if so, may strengthen its currency), but even if it does it need not improve its terms of trade.

to the poor one that would make both of them better off than if a tariff were imposed by the poor one. Likewise, if the poor country imposes a tariff we know that there is some transfer from the poor country to the rich one that would make both countries worse off than under free trade. However, it is not obvious that a country imposing a tariff is worse off than it would be if it instead received an amount of foreign aid equal to the previous tariff revenues.

The problem is solved in Section 3 as follows: Since in both cases the country faces the same price of commodity 1 (its export good) and has the same deficit (denominated in its own prices) in its balance of payments on goods and services (equal to the tariff revenues in the one case and to the foreign aid in the other), the country is better off according as the policy chosen leads to a lower price *on domestic markets* of its import good (commodity 2). Now, if a unilateral transfer to country 1 improves its terms of trade (in accordance with the orthodox presumption), then foreign aid in the absence of any trade restrictions will lower this import price; a tariff, however, will normally raise it—unless the so-called "Metzler paradox" holds (cf. Metzler 1949, Chipman 1990). Under these conditions, therefore, the domestic price of the import good must be higher under the tariff with no foreign aid than under the foreign aid with no tariff; consequently the country is better off accepting foreign aid than imposing a tariff yielding the same revenues. Thus, for the country to be better off with a tariff than with foreign aid, one of two anomalies must hold: either a transfer to the country must worsen its terms of trade, or imposition of a tariff must lower rather than raise the domestic price of the import good, i.e., the tariff must be the opposite of protective. It is shown in Chipman (1990) that it is impossible for both these anomalies to subsist simultaneously; thus it is rather unlikely *a priori* that a country would be better off imposing a tariff rather than accepting an amount of foreign aid equal to the revenues it would receive from the tariff. Combining this with the Fundamental Theorem of Welfare Economics we see that the choice of trade restriction as an alternative to foreign aid, when the latter is equal in amount to the revenues that would be earned from the trade restriction, would result in both countries being worse off, unless one of the above anomalies prevails.

1 Monetary Measurement of Change in a Country's Welfare

The simplest conceptual tool to use in evaluating different circumstances a country may face is that of the trade-demand function, which expresses the dependence of a country's trade in a commodity (which I define as the net import of that commodity—a positive quantity for an import good and a negative one for an export good) on the prices (on domestic markets) of the traded commodities and the deficit in the country's balance of payments on goods and services (or "trade balance" for short). For analytic simplicity I consider the case of two tradable goods; the derivation of a country's trade-demand function from its aggregate demand function and production relations is carried out in Section 2 for the cases in which (1) each country produces both commodities (but no nontradables) with the aid of two factors of production, and (2) each country produces an export good and a nontradable good (but no import-competing good) with two factors of production. (For other cases see Chipman 1981, 1987, 1989).

Denote country k's trade-demand for commodity j by $z_j^k = \hat{h}_j^k(p_1^k, p_2^k, D^k; l^k)$, where $z_j^k = x_j^k - y_j^k$ denotes the net import of commodity j and x_j^k and y_j^k denote consumption and production of this commodity; p_j^k denotes the price of commodity j on country k's markets; D^k denotes the deficit in country k's trade balance; and l^k denotes the vector of country k's factor endowments. For $j = 1, 2$ these maximize country k's trade-utility function $\hat{U}^k(z_1^k, z_2^k; l^k)$ subject to the balance-of-payments constraint $p_1^k z_1^k + p_2^k z_2^k \leqq D^k$. Country k's indirect trade-utility function may be defined as[8]

(1)
$$\hat{V}^k(p_1^k, p_2^k, D^k; l^k) = \hat{U}^k\left(\hat{h}_1^k(p_1^k, p_2^k, D^k; l^k), \hat{h}_2^k(p_1^k, p_2^k, D^k; l^k); l^k\right).$$

This function satisfies the Antonelli-Allen-Roy partial differential equa-

[8] A more general definition is possible without requiring the existence of a direct trade-utility function, but this need not be pursued here. A definition alternative to (1) is given in Woodland (1980, p. 909), but it is applicable only to the case in which all goods are traded; this assumption was also made in Chipman (1979). For derivations of trade-demand and trade-utility functions in the presence of nontraded goods see Chipman (1981; 1987, pp. 934, 944; 1989).

tion[9]

$$\frac{\partial \hat{V}^k}{\partial p_j^k} = -\hat{h}_j^k(p_1^k, p_2^k, D^k; l^k)\frac{\partial \hat{V}^k}{\partial D^k} \qquad (j = 1, 2). \tag{2}$$

Since by convention we assume that country k exports commodity k, it follows (assuming local nonsatiation of trade-preferences, implying that $\partial \hat{V}^k/\partial D^k > 0$) that for country 1, $\partial \hat{V}^1/\partial p_2^1 < 0$ (since $\hat{h}_2^1 > 0$), whereas for country 2, $\partial \hat{V}^2/\partial p_2^2 > 0$ (since $\hat{h}_2^2 < 0$). In words, country 1 gains, *ceteris paribus*, from a fall in the domestic price of its import good, while country 2 gains from a rise in the price of its export good (its terms of trade). This is illustrated for $k = 1$ in the three panels (a), (b), and (c) of Figure 1, where $D^1 = 0, D^1 < 0$, and $D^1 > 0$ respectively, it being assumed that country 1 initially exports commodity 1 and imports commodity 2.

Analogously to McKenzie's (1957) minimum-income function and Hurwicz & Uzawa's (1971) income-compensation function, we may define country k's *minimum-deficit function* as[10]

$$\begin{aligned}\hat{\mu}^k(p_1^k, p_2^k; p_1^{k*}, p_2^{k*}, D^{k*}, l^{k*}) = \\ \min\{D^k : \hat{V}^k(p_1^k, p_2^k, D^k; l^{k*}) \geqq \hat{V}^k(p_1^{k*}, p_2^{k*}, D^{k*}; l^{k*})\}\end{aligned} \tag{3}$$

where p_1^k, p_2^k, D^k are the current prices of the tradables (on country k's home markets) and country k's trade deficit, and $p_1^{k*}, p_2^{k*}, D^{k*}$ are the same variables in some base period; l^{k*} is country k's factor-endowment vector in the base period. Finally, by analogy with the definitions in Chipman & Moore (1980) we may define the *compensating trade-variation* in going from $(p_1^{k*}, p_2^{k*}, D^{k*}, l^{k*})$ to $(p_1^k, p_2^k, D^k, l^{k*})$ by

$$\hat{C}^k(p_1^k, p_2^k, D^k; p_1^{k*}, p_2^{k*}, D^{k*}, l^{k*}) = D^k - \hat{\mu}^k(p_1^k, p_2^k; p_1^{k*}, p_2^{k*}, D^{k*}, l^{k*}) \tag{4}$$

and the *equivalent trade-variation* in going from $(p_1^{k*}, p_2^{k*}, D^{k*}, l^{k*})$ to $(p_1^k, p_2^k, D^k, l^{k*})$ by

$$\hat{E}^k(p_1^k, p_2^k, D^k; p_1^{k*}, p_2^{k*}, D^{k*}, l^{k*}) = \hat{\mu}^k(p_1^{k*}, p_2^{k*}; p_1^k, p_2^k, D^k, l^{k*}) - D^{k*}. \tag{5}$$

[9] I use this terminology in place of the more customary but inaccurate expression "Roy's identity." Cf. Chipman & Moore (1980, p. 934n).

[10] Note that the negative of this function has the interesting mercantilist interpretation as the function that maximizes the country's balance of trade; cf. Chipman (1992).

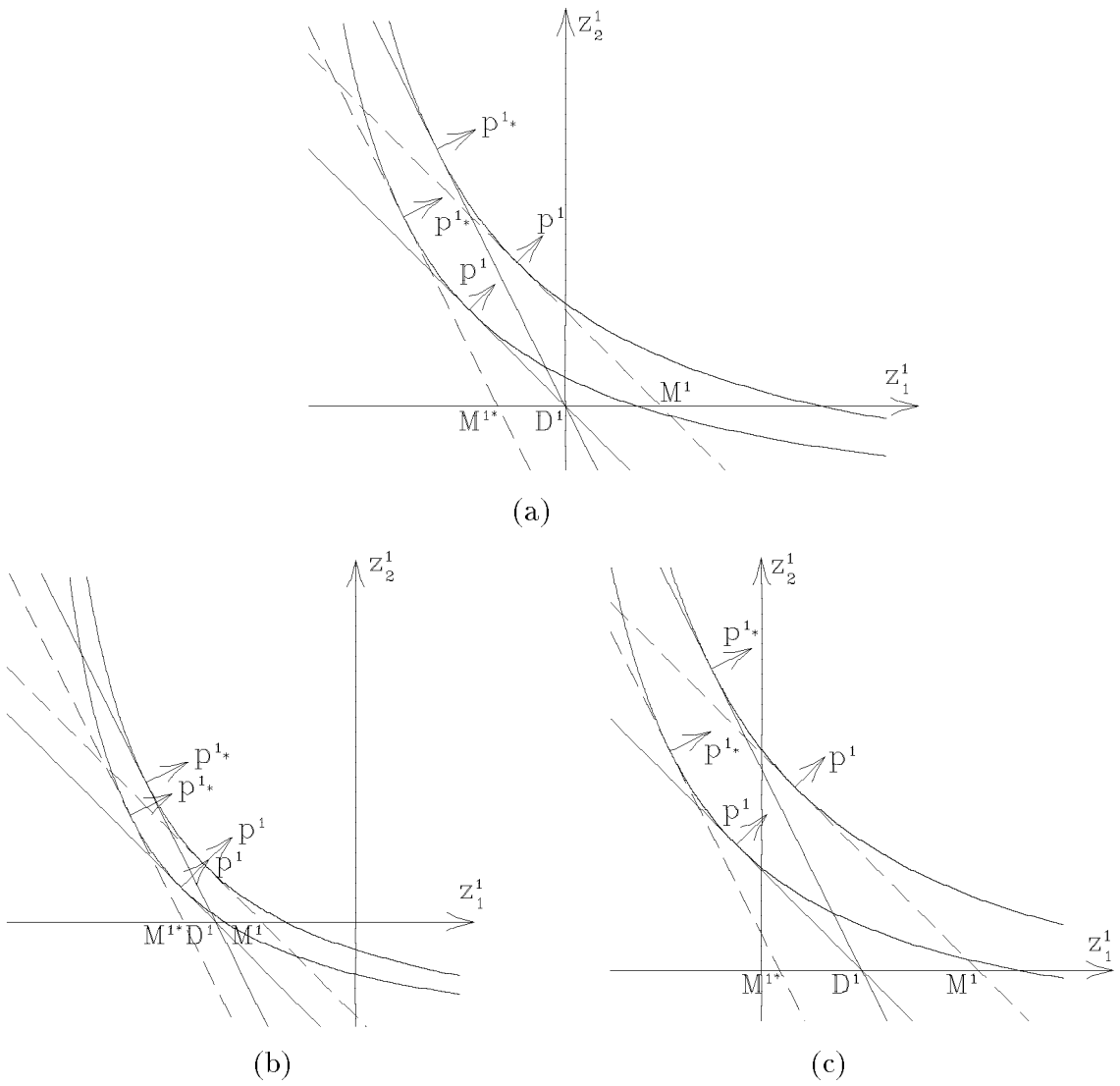

Figure 1

In each panel the original and final budget lines are shown as the solid lines tangential to the two trade-indifference curves with normals (perpendiculars) p^1* and p^1 at the points of tangency respectively, and both going through the point $(D^1, 0)$. With commodity 1 as numéraire, the equations of the budget lines are $z_1^1 + p_2^1 * z_2^1 = D^1$ and $z_1^1 + p_2^1 z_2^1 = D^1$ respectively. A rise in country 1's import price from p_2^1* to p_2^1 leads to a contraclockwise rotation of the budget line and a reduction in country 1's trade-utility. The dashed line parallel to the new (flatter) budget line and tangential to the original trade-utility curve goes through the point $(M^1, 0)$; this corresponds to the maximum balance of trade (i.e., the minimum trade deficit) at the new prices subject to the old welfare level. The segment M^1D^1 measures (in absolute value) the compensating trade-variation in units of commodity 1, corresponding to equation (4) of the text. Likewise, the dashed line parallel to the old (steeper) budget line and tangential to the new trade-indifference curve goes through the point $(M^1*, 0)$; this corresponds to the maximum balance of trade at the old prices subject to the new welfare level. The segment D^1M^{1*} measures (in absolute value) the equivalent trade-variation in units of commodity 1, corresponding to equation (5) of the text.

It is of some interest to note that in panel (c), the point of maximum trade balance subject to the old welfare level is one in which country 1 imports both commodities.

Assuming $p_1^1 = p_1^{1*} = 1$ and $D^1 = D^{1*}$ to be constant and $p_2^1 > p_2^{1*}$ (country 1's terms of trade to worsen[11]), the three panels of Figure 1 show for $k = 1$ the compensating and equivalent trade-variations corresponding to the three cases, where $M^1 = \hat{\mu}^1(1, p_2^1; 1, p_2^{1*}, D^1, l^{1*})$ is the minimum trade deficit (hence $-M^1$ is the maximum trade balance) at the new prices and old welfare level, and $M^{1*} = \hat{\mu}^1(1, p_2^{1*}; 1, p_2^1, D^1, l^{1*})$ is the minimum trade deficit (hence $-M^{1*}$ is the maximum trade balance) at the old prices and new welfare level.

Either one of these concepts would provide a reasonable measure of shortage of foreign exchange in the sense not of "shortage" that might result from foreign-exchange control but in the programming sense indicating the amount of foreign aid required to compensate for a terms-of-trade deterioration—or the loss of foreign aid that would be equivalent to a terms-of-trade deterioration—provided these compensating or equivalent transfers did not themselves affect the terms of trade. With this qualification it would be reasonable to use either one of them as an indicator of what Machlup (1950) called "a PROGRAMME BALANCE, i.e., a balance of hopes and desires," as opposed to the more usual accounting definitions of the balance of payments. However, it seems worth while to examine how the concept should best be altered when the qualification is removed.

Suppose we consider a case in which there is technical change in country 2 that worsens country 1's terms of trade. In terms of the traditional model in which there are no nontradable goods, as first pointed out by Haberler (1948, p. 438) and later by Hicks (1953) [12] (see also Corden 1956, Findlay & Grubert 1959, and Johnson 1959) this would require that technical change in country 2 be *import-biased* (or "anti-trade-biased" in Johnson's terminology), that is, concentrated in its import-competing industry. In particular the result would follow

[11] In the absence of trade restrictions $p_j^1 = p_j^2$ hence p_1^1/p_2^1 corresponds to country 1's terms of trade p_1^2/p_2^2. The case of trade restrictions is taken up in Section 3.

[12] Hicks adopted the Ricardian assumption of constant costs, and argued that if there was technical progress in country A that was limited to its import-competing industry, this would lower the relative price of its imports and improve its terms of trade. This argument can only make sense, as Mishan (1955, p. 217n) pointed out, if country A is so large that its cost ratio determines the world price ratio, as in Graham's (1948) model. On the other hand, if increasing cost is allowed, then Hicks's analysis is inadequate since it neglects consumption effects, as Mishan also showed. This is of importance when analyzing Hicks-neutral change in production functions, but not when analyzing technical change that takes the form of uniform enhancement to a factor's productivity, which automatically gives rise to what Johnson (1959) called the required "ultra-anti-trade-biased" technical change.

if there were factor-augmenting technical improvement in the factor used relatively intensively in country 2's import-competing industry (normally this would be its relatively scarce factor).[13] In this case, at the existing prices country 2, by virtue of the Rybczynski theorem, would shift its resources from exportables to importables. This would reduce the supply of country 2's export good (commodity 2) and increase its supply of its import good (commodity 1). The net result would be an improvement in country 2's terms of trade and a worsening of country 1's. By a similar argument, a technical improvement in country 2 taking the form of increasing efficiency of the factor used relatively intensively in its export industry would worsen its terms of trade and improve country 1's. (These propositions are proved in detail in the next section.)

Under these same circumstances, with identical and homothetic preferences between as well as within countries (hence identical marginal trade-propensities to spend as between countries on either of the two tradable commodities), a transfer from one country to the other will, according to Samuelson's (1952) criterion, have no effect on the terms of trade. The above concepts of foreign-exchange shortage would then provide reasonable measures of the actual amount of foreign aid needed to compensate for (or the reduction in foreign aid equivalent to) the worsened terms of trade.

Suppose we consider, on the other hand, the kind of model that would lead to what Samuelson (1952) called the "orthodox presumption" that a transfer would improve the receiving country's terms of trade. An example of such a model would be one in which each country produces an export good and a nontradable good, but does not produce any import-competing good; this would be a likely result of its having fewer than three factors of production—for definiteness I shall assume that each country has two factors. In these circumstances, assuming all goods to be superior goods in consumers' preferences, a

[13] Balogh (1953, p. 278) stated:

> Technical progress is not unlikely to be haphazard both in timing and industrial incidence. If any bias can be detected it is towards the economizing of that productive factor which in relation to others is scarce and expensive in the dominant country.

One could perhaps justify this on the basis of the theory of induced innovation, but only if factor rentals were not equalized among countries. Balogh apparently overlooked the fact that this suggestion did not square with his rejection of Hicks's hypothesis that technical change would be import-biased.

transfer from country 2 to country 1 would reduce purchasing power in country 2 and increase it in country 1; the increased demand for the nontradable in country 1 would require its resources to move into the nontradables sector out of its export industry (since it does not produce import-competing goods), and likewise the reduced demand for nontradables in country 2 would require its resources to move out of the nontradables sector into its export industry. The net result would be a rise in the world output (equal to country 2's output) of commodity 2 and a fall in the world output (equal to country 1's output) of commodity 1. If the three goods are Hicksian substitutes this must result in an improvement in country 1's terms of trade.[14]

Now suppose a technical change in country 2 is concentrated largely in its nontradables sector. In particular, suppose there is factor-augmenting technical improvement in the factor used relatively intensively in its nontradables sector. In this case, at unchanged prices there would be an increased demand for imports; since, however, at unchanged prices of tradables the prices of nontradables would fall, there would—assuming the three goods to be Hicksian substitutes—be a diversion of demand towards nontradables away from imports which might be strong enough to counteract the original income effect. Thus, there could be, but need not be, a fall in demand for imports and thus an improvement in country 2's, and thus worsening of country 1's, terms of trade. An unambiguous result can be obtained, however, in the case in which the technical improvement increases the efficiency of the factor employed relatively intensively in the export industry. As before, at unchanged prices there is an increased demand for imports; but at unchanged prices of tradables the technical change will increase the price of nontradables and—again assuming the goods to be Hicksian substitutes—cause a diversion of consumer demand from nontradables to importables. Since both effects go in the same direction, there is an increased demand for imports and a worsened terms of trade for country 2.

It is worth noting that if both countries produced import-competing goods as well as export and nontradable goods (which would be more likely if they had a third factor of production), there would be

[14]For details see Chipman (1987, pp. 945–6). Treatment of the one-factor case is dealt with in Chipman (1989).

no strong presumption that either a technical improvement in country 2's nontradables sector or a transfer of funds from country 1 to country 2 would draw more resources out of country 2's export industry than out of its import-competing industry. Thus, there is no strong presumption that either the technical improvement or the transfer would affect the terms of trade. It follows that if country 2's technical change takes the form of factor-augmenting improvement in the factor used relatively intensively in its nontradables sector, the circumstances that make it likely that this technical improvement will worsen country 1's terms of trade also make it probable that a compensating transfer from country 2 to country 1 will result in an offsetting improvement in country 1's terms of trade. Thus there is a general presumption that the above measures of foreign-exchange shortage will overestimate the magnitude of the compensating or equivalent transfers needed to alleviate a worsening of a country's terms of trade.

2 Technical Improvement and the Terms of Trade

This section will be devoted to deriving explicit conditions for factor-augmenting technical change to improve or worsen a country's terms of trade in a model of two countries endowed with two factors of production and trading in two commodities. Two cases will be considered: (1) the standard model in which these two commodities and no others are produced by both countries, and (2) a model in which each country specializes in an export good and a nontradable good. For the standard model a fairly general taxonomy has been developed in the literature using traditional geometrical techniques (Johnson 1955, 1959; Mishan 1955; Corden 1956; Findlay & Grubert 1959). The theoretical analysis of the second model is less well developed, though there have been pertinent contributions by Balassa (1964), Aukrust (1970), McKinnon (1971), Haberler (1973), Edgren, Faxen, & Odhner (1973), and Corden & Neary (1982), all of which have stressed that technical change tends to be more rapid in the tradables sector (both export and import-competing) than in the nontradables sector.[15] In general this carries important implications for the "real exchange rate" (con-

[15]For a general formulation see Chipman (1985), where the thesis that technical progress is more rapid in the "exposed" or tradables sector than in the "sheltered" or nontradables sector is found to be well supported by the data.

sidered as the ratio of prices of nontradables to those of tradables) rather than the terms of trade, but in the special case in which no import-competing goods are produced it implies that one could generally expect technical improvement to worsen the progressive country's terms of trade.

In this section a uniform analytic treatment will be applied to both models. Assuming factors of production to be measured in efficiency units, increases in endowments will be interpreted as increases in their efficiency.[16] I shall consider technical improvements in each factor separately as well as a uniform proportionate improvement in both. In the case of uniform improvement it is shown under fairly mild theoretical assumptions (basically, identical homothetic preferences) that in both models technical improvement will worsen the terms of trade of the progressive country—a result that goes back to Mill (1852, Vol. II, Book III, Ch. XVIII, §8, p. 148). *A fortiori*, improvement that takes the form of increased efficiency of the factor used relatively intensively in the export industry will have an even greater tendency to worsen the terms of trade of the expanding country. In the case of the first model, technical improvement in the form of increased efficiency of the factor used relatively intensively in the import-competing industry unambiguosly improves the terms of trade of the expanding country. In the case of the second model the results of increased efficiency of the factor employed relatively intensively in the nontradables sector are less clear-cut. The income effect of the technical improvement will lead to increased demand for imports, tending to a worsening of the progressive country's terms of trade; but the substitution effect of the fall in the price of the nontradable relative to that of the export good will lead consumers (at unchanged terms of trade) to switch from importables to nontradables; only if this outweighs the income effect will there be a net fall in the demand for imports and therefore an improvement in the progressive country's terms of trade.[17]

[16]Because of its possible confusion with the concept of productive efficiency, "efficiency" is not the best word to describe the intrinsic productive capacity of a factor of production, but it is employed here for convenience because of its common use in the phrase "efficiency units."

[17]The strong *a priori* presumption is thus that technical improvement in one country will improve rather than worsen the terms of trade of other countries, contrary to the Balogh-Prebisch-Singer thesis. The empirical evidence likewise does not support that thesis; cf. Haberler (1959, 1961, 1988), Machlup (1954), Lipsey (1963), Higgins & Dung (1981), Lal (1983). Higgins and Dung (1981, p. 138) could hardly be more emphatic:

> Considering the thoroughness with which the "deteriorating terms of trade" thesis has

World equilibrium is defined by the equation

$$\hat{h}_2^1(p_1, p_2, A^1; l_1^1, l_2^1) + \hat{h}_2^2(p_1, p_2, -A^1; l_1^2, l_2^2) = 0 \tag{6}$$

where the $\hat{h}_2^k$ are the countries' trade-demand functions for commodity 2, A^1 is the amount of foreign aid country 1 is getting from country 2, and l_i^k is country k's endowment in factor i. Since the l_i^k are measured in efficiency units, a rise in l_i^k will be interpreted as a factor-i–augmenting technical improvement in country k. Fixing the price of commodity 1 as numéraire, i.e., setting $p_1 = \bar{p}_1$, equation (6) implicitly defines the function

$$p_2 = \bar{p}_2(A^1, l_1^1, l_2^1, l_1^2, l_2^2). \tag{7}$$

Differentiating it with respect to l_i^2 we have from (6)

$$\frac{\partial \bar{p}_2}{\partial l_i^2} = -\frac{\dfrac{\partial \hat{h}_2^2}{\partial l_i^2}}{\dfrac{\partial \hat{h}_2^1}{\partial p_2} + \dfrac{\partial \hat{h}_2^2}{\partial p_2}}. \tag{8}$$

The denominator of (8) is negative by the usual dynamic stability condition, hence

$$\frac{\partial \bar{p}_2}{\partial l_i^2} > 0 \iff \frac{\partial \hat{h}_2^2}{\partial l_i^2} > 0. \tag{9}$$

In words: *A rise in country 2's endowment in factor i will improve its terms of trade if and only if, at unchanged world prices, it raises its trade-demand for its export good (commodity 2).* Since $\hat{h}_2^2$ is negative, what this means is that country 2's terms of trade will improve if and only if the increased endowment of factor i *lowers* country 2's supply of exports. It is in conformity with intuition that the increased world scarcity of commodity 2 will cause its price (country 2's terms of trade) to rise.

For the case of uniform technical improvement we may define the composed function

$$\hat{\hat{h}}_2^2(p_1, p_2, D^2; l_1^2, l_2^2, \lambda) = \hat{h}_2^2(p_1, p_2, D^2; \lambda l_1^2, \lambda l_2^2). \tag{10}$$

been disproved on both theoretical and empirical grounds, it may seem astonishing that the radicals continue to repeat it.

They go on in a footnote to say, "the case is so clear that informed men of reason cannot help but be in agreement."

Likewise, defining $\hat{\bar{p}}_2(A^1, l_1^1, l_2^1, l_1^2, l_2^2, \lambda) = \bar{p}_2(A^1, l_1^1, l_2^1, \lambda l_1^2, \lambda l_2^2)$, formula (8) is replaced by

$$\frac{\partial \hat{\bar{p}}_2}{\partial \lambda} = -\frac{\frac{\partial \hat{\hat{h}}_2^2}{\partial \lambda}}{\frac{\partial \hat{\hat{h}}_2^1}{\partial p_2} + \frac{\partial \hat{\hat{h}}_2^2}{\partial p_2}} = -\frac{\frac{\partial \hat{h}_2^2}{\partial l_1^2} l_1^2 + \frac{\partial \hat{h}_2^2}{\partial l_2^2} l_2^2}{\frac{\partial \hat{h}_2^1}{\partial p_2} + \frac{\partial \hat{h}_2^2}{\partial p_2}}. \tag{11}$$

2.1 The standard two-commodity–two-factor case

Let us first consider the standard case in which each country produces and trades two commodities with two factors of production, factor i being used relatively intensively in the production of commodity i for $i = 1, 2$. This is the model considered by Johnson (1955), Mishan (1955), Corden (1956), Findlay & Grubert (1959), and Johnson (1959). Country 2's trade-demand function is then given by

$$\begin{aligned} \hat{h}_2^2(p_1, p_2, D^2; l_1^2, l_2^2) = \\ h_2^2\big(p_1, p_2, \Pi^2(p_1, p_2, l_1^2, l_2^2) + D^2\big) - \hat{y}_2^2(p_1, p_2, l_1^2, l_2^2), \end{aligned} \tag{12}$$

where Π^2 is country 2's national-product function and $\hat{y}_j^2 = \partial \Pi^2 / \partial p_j$ is its Rybczynski (supply) function for commodity j. Then

$$\frac{\partial \hat{h}_2^2}{\partial l_i^2} = \frac{\partial h_2^2}{\partial Y^2}\frac{\partial \Pi^2}{\partial l_i^2} - \frac{\partial \hat{y}_2^2}{\partial l_i^2} = c_2^2 w_i^2 - \frac{\partial \hat{w}_i^2}{\partial p_2} = \frac{w_i^2}{p_2}\left[p_2 c_2^2 - \frac{p_2}{w_i^2}\frac{\partial \hat{w}_i^2}{\partial p_2}\right], \tag{13}$$

where $c_j^2 = \partial h_j^2 / \partial Y^2$ and use is made of Samuelson's (1953) reciprocity condition $\partial \hat{y}_j^2 / \partial l_i^2 = \partial \hat{w}_i^2 / \partial p_j$, the $\hat{w}_i^2(p_1, p_2)$ being the Stolper-Samuelson functions. Since by the factor-intensity assumption the Stolper-Samuelson theorem gives

$$\frac{p_2}{w_1^2}\frac{\partial \hat{w}_1^2}{\partial p_2} < 0 \quad \text{and} \quad \frac{p_2}{w_2^2}\frac{\partial \hat{w}_2^2}{\partial p_2} > 1,$$

it follows immediately—assuming both goods to be superior, i.e., $c_j^2 > 0$—that $\partial \hat{h}_2^2 / \partial l_1^2 > 0$ and $\partial \hat{h}_2^2 / \partial l_2^2 < 0$, hence from (9) $\partial \bar{p}_2 / \partial l_1^2 > 0$ and $\partial \bar{p}_2 / \partial l_2^2 < 0$. In words: *A rise in the efficiency of the factor used relatively intensively in country 2's import-competing industry will improve country 2's terms of trade, while a rise in the efficiency*

of the factor used relatively intensively in country 2's export industry will worsen country 2's terms of trade.

Now consider the case of uniform factor-augmenting technical change. For this case we will need to assume homotheticity of preferences, implying that $\partial \hat{h}_j^2/\partial Y^2 = \hat{h}_j^2/Y^2$, where Y^2 is country 2's disposable national income (absorption) $\Pi^2 + D^2$. Differentiating (10) with respect to λ and using the homogeneity of degree 1 of Π^2 and $\hat{y}_2^2 = \partial \Pi^2/\partial p_2$ in l_1^2, l_2^2 and the budget equation $p_1 x_1^2 + p_2 x_2^2 = Y^2$, we obtain from (12)

$$(14)\quad \frac{\partial \hat{\hat{h}}_2^2}{\partial \lambda} = \frac{\partial h_2^2}{\partial Y^2}\Pi^2 - y_2^2 = \frac{\Pi^2}{Y^2}x_2^2 - y_2^2 = \frac{x_2^2}{Y^2}(p_1 y_1^2 + p_2 y_2^2) - y_2^2$$
$$= \frac{p_1 x_1^2 y_1^2}{Y^2}\left[\frac{x_2^2}{x_1^2} - \frac{y_2^2}{y_1^2}\right] < 0,$$

the inequality following from the fact that country 2 by assumption exports commodity 2 and imports commodity 1, hence $x_1^2 > y_1^2$ and $x_2^2 < y_2^2$, so that

$$\frac{x_2^2}{y_2^2} < 1 < \frac{x_1^2}{y_1^2}.$$

Thus, a uniform technical improvement in both factors will worsen country 2's terms of trade. Note that these results are valid even if country 2's trade is unbalanced ($D^2 \neq 0$), but not so unbalanced as to prevent commodity 1 from being imported and commodity 2 from being exported.

2.2 The case of specialization on exports and nontradables

Now let us consider a model of two countries specializing in exports and nontradables with two factors of production. Let country 1 produce commodities 1 and 3 and country 2 produce commodities 2 and 3, the third commodity being nontradable; let each country have two factors of production. I shall assume that in country 2 factor 2 is used relatively intensively in the export sector (industry 2), and thus factor 1 is used relatively intensively in the nontradables sector (industry 3).

To obtain the expression for $\partial \hat{h}_2^2/\partial l_2^2$ we need to derive country 2's trade-demand function. Let $\Pi^2(p_2, p_3^2, l_1^2, l_2^2)$ denote country 2's

national-product function, equal to the maximum national product at prices p_2, p_3^2 and factor endowments l_1^2, l_2^2, and let

$$y_j^2 = \hat{y}_j^2(p_2, p_3^2, l_1^2, l_2^2) = \frac{\partial}{\partial p_j^2}\Pi^2(p_2, p_3^2, l_1^2, l_2^2) \qquad (p_2^2 = p_2) \tag{15}$$

denote country 2's Rybczynski function (supply function) for commodity $j = 2, 3$ (see for instance Chipman 1972). Let the aggregate consumer demand function for commodity j in country 2 be denoted $x_j^2 = h_j^2(p_1, p_2, p_3^2, Y^2)$ where Y^2 is disposable national income. Equating the aggregate demand and supply of the nontradable good implicitly defines the price of the nontradable as a function of the remaining variables, i.e.,

$$h_3^2\left(p_1, p_2, \tilde{p}_3^2(\cdot), \Pi^2(p_2, \tilde{p}_3^2(\cdot), l_1^2, l_2^2) + D^2\right) = \hat{y}_3^2\left(p_2, \tilde{p}_3^2(\cdot), l_1^2, l_2^2\right) \tag{16}$$

where

$$p_3^2 = \tilde{p}_3^2(p_1, p_2, l_1^2, l_2^2, D^2). \tag{17}$$

Country 2's trade-demand for its export good (commodity 2) is then defined by

$$\begin{aligned}\hat{h}_2^2(p_1, p_2, D^2; l_1^2, l_2^2) = \\ h_2^2\left(p_1, p_2, \tilde{p}_3^2(p_1, p_2, l_1^2, l_2^2), \Pi^2(p_2, \tilde{p}_3^2(p_1, p_2, l_1^2, l_2^2), l_1^2, l_2^2) + D^2\right) \\ - \hat{y}_2^2\left(p_2, \tilde{p}_3^2(p_1, p_2, l_1^2, l_2^2), l_1^2, l_2^2\right).\end{aligned} \tag{18}$$

Differentiating (17) implicitly in (16) we obtain, using the usual duality relationships (cf., e.g., Chipman 1972, 1987)

$$\frac{\partial \tilde{p}_3^2}{\partial l_i^2} = \frac{-1}{s_{33}^2 - t_{33}^2}\left[\frac{\partial h_3^2}{\partial Y^2}w_i^2 - \frac{\partial \hat{y}_3^2}{\partial l_i^2}\right] \tag{19}$$

where w_i^2 is the rental of factor i in country 2 and

$$s_{ij}^2 = \frac{\partial h_i^2}{\partial p_j^2} + \frac{\partial h_i^2}{\partial Y^2}h_j^2 \quad \text{and} \quad t_{ij}^2 = \frac{\partial \hat{y}_i^2}{\partial p_j^2} \tag{20}$$

define country 2's Slutsky and transformation terms. Defining also $c_j^2 = \partial h_j^2/\partial Y^2$, these terms satisfy

$$\begin{aligned} p_1 c_1^2 + p_2 c_2^2 + p_3^2 c_3^2 &= 1 \\ p_1 s_{13}^2 + p_2 s_{23}^2 + p_3^2 s_{33}^2 &= 0 \\ p_2 t_{23}^2 + p_3^2 t_{33}^2 &= 0. \end{aligned} \tag{21}$$

We are now able to compute from (18) (using (19) and the fact that $\partial\Pi^2/\partial p_3^2 = y_3^2 = x_3^2$)

$$\frac{\partial \hat{h}_2^2}{\partial l_i^2} = \left[\frac{\partial h_2^2}{\partial Y^2} w_i^2 - \frac{\partial \hat{y}_2^2}{\partial l_i^2}\right] - \frac{s_{23}^2 - t_{23}^2}{s_{33}^2 - t_{33}^2}\left[\frac{\partial h_3^2}{\partial Y^2} w_i^2 - \frac{\partial \hat{y}_3^2}{\partial l_i^2}\right]. \tag{22}$$

Using Samuelson's (1953) reciprocity conditions (cf., e.g., Chipman 1972, 1987), the bracketed terms in (22) may be written

$$\frac{\partial h_j^2}{\partial Y^2} w_i^2 - \frac{\partial \hat{y}_j^2}{\partial l_i^2} = \frac{w_i^2}{p_j^2}\left[p_j^2 c_j^2 - \frac{p_j^2}{w_i^2}\frac{\partial \hat{w}_i^2}{\partial p_j^2}\right]. \tag{23}$$

Thus, (22) becomes

$$\frac{\partial \hat{h}_2^2}{\partial l_i^2} = \frac{w_i^2}{p_2}\left\{\left[p_2 c_2^2 - \frac{p_2}{w_i^2}\frac{\partial \hat{w}_i^2}{\partial p_2}\right] - \frac{p_2(s_{23}^2 - t_{23}^2)}{p_3^2(s_{33}^2 - t_{33}^2)}\left[p_3^2 c_3^2 - \frac{p_3^2}{w_i^2}\frac{\partial \hat{w}_i^2}{\partial p_3^2}\right]\right\}. \tag{24}$$

The first bracketed term in (24) gives the effect the technical change would have if the price, p_3^2, of the nontradable good were fixed. This is the same as the bracketed term in (13). The second term gives the effect of the change in the price of the nontradable. From (19) and (23) we have

$$\frac{\partial \tilde{p}_3^2}{\partial l_i^2} = \frac{-1}{s_{33}^2 - t_{33}^2}\frac{w_i^2}{p_3^2}\left[p_3^2 c_3^2 - \frac{p_3^2}{w_i^2}\frac{\partial \hat{w}_i^2}{\partial p_3^2}\right] \tag{25}$$

where, from the Stolper-Samuelson theorem and the assumption that all goods are superior,

$$p_3^2 c_3^2 - \frac{p_3^2}{w_1^2}\frac{\partial \hat{w}_1^2}{\partial p_3^2} < p_3^2 c_3^2 - 1 < 0 \quad \text{and} \quad p_3^2 c_3^2 - \frac{p_3^2}{w_2^2}\frac{\partial \hat{w}_2^2}{\partial p_3^2} > p_3^2 c_3^2 > 0.$$

Thus, as is to be expected, $\partial \tilde{p}_3^2/\partial l_1^2 < 0$ and $\partial \tilde{p}_3^2/\partial l_2^2 > 0$, that is, the price of the nontradable falls when the factor used relatively intensively in the nontradables sector becomes more efficient and rises when the factor used relatively intensively in the export sector becomes more efficient. Owing to the factor-intensity situation, the bracketed terms in (24) necessarily have opposite sign; hence if (as I shall assume) goods 2 and 3 are substitutes in the sense that $s_{23}^2 - t_{23}^2 > 0$, since necessarily $s_{33}^2 - t_{33}^2 < 0$ formula (24) does not allow for an unambiguous sign.

The solution to this problem is to study country 2's demand for imports rather than its supply of exports. Since

$$p_1 \frac{\partial \hat{h}_1^2}{\partial l_i^2} + p_2 \frac{\partial \hat{h}_2^2}{\partial l_i^2} = 0,$$

these derivatives of course have opposite sign; further, since $y_1^2 = 0$ we have $\partial \hat{y}_1^2 / \partial l_i^2 = \partial \hat{w}_i^2 / \partial p_1 = 0$. Thus,

$$\frac{\partial \hat{h}_1^2}{\partial l_i^2} = \frac{w_i^2}{p_1} \left\{ p_1 c_1^2 - \frac{p_1 s_{13}^2}{p_3^2 (s_{33}^2 - t_{33}^2)} \left[p_3^2 c_3^2 - \frac{p_3^2}{w_i^2} \frac{\partial \hat{w}_i^2}{\partial p_3^2} \right] \right\}. \tag{26}$$

In the case $i = 2$ the bracketed term in (26) is unambiguously positive, by virtue of the Stolper-Samuelson theorem and the assumption that all goods are superior. Assuming commodities 1 and 3 to be Hicksian substitutes (i.e., $s_{13}^2 > 0$), the term preceding the bracketed expression in (26) is negative; consequently we can conclude that $\partial \hat{h}_1^2 / \partial l_2^2 > 0$ and hence $\partial \hat{h}_2^2 / \partial l_2^2 < 0$. The intuitive explanation is straightforward: The term $p_1 c_1^2$ corresponds to the increased demand for imports at unchanged prices—there being of course no change in the (zero) supply of importables. Now an increase in the efficiency of the factor used relatively intensively in the export industry causes the price of the nontradable to rise; the import good by hypothesis being a Hicksian substitute of the nontradable, this price rise causes consumers to switch from nontradables to imports. Therefore, both effects lead to an increase in the demand for imports, resulting in a worsening of country 2's terms of trade. This is fully in accord with the results of the standard model with no nontradables, except that the negative effect on country 2's terms of trade is stronger in this case.

In the case $i = 1$ the bracketed term in (26) is negative, as is the term preceding it (assuming substitutability between commodities 1 and 3); thus the term within braces is the difference between two positive terms, an income effect and a substitution effect. Thus, while the technical change with unchanged relative prices will as before lead to an increase in the demand for imports, it will cause the price of the nontradable to drop, causing consumers to switch from importables to nontradables. If this substitution effect is sufficiently strong, it will outweigh the income effect and the demand for imports will fall. Thus

it is possible but by no means certain that the technical change will improve country 2's terms of trade.

Now we consider the case of uniform factor-augmenting technical progress. Assuming preferences to be homothetic we find readily that

$$\frac{\partial \hat{\hat{h}}_2^2}{\partial \lambda} = \left[\frac{\Pi^2}{Y^2}x_2^2 - y_2^2\right] - \frac{s_{23}^2 - t_{23}^2}{s_{33}^2 - t_{33}^2}\left[\frac{\Pi^2}{Y^2}x_3^2 - y_3^2\right]. \tag{27}$$

If trade is balanced, $\Pi^2 = Y^2$ (national product equals absorption) and the second term vanishes; the whole expression reduces to country 2's export, z_2^2, of commodity 2 (a negative quantity). Thus, under these circumstances a uniform factor-augmenting technical improvement in country 2 must worsen country 2's terms of trade. If trade is unbalanced a small amount either way, then by continuity the qualitative result still holds.

To summarize, as in the case of the standard model either a uniform improvement in factor efficiency or an improvement in efficiency of the factor employed relatively intensively in country 2's export industry will worsen country 2's terms of trade. In the standard model an improvement in efficiency of the factor used relatively intensively in country 2's import-competing industry will improve its terms of trade, while in the model in which country 2 produces only export and nontradable goods an improvement in efficiency of the factor used relatively intensively in the nontradables sector may, but need not, improve country 2's terms of trade. Thus, in the second model it is less likely for technical progress in country 2 to worsen country 1's terms of trade; and even if it does have this effect, a smaller transfer payment from country 2 to country 1 will be needed than in the first model to compensate country 1 for its welfare loss.

3 Import Restrictions versus Foreign Aid

I shall assume that country 1 is in the process of receiving a certain amount A^1 of foreign aid from country 2, and/or tariff revenues from country 2 resulting from its imposition of a tariff of $100\tau_2^1\%$ on its imports of commodity 2 from country 2. For convenience I work with the tariff factor $T_2^1 = 1 + \tau_2^1$ in place of the tariff rate τ_2^1. As is customary, the price of country 1's export good (commodity 1), which

will be the same in both countries (i.e., $p_1^1 = p_1^2 = \bar{p}_1^2$), will be taken as numéraire.

Country 1's excess demand for its own import good (commodity 2), expressed as a function of the external (country-2) prices of the two tradable goods, is defined as the solution of the functional equation

$$(28) \qquad \begin{aligned} &\hat{z}_2^1(p_1^2, p_2^2, A^1, T_2^1, l^1) = \\ &\quad \hat{h}_2^1\big(p_1^2, T_2^1 p_2^2, A^1 + (T_2^1 - 1)p_2^2 \hat{z}_2^1(p_1^2, p_2^2, A^1, T_2^1, l^1); l^1\big)\,. \end{aligned}$$

Country 2's excess demand for commodity 2 (its export good) is defined simply by

$$(29) \qquad \hat{z}_2^2(p_1^2, p_2^2, A^1, T_2^1, l^2) = \hat{h}_2^2(p_1^2, p_2^2, -A^1; l^2).$$

World equilibrium is then defined by the equation

$$(30) \qquad \hat{z}_2^1(p_1^2, p_2^2, A^1, T_2^1, l^1) + \hat{z}_2^2(p_1^2, p_2^2, A^1, T_2^1, l^2) = 0.$$

Recalling that $p_1^2 = \bar{p}_1^2 =$ constant, and assuming the countries' factor endowments l^1, l^2 also to be constant, equation (30)—which holds for all values of the parameters A^1, T_2^1—implicitly defines the functions

$$(31) \qquad \begin{aligned} &p_2^2 = \bar{p}_2^2(A^1, T_2^1), \;\; p_2^1 = \bar{p}_2^1(A^1, T_2^1) \equiv T_2^1 \bar{p}_2^2(A^1, T_2^1), \\ &\quad \text{and} \;\; z_2^1 = \bar{z}_2^1(A^1, T_2^1) \equiv \hat{z}_2^1(\bar{p}_1^2, \bar{p}_2^2(A^1, T_2^1), A^1, T_2^1, l^1). \end{aligned}$$

Now let us consider the question at issue. Suppose country 1 initially receives no foreign aid but imposes a tariff of $\tau_2^1 = T_2^1 - 1 > 0$ on its imports of commodity 2 from country 2. Its tariff revenues, which are equal to its trade deficit (denominated in its own prices), are then equal to

$$(32) \qquad R^1(T_2^1) = (T_2^1 - 1)\bar{p}_2^2(0, T_2^1)\bar{z}_2^1(0, T_2^1).$$

Now, suppose country 1 is offered an amount A^1 of foreign aid by country 2 equal to these tariff revenues (32), on condition that it remove its tariff; then its trade deficit (denominated in its own prices) remains equal to the quantity (32). Is country 1 better or worse off than before? The question can also be put in the converse form. Suppose country 1 was initially receiving an amount A^1 of foreign aid from country 2, and imposed no tariffs. Now country 2 withdraws the foreign aid; if country 1 in these circumstances imposes a tariff

at a level such as to yield tariff revenues equal to the previous level of foreign aid (i.e., a T_2^1 satisfying $R^1(T_2^1) = A^1$), will it be better or worse off?

This question may be answered by considering each country's indirect trade-utility function. For example, we may take this to be the equivalent trade-variation (5) for some fixed base prices of tradables and factor endowments.

With the tariff, country 1's potential welfare is

$$u_T^1 = \hat{V}^1\big(\bar{p}_1^2, T_2^1\bar{p}_2^2(0,T_2^1), (T_2^1-1)\bar{p}_2^2(0,T_2^1)\bar{z}_2^1(0,T_2^1); l^1\big) \tag{33}$$

whereas with foreign aid it is equal to

$$u_A^1 = \hat{V}^1\big(\bar{p}_1^2, \bar{p}_2^2(A^1,1), A^1; l^1\big)\,, \tag{34}$$

where

$$A^1 = (T_2^1-1)\bar{p}_2^2(0,T_2^1)\bar{z}_2^1(0,T_2^1).$$

Since (33) and (34) have identical first and third (as well as fourth) arguments, and country 1 must be better off, *ceteris paribus*, with a lower domestic price of its import good, we have the simple criterion

$$u_A^1 \gtreqless u_T^1 \text{ according as} \tag{35}$$
$$\bar{p}_2^1(A^1,1) = \bar{p}_2^2(A^1,1) \lesseqgtr T_2^1\bar{p}_2^2(0,T_2^1) = \bar{p}_2^1(0,T_2^1).$$

In words: *In order for country 1 to be better off with foreign aid than with a tariff that will yield the same revenue as the foreign aid, it is necessary and sufficient that the internal price of its import good be lower (relative to the price of its export good) with the foreign aid than with the tariff.*

A sufficient condition for this result is readily established. Suppose that the following two conditions hold:

(a) A transfer from country 2 to country 1 has the "orthodox" effect of improving (or at least not worsening) country 1's terms of trade in the absence of tariffs, i.e.,

$$\bar{p}_2^2(A^1,1) \leqq \bar{p}_2^2(0,1).$$

(b) A tariff imposed by country 1 does not lead to the "Metzler paradox," i.e., does not lower the domestic price of its import good:

$$\bar{p}_2^1(0,T_2^1) \geqq \bar{p}_2^1(0,1).$$

Then

$$\bar{p}_2^2(A^1,1) \leqq \bar{p}_2^2(0,1) = \bar{p}_2^1(0,1) \leqq \bar{p}_2^1(0,T_2^1) = T_2^1\bar{p}_2^2(0,T_2^1). \tag{36}$$

From (35) and (36) we may conclude that $u_T^1 \leqq u_A^1$, with strict inequality holding if either of the inequalities (a) or (b) is strict. In words: *Under conditions (a) and (b) country 1 can never be better off with a tariff than it would be with an amount of foreign aid equal to the tariff revenues; and if either (a) a transfer to country 1 strictly improves the latter's terms of trade or (b) a tariff imposed by country 1 strictly raises the domestic price of its import good, then country 1 must be better off with foreign aid than with a tariff yielding the same amount of revenues.*

A simple alternative sufficient condition can be stated for this result. Suppose that

$$\bar{p}_2^2(0,T_2^1) \geqq \bar{p}_2^2(A^1,1) \tag{37}$$

where

$$A^1 = (T_2^1 - 1)\bar{p}_2^2(0,T_2^1) \text{ and } T_2^1 > 1;$$

then

$$\bar{p}_2^1(0,T_2^1) = T_2^1\bar{p}_2^2(0,T_2^1) > \bar{p}_2^2(A^1,1) = \bar{p}_2^1(A^1,1), \tag{38}$$

hence $u_T^1 < u_A^1$ by (35). In words: *If foreign aid leads to at least as great an improvement in country 1's terms of trade as a tariff that yields the same amount in revenues, then the domestic price of imports is greater under the tariff and consequently country 1 is better off with the foreign aid than with the tariff.*

It might be thought that by reversing the two inequalities in (a) and (b) one could reverse the conclusion; i.e., that by assuming (a′) that a transfer has the "anti-orthodox" effect of worsening the receiving country's terms of trade and (b′) that the Metzler paradox holds, one could conclude that country 1 would be better off under a tariff than with an equal amount of foreign aid. However, it has been shown in Chipman (1990) that the Metzler paradox can occur only if the orthodox presumption of the transfer problem holds. Thus, (a′) and (b′) cannot both be true and we cannot therefore obtain the converse result.

To understand the situation it is instructive also to investigate *necessary* conditions. Suppose we assume that country 1 will be better off with the tariff and that the Metzler paradox does not hold. Then, using the corresponding two inequalities (35) and (b) in succession we obtain

$$\bar{p}_2^2(A^1, 1) > T_2^1 \bar{p}_2^2(0, T_2^1) = \bar{p}_2^1(0, T_2^1) \geqq \bar{p}_2^1(0, 1) = \bar{p}_2^2(0, 1).$$

This shows that a transfer must have the anti-orthodox effect of worsening the receiving country's terms of trade. Likewise, suppose that country 1 will be better off under the tariff and that the orthodox presumption holds that foreign aid will improve or at least not worsen its terms of trade. Then using the corresponding inequalities (35) and (a) in succession we obtain

$$\bar{p}_2^1(0, T_2^1) = T_2^1 \bar{p}_2^2(0, T_2^1) < \bar{p}_2^2(A^1, 1) \leqq \bar{p}_2^2(0, 1) = \bar{p}_2^1(0, 1).$$

This implies that the Metzler paradox must hold. Thus we may conclude: *In order for country 1 to be better off under a tariff than with foreign aid equal to the amount of the tariff revenues, it is necessary either that the tariff give rise to the Metzler paradox, i.e., cause a lowering of the post-tariff internal import price, or that the foreign aid have the anti-orthodox effect of worsening its terms of trade.* Thus, one of two anomalies must hold if it is to be the case that country 1 is better off with the tariff. As pointed out above, it is logically impossible for both these anomalies to hold simultaneouly.

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