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The Relationship Among the International Movements of Workers, Capital, and Goods

THE international movements of the means of production and of products are interrelated in a minimum number of definite ways which this paper will set forth in an attempt to motivate and to guide future research into this important area. In particular, we shall explore the extent to which the world caa forego *'any* international movements of workers, without losing any of the purely economic benefits (higher real incomes) of that migration. This, it seems to me, is the most important question in-as-much-as international migration imposes obvious and severe hardships on most of the workers involved, including their competitors in host countries. We undertake therefore to develop a framework capable (0 of measuring the economic gains of international integration in particular cases and *(if)* of mapping the alternative combinations of trade, migration, and foreign investment that achieve a given level of integration, as measured and defined by the economic gains. We shall begin with a brief reference to the main body of literature that currently bears on these matters.

I. The Heckscher-Ohlin Trade Theory[1]

An important body of existing formal literature[2] discusses the special conditions under which trade in products alone not only perfectly substi-

1. Heckscher, E. F., 1919. The effects of foreign trade on the distribution of income, *Ekonomisk Tidskrift,* **21,** 497-512. Ohlin, B.. 1967, *Interregional and International Trade* (Revised Ed.), Cambridge, Massachusetts (Harvard University Press).

2. Sodersten, Bo, 1970, *International Economics,* New York (Harper and Row, Inc.).

tutes for any migration of workers, but of all other primary factors as well. These conditions ensure what we might call the *effective* integration of the partner economies in question: all of their prices as well as real factor wages are equalized internationally, even though all factors remain in their home countries[3]. The first condition for effective integration to hold is obviously that some, though not necessarily all, products are freely mobile internationally, in the sense that their prices are the same in both countries, a condition that requires free and costless international trade in goods. In addition, movement of goods substitutes perfectly for movement of factors only if both countries use the same constant-returns production technology (see below Section III) and if the relative factor endowments are not too different, in which case full specialization would supervene in advance of completely effective integration.

Of these three conditions, the first is quite unrealistic : all countries do not know and exploit a common technology. The second condition is also counterfactual, but because products are so numerous in the real world, it does not really contribute to the vast international disparities in real wage rates that induce international migration. The numerousness of products means that even small countries, e. g., Denmark, Belgium, etc., can fully realize scale economies by concentrating on a limited number of products. The third condition says, in effect, that product trade alone can integrate only those international economies the member countries of which have similar factor endowments and so would feel relatively little need to integrate.

The third condition raises another important problem as well, namely the *willingness* of countries to exchange products up to the limits of full specialization, characterized by the phasing out of given industries. To put the matter slightly differently, a large amount of two-way trade is necessary to substitute for a small amount of worker migration even if all three conditions for factor-price equalization can be assumed[4]. The large volume of trade becomes unstable, however, as particular industries demand and receive protection. This process[5] throws other industries out

3. Samuelson, P. A., 1953-54, Prices of goods and factors in general equilibrium, *Review of Economic Studies, 21,* 1-20.

4. Travis, W.P., 1964, *The Theory of Trade and Protection,* Cambridge, Massachusetts (Harvard University Press).

5. Travis, W. P , 1972, Production, trade, and protection when there are many commodities and two factors, *American Economic Review,* 60, 87-106.

of international competitive equilibrium, whereupon they demand protection in turn. The final result, judging from the history of commercial policies in most countries, is to eliminate the type of international exchange, of capital-intensive for labor-intensive products, that would close international disparities in real wages. Indeed, the richer countries clearly view migration as an adjunct of customs policy in rescuing national labor-intensive and inefficient industries.

The ability to trade products and to trade capital services directly, through portfolio international investment, would eliminate the problem of complete specialization if the universal-technology assumption were valid. Using the model in Section III below it is easy to show that the inability to trade any given factor's services directly (notably labor's) is binding whenever technology differs (as it does) from country to country.

Fortunately, as we shall see in the following section, all factors' services *can* be directly traded, even though it is obvious that not all factors can migrate. Completely effective integration can be achieved through international trade combined with international direct and indirect investment alone, and thus by means of the international movement of goods alone; this form of effective integration requires none of the special Heckscher-Ohlin assumptions.

II. Foreign Investment and Trade in Factor Services

Imagine a plant or factory operating in country A, where it hires workers residing in country A. Suppose that its capital equipment is entirely owned by citizens of country A and that the factory transforms materials supplied by other plants located in country A to make a product which is sold exclusively in country A. Suppose now that the plant is physically transplanted (a form of direct foreign investment) to country B, where it hires only workers residing in (and presumably citizens of) country B. The plant continues, moreover, to patronize the same suppliers and to serve the same clients as before. That is, it transforms materials shipped to it from country A and it sends back to country .A its entire output. Because the owners of its capital equipment continue to reside (let us suppose) in country A, the corresponding dividends

and interest payments are also remitted to country A. The plant's entire wage bill is now paid to country B, however.

Obviously, we could describe the second situation above as one in which country A simply imports labor services, via the direct overseas-investment involved, rather than, as in the former situation, purchasing all labor services domestically. The situation is perfectly equivalent to one in which the B workers would commute daily to country A to work and return home again at night.' The workers do not need actually to commute, however; the shipment of machines and raw materials to B and of finished products to A performs the same function.

Suppose next that country A borrows from country B the machines with which it equips the above cited plant or factory. Country B can be said in such a case to have invested *indirectly* in country A or, what comes down to the same thing, to be selling current capital services to country A. It does not matter, obviously, that the plant is physically located in country B and happens also to purchase there labor services from country B.

The above examples envisage a manufacturing plant which does not directly employ any primary factor other than capital and labor. Nothing prevents us from imagining the plant to be engaged in some form of agriculture or mining, and thus to employ local third-factor services as well as capital and labor.

We see, though, that the employment of labor and of local land is tied to some extent and that a particular country B might lack sufficient labor of its own to export, through foreign investment, a given amount of its land services. In this case some labor would have to migrate or commute internationally in order to export all of country B's third-factor services. Obviously such migration took place during the period in which vast new lands were discovered and settled. That phase of world settlement now seems to be completed.

An interesting special case helps to illustrate the interrelationship among the international trade of goods and of labor and capital services. It is the case exactly opposite to that assumed by the Heckscher-Ohlin trade theory, namely that in which the two partner countries exchange interna-

tionally *only* capital and labor services, and no products. Suppose that country A has plants in country B, that they hire country B's labor services only, and that country A's citizens meanwhile invest indirectly in enterprises (located in country B) of country B. Suppose further that all the overseas production of country A's plants is repatriated, so that nothing but capital services are sold to country B, and that no ordinary merchandise exports are sold by either country. Although A's goods are shipped from country B to country A in this example, those goods are *not* internationally traded. Country A balances its purchases of labor services from country B therefore entirely by its sale of capital services to that country.

In such a world (trade in factor services only), only the *relative* prices of factor services can be equalized unless both countries employ the same technology. Can relative factor prices always be equalized ? That question (in this special case) turns on the international mobility of goods. We note that about half of any given country's income is typically spent on movable goods and that total returns to capital are typically one half of national income. Trading factor services requires movement of goods in only one direction, moreover. We can conclude that the international movement of goods alone would suffice to export any desired proportion of the available capital services of any given country, in return for labor services.

In fact, of course, countries may exchange products as well as factor services. If it is technologically superior to country B, country A can profitably sell some of its goods-to country B, in return for factor services. In the limit, country A might hire, through direct foreign investment and indirect foreign borrowing, *all* of country B's primary factor services (labor, capital, and various types of land).

A curious seeming paradox could arise, depending on the relative sizes of the countries' labor forces and the extent of country A's technological superiority over country B. If some goods were immobile internationally, workers might migrate from the *richer* to the *poorer* country simply to consume locally supplied services there. This would happen if the richer workforce were insufficiently numerous to supply all the immobile products demanded at its post-trade level of real income and if the richer workers were more mobile than the poor workers. This case and that in

which a given country lacks sufficient workers to export, through direct investment, its third-factor services are the only ones in which direct and indirect foreign investment would ever fail to transfer internationally without worker migration, any desired amount of direct factor services.

Foreign investment, then, is able in every important case completely to substitute for international worker migration as a means of reaping the full gains from economic integration. Foreign investment can do more than can worker migration, however. Migration alone can equalize relative factor returns in all countries only if technology is everywhere the same and if at least all factors but one are mobile. Foreign investment, by contrast, automatically applies the technology of one country to all the factors, including land and capital, of the other country and thus prevents the stranding of any immobile factor supplies as the mobile factors seek higher earnings elsewhere.

The above proposition does not, of course, mean that all forms of foreign investment are better than any form of international worker migration. Certain forms of foreign investment though are certainly better than any form of migration as a means for deriving all the real benefits of internationl economic integration. We need to examine the exact impact of specific forms of foreign investment on the sentiments of national independence and sovereignty, for example, in order to see which forms transact the largest amount of factor services for a given perceived sacrifice of non-economic objectives.

The bad press suffered "by direct foreign manufacturing investment often results from the practice of tying such investment to commercial-policy and foreign-exchange considerations. In many cases direct foreign investment is courted as a way to substitute for imports and the foreign investor is granted customs protection in the market of the host country. Such schemes always turn sour as the local subsidiary fails to export (its costs are always too high because its scale is too small) and yet remits foreign exchange to the home office. The home office, to the extent that its foreign subsidiary is partly locally owned, usually stipulates, moreover, that the subsidiary must not produce exports to compete with its own products in world markets and, for the same reason, tries to keep its productive and commercial secrets from leaking to the host country. The subsidiary's failure to export goods means, of course, that the direct

investment fails to export labor services from the host country, beyond those exchanged for the subsidiary's locally vended, and expensive, output.

Obviously much better forms of direct investment in labor-exporting countries can be devised. One of the more promising is that in which the host country provides (a form of indirect lending) the necessary industrial infrastructure (commercial and industrial buildings) for rent, against foreign exchange, to foreign producers. Those producers should be required to pay their local wage bills also in foreign exchange, in which case, of course, they would automatically be obliged to produce in the host country for world, rather than for local markets and thus to export from the host country the labor services employed there.

This scheme has several important side advantages, notably regarding the transfer of technology and the sharing of risk. As the host-country entrepreneurs gain more and more experience in renting to foreign producers, they will incidentally learn a considerable amount about their technology, markets, etc. Eventually those entrepreneurs might use their facilities directly to satisfy local as well as foreign demand for the products in question. Much pragmatic research involving the design and marketing of such facilities, the training of local staff, etc., needs to be done, of course. The following section sets forth the general methods necessary to evaluate their economic effectiveness.

III. Definition and Measurement of the Gains from Foreign Trade, Investment, and Migration

It is possible, under reasonable assumptions, both to define and to measure the economic gains from international commerce-migration, trade, and investment. The methods briefly discussed below indicate that many trading pairs either do or could reap substantial gains from foreign commerce. The EEC and North Africa, for instance, must already be realizing substantial gains from worker migration, even though those gains do not depend on migration but could be secured through direct foreign investment. All forms of Indo-American international commerce are miniscule, on the other hand, even though the prospective returns to opening up such commerce are very large[6].

6. Cambon. J. D., 1974, *Foreign Investment and trade Between Rich and Poor Countries,* unpublished Ph. D. thesis, Univ. Calif. (San Diego).

The problem of evaluating the real economic gains from foreign trade is an old and very difficult one[7]. A highly general scheme is necessary in order to ensure that the gains made by one group (e.g., the workers who sell their labor services to another country) offset any losses suffered by other economic agents (e.g., workers in the countries that import labor services). In practice such losses must be made good through some form of social policy and we need to know therefore whether any practical and objective compensatory policies exist. Thus, in addition to the pragmatic research called for to devise efficient forms of foreign investment, considerable research should be devoted to analyzing and measuring the gains from such schemes.

The following system is intended to indicate a possible line of approach. The approach consists, in its practical application, of using ordinary fitted aggregative production functions (fitted before foreign investment, migration, and trade are opened up or expanded)[8]; to estimate the gains from expanded foreign commerce as between any two actual or prospective trading partners. On the theoretical side, the suggested approach guarantees, subject to only one assumption, that the estimates of real-income gains correspond to true gains in welfare possibilities. The gain estimates can thus be compared with one's subjective estimate of the non-economic costs (loss of the sense of sovereignty, etc.) of the best foreign-investment or migration scheme that effectuates the necessary international exchange of products and of factor services.

A Model of Foreign Investment, Migration and Trade

The two countries integrating their economies through some combination of foreign investment, trade, and migration have the joint endowment supplies of factor services indicated by the vector $W = (W_1, W_2, \ldots, W_r)$ where W_k is the joint (world) supply of the k-*th* ($k = 1, \ldots,$ r) factor service and where r is the total number of factors primary

7. SamueSson, P. A., 1950, The evaluation of real income, *Oxford Economic Papers, New Series, 2,* 1-29.

___, 1956, Social indifference curves, *Quarterly Journal of Economics,* 70, 1-22,

8. Douglas, P.H., 1948, Are there laws of economic production ? *American Economic Review,* **38,** 1-41. Nerlove, M., 1967, "Recent Empirical Studies of the C, E. S. and Related Production Functions, "In : M. Brown (ed.). *The Theory and Empirical Analysis of Production,* Nat. Bur. Econ. Res., *Studies in Income and Wealth,* 31, New York, 55-122.

to both countries. Country B employs directly, in its home and overseas plants, the amounts, P_k, of the r factor services specified by the foreign-employment vector $P = (P_1, \ldots, P_r)$. Country A therefore employs the factor-service amounts $(W_k - P_k)$ specified by the vector $(W - P)$. The vector W is considered to be fixed and given during the time period under scrutiny. Country B's actual endowment supplies, E_k, of each factor service, specified by the vector $E = (E_1, \ldots, E_r)$, are also fixed and given during the time period. The difference between E and P is the result, therefore, of the foreign investment or foreign migration policy in effect, as explained in Section II, above.

We wish to know how setting P with respect to W affects potential world welfare. World welfare is described at any given moment of time by the utility-distribution vector u^W :

(Def. 1) $u^W = (u_1, \ldots, u_W)$ is the vector indicating the level, u_m $(m = 1, \ldots, w)$, of utility felt, subjectively, by each of the w persons belonging to country A and country B. The subjective utility indicator u_m is thus a *scalar* measure of person m's happiness.

The scalar u_m can safely be considered to be a function of the allocation of all n products among all w members of the world community. Thus

$$u_m = U_m(D), \tag{1}$$

where

(Def. 2)
$$D = \begin{bmatrix} d_{11} & \ldots & d_{1w} \\ \cdot & & \cdot \\ \cdot & & \cdot \\ \cdot & & \cdot \\ d_{n1} & \ldots & d_{nw} \end{bmatrix}$$

is the n-by-w matrix showing the amount, d_{ig} $(i = 1, \ldots, n$ and $g = 1, \ldots, w)$, of the i-th product which the g-th person uses up, invests, stores away, throws away, or otherwise disposes of (except, of course, through a gift to some other person, whose disposition of

the product would already be counted elsewhere in D) during the given time period.

The scalar measures u_m cannot be added, of course, to obtain any scalar measure of general social welfare. This is because they are perfectly ordinal indicators, whereby each person ranks only his own private utility levels. In order, however, to summarize social demand, $d_i^W = \sum_{m=1}^{w} d_{im}$, for each $(i = 1, \ldots, n)$ of the n products we can construct the following product-availabilities, utility set for any given utility-distribution described by Definition 1 :

(Def. 3) $\quad D^W(u^W) = \{d^W = D\,1 \mid U_m(D) \geqq u_m, \quad m = 1, \ldots, w\}$

is the set of all vectors $d^W = (d_1^W, \ldots, d_n^W)$ of amounts $d_i^W (i = 1, \ldots, n)$ of products which could be distributed in at least one way D (cf. Definition 2) among the w members of the world community to make, in the sense of Equation 1, each person m $(m = 1, \ldots, w)$ feel at least the level u_m which the utility-distribution vector $u^W = (u_1, \ldots, u^W)$ described by Definition 1 specifies.

The boundary of the product-utility set $D^W(u^W)$ is, of course, the community indifference curve (surface or hypersurface, as the case may be) first discussed by Tibor N. Scitovsky[9]. Samuelson[7] pointed out that such indifference hypersurfaces must surely intersect in practice, given the idiosyncracy of individual tastes for products. That means of course that in general the sets $D^W(u^W)$ are not *comparable* and so fail to rank alternative different utility distributions, e. g., u^W and u'^W, unambiguously, as a true real-income measure would require.

A change in international migration, investment, and trade policy, meanwhile, is certain not only to change the world utility distribution but to make some people worse off than before the change, no matter how many others benefit or to what degree. In principle, as Samuelson points out, policies can be ranked, according to ascending real-income levels, by allowing, in each case, the winners to bribe the losers until everyone's total welfare position is improved [note that our formulation, in

9. Scitovsky, T. N. 1942, A reconsideration of the theory of tariffs, *Review of Economic Studies*, 89-110.

(1) and Definition 2, takes the income distribution into explicit account]. In practice, of course, such universal welfare bazaars would be too difficult to organize to serve as a practical means of evaluating policy.

While tastes for final products (consumer and investor goods) are doubtlessly idiosyncratic, relative preferences for underlying primary-factor services (notably those of labor and capital) may well be identical among different individuals. The measurement of the gains from foreign investment, trade, and migration requires fortunately only this type of interpersonal taste identity, not the complete identity of tastes for products. The lack of factor-bias in tastes means that alternative trade policies can be ranked directly by means of a scalar real-income measure that is fairly simple to derive and to estimate in practice.

We propose therefore the following *factor-service* utility sets, as a way of circumventing Samuelson's criticism of the *product-utility* sets of Definiton 3:

(Def. 4) $F(u^W, P)$ is the set of all factor-service input vectors $f = (f_1, \ldots, f_r)$ of factor-service employments f_k $(k = 1, \ldots, r)$ each of which is capable of producing at least one vector $x = (x_1, \ldots, x_n) = d^W$ of output amounts x_i $(i = 1, \ldots, n)$ which could be allocated in at least one way D (cf. Definition 2) among the w members of the world community to make, in the sense of Equation 1, each person m $(m = 1, \ldots, w)$, feel the level u_m of utility which the utility-distribution vector u^W of Definition 1 specifies, and of doing so *even though* country B must employ of each factor service k $(k = 1, \ldots, r)$ no more than the amount P_k which the given foreign-employment vector $P = (P_1, \ldots, P_r)$ stipulates.

The *employment-constrained, factor-service utility sets* of Definition 4 work as follows. Suppose that a given utility-distribution vector u^W is specified in the manner described by Definition 1 and that two alternative foreign-employment vectors P and P' are determined by two alternative foreign migration and investment policies. We have then two alternative factor-utility sets; $F(u^W, P)$ and $F(u^W, P')$, respectively. We might find that the world endowment vector, W is not a member, $W \notin F(u^W, P)$, of the former utility set, in which case the utility-distribution u^W is unattainable under the policy determining P. On the other hand, we may find

that $W \in F(u^W, P')$, in which case we can say that shifting from policy P to policy P' has rendered u^W feasible.

In order to compare directly any two alternative foreign employment policies it is necessary to rank alternative utility distribution vectors, e. g., u^W and u'^W, despite the purely subjective nature of each private measure $u_m (m = 1, \ldots, w)$ of utility. The following hypothesis permits us to rank any collection of utility distributions in terms of levels of a single scalar number that we call g :

(Hyp. 1) There exists at least one function (whether or not we know its form) $g = G(f; P)$ having associated sets (we can call them *factor-service input, real-income sets*) $F(g, P) = \{f | G(f; P) \geqq g\}$ such that, for any given specification of the maximum amount, P_k, of each $(k = 1, \ldots, r)$ factor service employed by country B and thus for any fixed foreign-employment vector $P = (P_1, \ldots, P_r)$, either $F(u^W, P) < F(g, P)$ or $F(g, P) < F(u^W, P)$ or else $F(u^W, P)$ equals $F(g, P)$ for all sets $F(u^W, P)$ described by Definition 4 and therefore for all levels of the scalars $g, u_1, u_2, \ldots,$ and u_W.

The symbol $<$ in Hypothesis 1 is the proper-inclusion sign. For any two sets S_1 and S_2, $S_1 < S_2$ means that every element of S_1 also belongs to S_2 but S_2 has elements that are not in S_1. Hypothesis 1 asserts therefore that, for any fixed foreign-employment vector P, all sets $F(u^W, P)$ are mutually *comparable*, regardless of the specification of the utility-distribution u^W (cf. Definition 1).

The function $g = G(f; P)$ that guarantees the comparability of the different factor-utility sets may be called the *factor-service social-preference function* for the fixed stipulation P regarding foreign employment of each factor. The incomparability of the product-utility sets $D^W(u^W)$, while it rules out the existence of a social-preference function for end-products, d_i^W, does not rule out the existence of functions $g = G(f; P)$. Their empirical specification is therefore of paramount importance in studying international migration, investment, and trade.

The specification of the factor-service social preference functions for different foreign-employment policies (that is, policies determining or constraining the foreign employment vector P) is an area for extremely

promising research. We conclude therefore by showing how to justify and to derive such functions in a sampling of cases. These cases are classified according to the pattern of international technology that prevails which we must define.

Technology

To specify the sets $F(u^W, P)$ we need obviously to show how both demand (as summarized by Definition 3) and supply conditions determine the form of such sets. Only then can we cast about to see whether practical methods exist for actually estimating the employment-constrained social preference functions defined in Hypothesis 1. Our examples will be based on the following quite comprehensive definition of production technique and of technology :

(Def. 5) The economic representation, t_j, of the j-th production *technique* ($j = 1, \ldots, N$) is a (column) vector: $t_j = (f_{1j}, \ldots, f_{rj}; x_{1j}, \ldots, x_{nj}) = (f_j; x_j)$ of required factor services, $f = (f_{1j}, \ldots, f_{rj})$, and of net outputs, $x = (x_{1j}, \ldots, x_{nj})$, produced within the fixed and given time period over which the technique j in question is defined;

(Def. 6) Technology, T, is the set of all techniques, defined for a common production period (day, year, etc.), and known by either country A (T^A) or by country B (T^B) or by both country A and country B jointly ($T^A \cup T^B$) :

$$T = (t_1 \ldots t_N) = T^A \cup T^B = \left[\begin{array}{ccc} f_{11} & \ldots & f_{1N} \\ \cdot & & \cdot \\ \cdot & & \cdot \\ \cdot & & \cdot \\ f_{r1} & \ldots & f_{rN} \\ \hline x_{11} & \ldots & x_{1N} \\ \cdot & & \cdot \\ \cdot & & \cdot \\ \cdot & & \cdot \\ x_{n1} & \ldots & x_{nN} \end{array}\right]$$

The total number, n, of products is selected in such a way as to ensure that any two or more production techniques are additive :

(Def. 7 : *additivity*)

$$t_j \in T \text{ and } T_v \in T \Rightarrow (t_j + t_v) \in T$$

for all subscripts j and $v = 1, \ldots, N$ which alternatively denumerate the same set, T, of N production techniques. The process $(t_j + t_v)$ is a *composite* technique, consisting of one or more *indecomposable* techniques.

(Def. 8 : *technical inefficiency*). The technique t_h $(h = 1, \ldots, N)$ is inefficient in country A if, for any $j = 1, \ldots,$ or N, $t_j \in T^A$, $t_h \in T^A$, $f_j \leq f_h$, and $x_h \leq x_j$. The corresponding criterion applies also to country B.

In order to describe *internatianal technological disparity* we invoke : (Hyp. 2)

$$t_j \in T^B \Rightarrow t_j(a_j) = (f_j; a_j x_j) = t_j^A \in T^A$$

where : a_j is a non-negative scalar number, $a_j > 1 \Rightarrow t_j^A \notin T^B$, $a_j < 1 \Rightarrow t_j \notin T^A$, and $j = 1, \ldots, N$.

Hypothesis 2 permits us to conveniently describe any given pattern of international technological disparity by a single vector :

(Def. 9 : *technological disparity*). International technological disparity is the vector $a = (a_1, \ldots, a_N)$ of technical disparity coefficients a_j $(j = 1, \ldots, N)$ defined in Hypothesis 2.

Although Hypothesis 2 appears to have a very special form, in practice it will never be restrictive in as much as one can always augment a given input requirement f_{kj} $(k = 1, \ldots, r)$ of any given technique j $(j = 1, \ldots, N)$ by a fictitious amount without increasing that activity's efficiency (cf. Definition 8) relative to any other activity producing the same net output vector $x = (x_1, \ldots, x_n)$.

Foreign Trade, Migration, and Investment when Technology is Universal

Our first special case illustrating the use of the sets $F(u^W, P)$ to measure

the benefits of international migration and investment assumes, with the Heckscher-Ohlin theory, that $T = T^B$, i. e., that both countries use country B's technology exclusively. Using Definitions 3, 5, and 6 we can derive, from any given utility distribution u^W described by Definition 1, the set $F(u^W, P)$ of Definition 4. We do so by means of the following auxiliary definitions. Note that x^A and x^B are net output vectors of country A and country B respectively and that f^A is the vector of the factor service amounts employed by country A :

(Def. 10 : country A's input-output set under B's technology)

$$F^B(x^A) = \bigcup_{j=1}^{n} \{f^A \geqq f_j \mid (f_j;\ x_j) \in T^B \text{ and } x_j \geqq x^A\},$$

(cf. Definitions 5, 6, and 7)

(Def. 11 : country B's input-output set)

$$F^B(x^B) = \bigcup_{j=1}^{N} \{P \geqq f_j \mid (f_j;\ x_j) \in T^B \quad \text{and} \quad x_j \geqq x^B\}.$$

(Def. 12 : the world's employment-constrained input-output set for the given vectors P and x)

$$F^B(x, P) = \{f \geqq (F_*^A + P) \mid f^A \in F^B(x^A),\ P \in F^B(x^B),\ \text{and } x \geqq (x^A + x^B)\}.$$

(Def. 13; the world's employment-constrained factor-utility set)

$$F^B(u^W, P) = \{f \in F^B(x, P) \mid x \in D^W(u^W)\}$$

(cf. Definitions 3 and 12);

and

(Def. 14) $$F^B(u^W) = \{f \in F^B(u^W, P) \mid 0 \leqq P \leqq f\}.$$

Note that if T^B truly equals T, $F^B(u^W, P)$ equals $F(u^W, P)$ in Definition 4 and the sets $F^B(u^W)$, via the factor-income sets $F(g, P = f)$

of Hypothesis 1, therefore, fit country B's factor-service, social-preference function

$$g = G^B(f) = G(f; P = f). \tag{2}$$

The final task is to compare the sets $F^B(u^W)$ and $F^B(u^W, P)$ in order to examine the impact of foreign migration and investment policy on world income g, as measured by country B's ordinary aggregative national-income production function, Equation 2. To make this comparison we first define as sets of alternative foreign employment vectors the conditions governing international specialization in production :

(Def. 15 : *production* specialization set for a given production vector x and factor-service input vector f)

$$P(x, f) = \{P \leqq f \mid f \in F^B(x, P)\}$$

and, via Definition 3,

(Def. 16 : *utility* specialization set for a given utility-distribution vector u^W and factor-service input vector f)

$$P(u^W, f) = \{P \leqq f \mid f \in F^B(u^W, P)\} = \{P \in P(x, f) \mid x \in D^W(u^W)\}.$$

Formula 2 above measures prospective gains from international economic integration under free-trade for any international investment and migration policy that guarantees that P lies in $P(u^W, f)$, when both countries use in common the technology of country B.

If, moreover,

(Hyp. 3) $$P(u^W, f) = \{P \mid 0 \leqq P \leqq f\},$$

so that

$$F^B(u^W, P) = [F^B(u^W) \cap \{f \mid f \geqq P\}], \tag{3}$$

then Equation (2) serves to measure the gains of international economic integration for *any* foreign investment and migration policy, P, operated in conjunction with free trade in products.

While in fact the sets $P(u^W, f)$ are rather "narrow," Hypothesis 3

serves to focus on their importance. Sets analogous to the sets $P(x, f)$ can be observed in the context of any closed national economy and they can be used in turn to estimate the configuration of the set $P(u^W, f)$ that would apply to any specified world factor-service input vector $W = f$. For this, it is necessary only to hypothesize that the shape of the sets $P(u^W, f)$ is independent of the utility distribution, a very weak assumption.

Foreign Trade, Migration, and Investment when Technology Differs Internationally.

International technological disparity, $T^A \neq T^B$ (cf. Definitions 5, 6 and 9), implies potentially very large returns to policies affecting P. Definitions 5 and 6 provide directly :

$$\text{(Def. 17)}\quad F^A(x^A) = \bigcup_{j=1}^{N} \{\, f^A \geqq f_j/(f_j\,;\, x_j) \in T^A \quad \text{and} \quad x_j \geqq x^A \,\},$$

and

$$\text{(Def. 18)}\quad F(x, P) = \{\, f \geqq (f^A + P) \mid f^A \in F^A(x^A),\ P \in F^B(x^B),\ \text{and } (x^A + x^B) \geqq x \},$$

whereupon, by Definitions 3 and 4 :

$$F(u^W, P) = \{\, f \in F(x, P) \mid x \in D^W(u^W) \,\}. \qquad (4)$$

Define next the sets

$$\text{(Def. 19)}\qquad F^A(u^W) = \{\, f \in F^A(x^A) \mid x^A \in D^W(u^W) \,\},$$

which, via the factor-income sets $F(g, P = 0)$ of Hypothesis 1, fit country A's aggregative national-income production function :

$$g = G^A(f) = G(f; P = 0) \qquad (5)$$

If country A is technologically superior to country B, then by Hypothesis 1 :

$$F^B(u^W) = AF^A(u^W), \qquad (6)$$

where A is a non-negative scalar and, in relationships (2) and (5),

$$G^A(f) = AG^B(f). \tag{7}$$

The aggregative relative international efficiency multiplier A can be computed simply by comparing pretrade national incomes, $G^B(E)$ and $G^A(W - E)$, and correcting, via Equation (7), for pretrade differences in factor employment, $f = E$ versus $f = (W - E)$. Thus A for the EEC *vis a vis* Morocco appears to be about 3, for the U. S. *vis a vis* India to be about 6, for the U.S. *vis a vis* the rest of the world to be about 2, and so forth.

There are many patterns $(a_1, \ldots, a_N)$ in Definition 9 capable of explaining any given level A of aggregative technological superiority, of course. We consider the simplest pattern, namely :

(Hyp. 4) In Hypothesis 2, $A = a_1 = a_2 = \ldots = a_N$,

which implies not only relationship (6) but also the fundamental relationship for studying the resource-saving potential of policies determining P, namely

$$F(u^W, P) = \left[\frac{1}{A}[F^B(u^W, P) - P] + P\right]. \tag{8}$$

To study the potential real-income impact of those policies we first reinvoke relationship (3) and then use Hypothesis 1 to write

$$F(g, P) = \left[\frac{1}{A}[F(g, P = f) - P] + P\right]. \tag{9}$$

Next we recall that the sets $F(g, P = f)$ can be derived directly from country B's aggregative production function, fitted before the change in policy P. Finally, we point out that Hypothesis 3 is not binding so long as $P \in P(u^W, f)$, which can always be effectuated by means of a flexible foreign-investment policy and, in particular, for $P = 0$ and $P = f$.

Hypothesis 4 is strong. In general, whatever the value of the aggregative relative international efficiency multiplier A determined by Equation (7), the individual coefficients a_j $(j = 1, \ldots, N)$ will vary around some average close to A. Whenever a_j exceed unity, country A should be

assigned the operation of the j-th technique and whenever unity exceeds a_j, country B should operate the technique in question. This is the principle *of absolute advantage*. Applying it to the construction, via Definitions 7, 8, 11, 17, 18, and 19, of the sets $F(u^w)$ will indicate the best foreign-employment vector P to choose as a function of any given preexisting international technical disparity vector $a = (a_1 \ldots, a_N)$, as described by Definition 9.

So long as every a_i in Definition 9 exceeds unity (and regardless therefore of the actual distribution of the a_i's with respect to *A),* direct application of formulas (8) and (9), will always supply conservative estimates of the prospective gains from foreign migration and investment policies affecting *P*. The reader can see, by experimenting with given initial values of P (notably that $P = E$, B's national factor-service endowment-supply vector) and values *of A,* that the returns to foreign migration of workers (which always come from countries with low A's) are very high indeed. That is the first point to make in suggesting definitions to guide further research on the economics of *international* migration. The second is that absolutely no international migration is required fully to realize those returns.