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by

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1. Introduction

Despite the well-known efficiency gains to factor mobility, many governments currently impose policies which interfere with the free flow of factors into and out of their jurisdictions. These policies sometimes restrict flows below free-market levels, for example via limits on emigration, capital export taxes, skill-based quota systems for immigrants, or government reviews of foreign direct investments; sometimes they appear to increase migration flows beyond free-market levels by, for example, paying migrants' transportation costs or offering location subsidies to firms.

One possible explanation for the existence of these policies is that, while lowering total world output, they maximize the national income of the country (or region) imposing them[1] (given whatever policy response, if any, is expected from the world outside). If this is true, then economic theory should be able to supply a number of testable propositions concerning the incidence of mobility restrictions or subsidies and their relationship to other national or regional policies. In particular, predictions concerning the relationship between factor mobility policy and a country's relative factor endowment pattern, its relative size, its fiscal treatment of mobile factors (i.e., is it able, or does it choose to discriminate against foreign factors by paying them only their opportunity wage?), and other policies, such as its trade policy, will in principle exist.

One model which currently provides a set of predictions of this kind is so elegant and simple in structure to have earned the title of the "basic model" (Ramaswami (1968, 1970), Webb (1970), Calvo and Wellisz (1983), Bhagwati and Srinavasan (1983), Jones, Coelho, and Easton (1984)). It considers a world of two countries producing the same output[2] using identical constant-returns-to- scale production functions with two factors, fixed in supply. One country then controls the international allocation of factors in order to maximize its national income. Unfortunately, it remains difficult to reconcile the predictions of the basic model with observed policies, both because the model is insufficiently rich in structure to predict some actual policies--for example, simultaneous restrictions on inflows of both capital and labour, and subsidies paid to mobile factors in equilibrium--and because the optimal policies that <u>are</u> predicted can be considerably more extreme--including in one case, the total absorption of one country by the other--than any known practices.

This paper argues that one source of the above difficulties with the basic model is in its assumptions about technology--assumptions which make it immaterial, from the point of view of world production efficiency, whether production occurs in one country or region or another.[3] These assumptions make it impossible for the model to predict where production will occur (and hence the direction of factor mobility) if free mobility policies are adopted, and are largely responsible for the extreme predictions noted above. An obvious solution to this problem, which we adopt here, is to imagine that, in addition to their endowment of mobile factors, countries or regions are characterized by a fixed endowment of some third, immobile factor--for example land, climate, resources, an immobile group of skilled workers, or even political stability--that affects the productivity of the other two (mobile) factors there. We show below that this simple extension to the basic model considerably enhances its realism without compromising its predictive content to the extent that the model becomes untestable. Section 2 of the paper summarizes what is currently known about optimal labour and capital mobility in the context of the "basic model". Section 3 outlines the structure of the model, while Sections 4 and 5 describe the optimal discriminatory and non-discriminatory policies respectively. Conclusions are summarized and compared to previous results in Section 6.

2. Optimal Factor Mobility in the Basic Model

As noted above, the "basic model" of factor mobility considers a two-country world in which both countries possess identical CRS production functions, in which the "home" country actively designs policy and the foreign country remains passive,[4] factor supplies are fixed, and (without loss of generality) at autarky the home country is relatively well-endowed with capital (K) and the foreign country relatively well-endowed with labour (N). This situation is illustrated in Figure 1, where the diagonal represents the set of world-efficient loci (embodying equal factor prices) and E represents the endowment point. Note that, because factor prices are equalized everywhere along OO*, the basic model is silent on the question of where on OO* production will take place if a policy of unrestricted factor mobility from a given endowment point is allowed.

If the home country is able to discriminate against foreign factors by paying them their opportunity wage (i.e., the lower foreign wage), the following is known about national-income maximizing factor mobility policies. If only capital can move, less-than-full mobility of capital (at a point like a, where not enough capital leaves the home country to equate factor prices) is optimal. Similarly, if only labour can move, a point like b is best. Simple monopoly and monopsony effects, in which transactions are restricted to avoid "spoiling the market", explain these results. If <u>either</u> capital or labour may move, but not both, Ramaswami (1968) has further shown that optimal imports of the scarce factor always dominate optimal exports of the plentiful factor (i.e., point b is always preferred to point a). The intuition behind this result is based on the efficient use of the home country's factors of production. When a (restricted) quantity of capital is exported, it is used more intensively abroad than in domestic production, thereby earning a different rate of return and resulting in an efficiency loss borne by the exporter. However, when labour is imported, all domestically owned capital is employed at the same capital-labour ratio. Finally, Jones <u>et</u> <u>al</u>. have shown that the global optimum combination of capital and labour mobility implies not, as one might expect, some combination of restrictions on capital outflows and labour inflows, but point O* instead. Thus, when discrimination is possible, the home country's optimal policy is always to import <u>both</u> labour and capital until the other country is completely absorbed. To see why this occurs, consider moving along a ray from E to O*. This leaves factor prices abroad unchanged and hence keeps foreign national income at the autarky level. The home country gains as its factor proportions move closer and closer to the world average, and its appropriates <u>all</u> the efficiency gains to free factor mobility at O*, which is consistent with global efficiency. While this result is interesting, it is clearly very dependent on the assumption of CRS technologies and seems too extreme to describe any real-world policies.

If the home country cannot discriminate and must thereby pay immigrant labour the same as is paid to domestic workers, and only capital is mobile, a is again the optimal point. If only labour is mobile, however, the optimum is free immigration at c. This occurs because, while each successive immigrant is paid his marginal product in the host country, his entry bids down the wages of all previous migrants. Thus, even though the home country is "large", its national income increases monotonically with the number of immigrants. In this case the sometime-used analogy between international factor mobility and goods trade (for example, see Jones et al., 1984) breaks down: whereas the optimal commercial policy is to limit the quantity of goods imported, the optimal immigration policy is to permit an unrestrained inflow of workers--additional immigrants bid down the wages of previous immigrants, while additional imports of goods push up the relative price of all imports. If the home country must choose between labour and capital mobility, Calvo and Wellisz have shown that now, in contrast to the discrimination case, optimal export of the plentiful factor (point a) dominates optimal import of the scarce factor (point c). Intuitively, this occurs because the home country is equally well off at d as at c, where it exercises no monopoly power (a simple redrawing of national boundaries without any change in allocation shows this equivalence); restricted capital imports at point a are clearly better than this. Finally, Jones et al. have shown through an involved argument that, if any combination of labour and capital mobility at all can be chosen, the globally optimal policy is still at a (an absolute prohibition of immigration and limited capital exports). The proof depends heavily on CRS, and it is interesting to ask if such an extreme policy is still predicted by a more general model.

To summarize, we note again that, in the basic model, each country is by definition relatively well-endowed with exactly one of the two mobile factors[5] and that the factor flows resulting from free mobility are not uniquely determined. Under discrimination, the home country's best overall policy is always to completely absorb the other country; without discrimination its best policy is to prohibit the inflow of the factor which is scarce at home and to allow a restricted outflow of the plentiful factor.

3. Model Description

The present model retains all the assumptions of the basic model except for the presence of a third, immobile factor. Thus we now suppose that each of two countries, home and foreign, produces the same good using three factors according to identical constant-returns-to-scale technology

$$Q = F[K,N,S] \tag{1.a}$$

$$Q^* = F[K^*,N^*,S^*] \tag{1.b}$$

We shall assume, for convenience, that F is strictly quasi-concave, that F_N, F_K, and F_S are all positive, that $F_N \to \infty$ as $N \to 0$ for $S > 0$ and similarly for F_K, and that $F_{NK} \geq 0$. Q is the home country's output, K (say, capital) and N (say, labour) are variable factors which are internationally mobile, while S (say, "resources") is fixed in place in each country. Variables with asterisks denote the foreign-country counterparts. Each country is endowed with a stock of each factor, $\bar{K}$, $\bar{N}$, $\bar{S}$ and $\bar{K}^*$, $\bar{N}^*$, $\bar{S}^*$. Due to the assumed immobility, $S = \bar{S}$, $S^* = \bar{S}^*$. The other two factors will, if so permitted, migrate from one country to another until international factor prices are equalized. Let the size of the migrant population be designated by a "hat":

$$K = \bar{K} + \hat{K}, \qquad K^* = \bar{K}^* - \hat{K} \tag{2}$$

$$N = \bar{N} + \hat{N}, \qquad N^* = \bar{N}^* - \hat{N} \tag{3}$$

National income is equal to national output minus payments to migrant factors

$$Y = Q - w\hat{N} - r\hat{K} \tag{4}$$

$$Y^* = Q^* + w\hat{N} + r\hat{K} \tag{5}$$

where w and r are the factor payments made to <u>migrant</u> labour and capital, respectively. It is assumed that the foreign country pays all immigrants their marginal products. Thus if:

$$\hat{K} < 0, \quad r = F^*_K;$$

$$\hat{N} < 0, \quad w = F^*_N;$$

where F^*_K and F^*_N are the partial derivatives of the foreign production function with respect to $\hat{K}$ and $\hat{N}$, respectively.

The payments made by the home country to migrant factors, however, depend on the range of fiscal instruments available. In principle these can include (a) discriminatory taxes on migrant factors, (b) discriminatory subsidies to immigrant factors, (c) discriminatory taxes on emigrant factors, and (d) discriminatory subsidies to emigrant factors.[6] Of these, (a) functions to extract rents from immigrant factors by paying them their opportunity wage only, and is the only policy generally discussed in the literature. Policy (c) is redundant when the home country can control the amount of factor mobility directly. Policies (b) and (d) are sometimes implicitly assumed[7] and allow the home country to induce factors to move towards areas where their marginal product is lower, when this is advantageous to it.

For the sake of simplicity, we shall make two sets of extreme assumptions about the fiscal instruments available to the "home" country. In the first, "discriminatory" case, all the above instruments are available, in which case it is easy to verify that $w = F_N^*$ and $r = F_K^*$, regardless of the direction of factor mobility and the relative pattern of rewards.[8] In the second, "nondiscriminatory" case, none of those instruments is available. Thus the home country can neither extract rents from immigrants via discriminatory taxes, nor can it induce factors to move "against" the price gradient via discriminatory subsidies. All it can do is to limit "naturally occurring" factor mobility, to levels below or equal to the free-mobility level. In this case we must have:

$$F_N > F_N^* \leftrightarrow \hat{N} > 0 \leftrightarrow w = F_N$$

$$F_N > F_N^* \leftrightarrow \hat{N} < 0 \leftrightarrow w = F_N^*$$

$$F_K > F_K^* \leftrightarrow \hat{K} > 0 \leftrightarrow r = F_K$$

$$F_K < F_K^* \leftrightarrow \hat{K} < 0 \leftrightarrow r = F_K^*$$

which renders infeasible several patterns of factor mobility which were feasible in the discriminatory case.

World income is the sum of the two countries' incomes,

$$Y^W = Q + Q^* = F[K,N,S] + F[K^*,N^*,S^*], \qquad (6)$$

and is maximized when the marginal physical products of each factor are the same in the production processes of both countries. This can be achieved by the free mobility of any two factors. The free mobility of one factor alone will result in the equalization of its return in both countries. However, in contrast to the "basic model", unless the other factors are being utilized in the same proportions in both the domestic country and the foreign country, the movement of the one factor will not be sufficient to yield internationally identical factor proportions and so world income would be sub-optimal. This is illustrated in Figure 2, a box diagram the axes of which represent quantities of the mobile factors, capital and labour. The allocation of these between countries may be measured with respect to the home-country and foreign-country origins, O and O*, respectively. The ray OO* is then the locus of identical capital-labour ratios $(\frac{K}{N} = \frac{K^*}{N^*})$. Given the fixed allocation of "resources" between countries, $\frac{\bar{S}}{\bar{S}^*}$, there is one point on OO*, W, at which all factors are allocated between countries in the same proportion, $\frac{K}{K^*} = \frac{N}{N^*} = \frac{\bar{S}}{\bar{S}^*}$. This is the unique point at which world income is maximized and, additionally,

$$F_N = F^*_N$$

$$F_K = F^*_K$$

$$F_S = F^*_S$$

the marginal physical products of each factor are equal internationally. For any endowment point E in Figure 2, the factor flows that would ultimately result from free factor mobility are now determined unambiguously by the vector from E to W.

Although W represents the only point on the plane at which all factor prices are equalized, other points correspond to factor allocations at which the marginal product of one factor is the same in both countries. The loci of capital and labour combinations yielding the same rentals on capital in either country and the same wages to workers in either country can be derived. Wages in both countries are equalized when:

$$F_N[\bar{K} + \hat{K}, \bar{N} + \hat{N}, \bar{S}] = F^*_N[\bar{K}^* - \hat{K}, \bar{N}^* - \hat{N}, \bar{S}^*]$$

Differentiating with respect to the variable factors,

$$F_{NK}\, d\hat{K} + F_{NN}\, d\hat{N} = -F^*_{NK}\, d\hat{K} - F^*_{NN}\, d\hat{N}$$

Thus $$\left.\frac{d\hat{K}}{d\hat{N}}\right|_{F_N = F^*_N} = \frac{-(F_{NN} + F^*_{NN})}{(F_{KN} + F^*_{KN})} \geq 0.$$

Similarly, rentals on capital are equalized when:

$$F_K[\bar{K} + \hat{K}, \bar{N} + \hat{N}, \bar{S}] = F^*_K[\bar{K}^* - \hat{K}, \bar{N}^* - \hat{N}, \bar{S}^*].$$

Differentiating with respect to the variable factors,

$$F_{KK}\,d\hat{K} + F_{KN}\,d\hat{N} = -F^*_{KK}\,d\hat{K} - F^*_{KN}\,d\hat{N}$$

Using $F_{KN} = F_{NK}$ and $F^*_{KN} = F^*_{NK}$,

$$\left.\frac{d\hat{K}}{d\hat{N}}\right|_{F_K = F^*_K} = \frac{-(F_{KN} + F^*_{KN})}{(F_{KK} + F^*_{KK})} \geq 0 .$$

Comparing the slopes of the loci,

$$\left.\frac{d\hat{K}}{d\hat{N}}\right|_{F_K = F^*_K} = \frac{(F_{KN} + F^*_{KN})^2}{(F_{KK} + F^*_{KK})(F_{NN} + F^*_{NN})} \left.\frac{d\hat{K}}{d\hat{N}}\right|_{F_N = F^*_N}$$

At W, $\dfrac{(F_{KN} + F^*_{KN})^2}{(F_{KK} + F^*_{KK})(F_{NN} + F^*_{NN})} = \dfrac{F^2_{KN}}{F_{KK}F_{NN}} < 1$, by concavity, and homogeneity of

of F.[9] Thus the relative slopes of the contours where they intersect is

$$\left.\frac{d\hat{K}}{d\hat{N}}\right|_{F_N = F^*_N} > \left.\frac{d\hat{K}}{d\hat{N}}\right|_{F_K = F^*_K} \geq 0.$$

They are illustrated in Figure 2, in which they form the boundaries to four zones.[10] The relative factor payments in each zone are listed in Table 1. For ease of reference, we shall refer to a country whose endowment lies in Zone 1 as "resource-rich", and Zone 2 as "resource-poor", since in these cases the home country is (respectively) poorly- or well-endowed with <u>both</u> mobile factors. Zone 3 is considered the "traditional case" since it corresponds to the basic model where the home country is relatively well endowed with K but poorly endowed with N; Zone 4 is its mirror image.

TABLE 1: ENDOWMENT ZONES

Zone 1	$F_N > F_N^*$	$F_K > F_K^*$	$F_S < F_S^*$
Zone 2	$F_N < F_N^*$	$F_K < F_K^*$	$F_S > F_S^*$
Zone 3	$F_N > F_N^*$	$F_K < F_K^*$	$F_S \gtrless F_S^*$
Zone 4	$F_N < F_N^*$	$F_K > F_K^*$	$F_S \gtrless F_S^*$

It is clear from Figure 2 that, unless the initial allocation is on either axis AA* or BB*, movement of a single factor will not be sufficient for factor price equalization. However, it is less clear that it would necessarily be in a country's best interests to have free factor mobility, with production at W. This question is explored in the following two sections.

4. Discriminatory Policies

Because payments to mobile factors are always $w = F_N^*$ and $r = F_K^*$ respectively, home country income can be written

$$Y = F[\bar{K} + \hat{K}, \bar{N} + \hat{N}, \bar{S}] - F_K^*\hat{K} - F_N^*\hat{N}, \quad \text{for } \hat{K}, \hat{N} \gtrless 0 . \qquad (7)$$

Because subsidies to mobile factors are available, all allocations in the box diagram of Figure 2 can be considered feasible.[11]

Consider the effects on Y of permitting the migration of one of the factors, say capital, to increase:

$$\left.\frac{dY}{d\hat{K}}\right|_{\hat{N}} = (F_K - F_K^*) + F_{KK}^*\hat{K} + F_{NK}^*\hat{N} \qquad (8)$$

As the capital moves across frontiers, it captures the difference between its marginal products in the two countries but also affects the payments made to both migrant factors. It is this interaction which determines the optimal factor movement.[12] Permitting further migration of unskilled labour will also affect the level of national income,

$$\left.\frac{dY}{d\hat{N}}\right|_{\hat{K}} = (F_N - F_N^*) + F_{NN}^*\hat{N} + F_{NK}^*\hat{K}. \qquad (9)$$

The Inada conditions $F_N \to \infty$ as $N \to 0$ and $F_K \to \infty$ as $K \to 0$ guarantee that the solution is not on a boundary of the feasible set (i.e. on the axes of Figure 2); thus (8) and (9) must both equal zero when Y is maximized. This allows us to establish the two simple theorems below:

Definition. If, at the optimum factor mobility point, $\hat{N}$ has the same sign as $F_N - F_N^*$, we say that labor has migrated <u>with</u> the price gradient.[13] If their signs are opposite, labor has moved against the price gradient. Similarly for capital, $\hat{K}$.

Proposition 1. If, in the optimal discriminatory policy, the two mobile factors move in opposite directions, neither of them may move against the price gradient.

Proof. This follows trivially from the fact that, if (8) and (9) are to equal zero at the optimum, all three terms in each cannot be of the same sign. For example, if $\hat{K} > 0$ and $\hat{N} < 0$, (8) implies $F_K > F_K^*$ and (9) implies $F_N < F_N^*$. Conversely for $\hat{K} < 0$, $\hat{N} > 0$.

Proposition 2. If, in the optimal discriminatory policy, the two mobile factors move in the same direction, at most one of them may move against the price gradient.

Proof. This follows from strict quasiconcavity of F. To see this, imagine the optimum has $\hat{K} > 0$, $\hat{N} > 0$ and that both factors move against the price gradient, i.e. $F_K < F^*_K$ and $F_N < F^*_N$. From (8) this implies $F^*_{NK} > -\frac{\hat{K}}{\hat{N}} F^*_{KK}$ and from (9), $F^*_{NK} > -\frac{\hat{N}}{\hat{K}} F^*_{NN}$. Together these imply $F^{*2}_{NK} > F^*_{NN} F^*_{KK}$, which violates strict quasiconcavity. The proof for $\hat{K} < 0$, $\hat{N} < 0$ is parallel. It is also easy to see that the movement of only one factor against the price gradient does not necessarily violate concavity when factors move in the same direction.

The nature of the optimal discriminatory policies when endowments lie in different zones can be characterized by straightforward application of propositions 1 and 2 to the various cases. We discuss these results in turn below, with reference to Figure 3, which indicates the region in which the optimal factor mobility policy must lie by the unshaded area in each of four cases.

4.1 Zone 1

In this case the home country is relatively poorly endowed with both mobile factors, or, in other words, is relatively "resource rich". From Figure 3a it is apparent that such a country's privately optimal migration policy will involve inflows of both factors, and indeed we can think of it as a monopsonist operating in two markets simultaneously, with its optimal policy depending on how these markets are related. Note first from (9) that the optimal mobility of labor, in the presence of zero capital mobility, is less than full mobility ($F_K > F_K^*$ at the optimum, at a point like a), and similarly for capital (point b). Second, if the labor and capital markets are unrelated ($F_{NK}^* = 0$) inflows of both factors will be restricted below free-mobility levels. However, if the two markets are related ($F_{NK}^* > 0$) the home country is in the happy position of a monopsonist which, by buying more in one market, lowers the price it pays in the other. Indeed if F_{NK}^* is large enough, then according to Figure 3a it may be in the home country's interest to subsidize the inflow of one of the two mobile factors beyond the bounds of free mobility (i.e. choose a point in Zone 3 or 4). Concavity of the foreign production function, through theorem 2, rules out subsidization of both. In sum, we expect national-income maximizing resource-poor countries to import both mobile factors, and if these factors are strongly complementary, to subsidize the inflow of at most one of those factors.

4.2 Zone 2

The case of the "resource poor" country in Figure 3b is entirely parallel to the Zone 1 analysis. The home country is now a monopolist operating in two markets; and the more sold in the one market, the higher the price received in the other. Both factors will be exported, perhaps one of them beyond the bounds of free mobility.

4.3 Zones 3 and 4

Without loss of generality, we restrict our discussion to Zone 3, and recall that this is the only case here that corresponds directly to the basic model (the other two cases, in which one country is relatively well-endowed with both mobile factors, cannot occur there). This case differs from the previous two in a fundamental way. That is, that the direction of the optimal migration flow, unlike before, is no longer necessarily in the "expected" direction. The home country may decide to import both factors, export both factors, or import labor and export capital, depending on how relatively well-endowed it is with the third, fixed factor and on the degree of complementarity between the mobile factors, N and K. The first two of these policies may require discriminatory subsidies to migrant factors.[14] The only policy which cannot occur is labor emigration and capital immigration--movement of both factors against the "price gradient". It is worth noting, however, that given our Inada conditions, the optimum will not involve complete absorption of the other country--this would waste its endowment of the fixed factor--and may indeed involve movement of both factors <u>out of</u> the home country. Movements from E towards O* no longer necessarily improve efficiency, especially if the foreign country has a relatively large endowment of the fixed factor.

5. <u>Non-Discriminatory Policies</u>

We now restrict our attention to non-subsidized factor flows, and recall that, in the nondiscriminatory case, whether factors are paid their home or foreign marginal product depends on the direction of factor flows. This obliges us to formulate the problem separately for the cases of endowments in each zone, as we do below.

<u>5.1</u> <u>Zone 1</u>

The shaded areas in Figure 4a are those in which, when the endowment lies in Zone 1, subsidized migration flows occur. Thus the feasible region for nondiscriminatory policies is the unshaded area, which in turn implies $\hat{N} > 0$, $\hat{K} > 0$. National income in the feasible region is just:

$$Y = F[\bar{K}+\hat{K}, \bar{N}+\hat{N}, \bar{S}] - F_K\hat{K} - F_N\hat{N}, \text{ for } \hat{K},\hat{N} \geq 0 \,. \qquad (10)$$

Consider the effect on the home country's income of permitting immigration of only one factor, say unskilled labour,

$$\left.\frac{dY}{d\hat{N}}\right|_{\hat{K}} = -\hat{N}F_{NN} - \hat{K}F_{KN} \qquad (11)$$

For zero capital mobility, this is always nonnegative, implying that free immigration is the optimal policy if $\hat{K}$ is restricted to equal zero. This occurs because each successive immigrant, by lowering F_N, drives down the payments made by the home country to all previous immigrants. Indeed, $\left.\frac{dY}{d\hat{N}}\right|_{\hat{K}=0} = 0$ at $\hat{N} = 0$, which is a minimum of Y. If $\hat{K} > 0$, however, the benefits of immigration are diminished, since labor immigration now also drives up the payments made to immigrant capital.

The effects on income of capital immigration alone are similar:

$$\left.\frac{dY}{d\hat{K}}\right|_{\hat{N}} = -\hat{N}F_{KN} - \hat{K}F_{KK} \qquad (12)$$

implying that free capital mobility is optimal if $\hat{N} = 0$, but not necessarily so if $\hat{N} > 0$.

Finally, given the adverse effects of immigration of one factor on the cost of the other factor's services, can anything be said about the optimal combination of capital and labor mobility here? The answer to the question can be seen by thinking of our problem as an inequality-constrained maximization problem, where the feasible set of instruments is constrained to lie in the unshaded region of Figure 4a. If the solution is to be internal to that set, then (11) and (12) must both equal zero there. But it is easy to see that this violates strict quasiconcavity of F (it implies $F_{NK}^2 = F_{NN}F_{KK}$). Therefore the solution must be on the boundaries of that set. By previous arguments, the solution also cannot lie on the half-open intervals [E, N') or [E, K'); therefore it must lie on one of the free-mobility constraints [K', W] or [N', W]. In other words, despite the negative effects of immigration of one factor on the price of the other's services, concavity of the production function implies <u>free mobility of at least one factor</u> in the optimal policy. This is illustrated by a set of possible iso-income contours sketched in Figure 4a: as drawn, the optimal policy will be at K', N', or W, although "internal" optima along K'W and N'W are also possible for different configurations of nn' and kk'.[15]

5.2 <u>Zone 2</u>

The assumption that factor flows may not be subsidized makes the shaded areas in Figure 4b infeasible. In the feasible region, $\hat{N}$, $\hat{K} < 0$, and therefore $w = F_N^*$, $r = F_K^*$. Thus, <u>when both factors emigrate, the nondiscriminatory rose case is identical to the discriminatory case</u>, except for the restriction that we now consider nonsubsidized factor flows only. Applying the analysis of section 4.2, this implies simply that the solution will either be in the interior of the feasible region of Figure 4b, or on one or both of the free-mobility boundaries: $F_K = F_K^*$ or $F_N = F_N^*$. It will not be on the axes where $\hat{N} = 0$ or $\hat{K} = 0$, since these allocations can always be improved upon. Without more information on the structure of F, however, (for example, if $F_{NK}^* = 0$, migration of both factors will be restricted) it appears that the theory cannot impose further restrictions on the set of optimal solutions.

5.3 Zone 3[16]

The feasible region is now shown as the unshaded area in Figure 4c, which implies $\hat{N} > 0$, $\hat{K} < 0$, and $w = F_N$, $r = F^*_K$.[17] Thus national income in the feasible region is:

$$Y = F[\bar{K}+\hat{K},\ \bar{N}+\hat{N},\ \bar{S}] - F^*_K\hat{K} - F_N\hat{N} \tag{13}$$

Determining the optimal level of capital migration for fixed $\hat{N}$, by differentiating equation (19) with respect to migrant capital,

$$\left.\frac{dY}{d\hat{K}}\right| = (F_K - F^*_K) + F^*_{KK}\hat{K} - F_{NK}\hat{N} \tag{14}$$

For $\hat{N} = 0$, home-country income is maximized at less-than-free emigration of capital. As before, this results from the immiserizing effects of further capital emigration on already-emigrant capital. For $\hat{N} > 0$, there is one added benefit to emigration of capital: it makes domestic production more labor-intensive and reduces payments made to immigrant workers.

Differentiating equation (13) to find the impact on the home country's income of labour migration, gives

$$\left.\frac{dY}{d\hat{N}}\right|_{\hat{K}} = F^*_{NK}\hat{K} - F_{NN}\hat{N}. \tag{15}$$

When there has been no capital movement, income is minimized with zero migration of unskilled workers and increases monotonically with $\hat{N}$ for $\hat{N} > 0$. But when $\hat{K} > 0$, the immigration of labour makes foreign production increasingly capital-intensive, reducing the earnings of any of the home country's capital employed abroad. Thus the benefits of immigration are reduced by the presence of home country capital abroad.

Examples of loci along which (14) = 0 and (15) = 0, as well as iso-income contours, are shown in Figure 4c. As drawn, the optimal policy will not be at the intersection of the loci (this is a saddle point), and will be either at a (limited capital exports and a prohibition of immigration) or along WN' (limited capital exports with free immigration). In general, few restrictions on the location of the optimum (except that it will not lie on [E, N'], and will be at a if $\hat{N} = 0$) appear to exist. It is interesting however to note the presence of more than one local maximum in this case (as in Section 5.1), which suggests that small changes in the parameters of the problem may lead to large changes in the optimal policy--from zero to free immigration, for example. This phenomenon occurs, because at $\hat{N} = 0$, a small amount of immigration (in the presence of large capital exports) is actually harmful, while at larger $\hat{N}$ the marginal gains may become positive, causing a nonconvexity in the problem (for fixed $\hat{K}$).

6. Summary

The addition of a third, immobile factor adds considerable realism to the basic model of international factor mobility without eliminating its predictive content. Unlike the basic model, the factor flows which result from a policy of free mobility are now uniquely determined. Also, a large variety of privately optimal national policies is predicted, depending in an interesting way on the country's endowment pattern and the fiscal instruments available to it; these are summarized in Table 2. Of some note is that several of the policies predicted--for example, subsidies paid to mobile factors in equilibrium, and export restrictions on both mobile factors

TABLE 2: SUMMARY OF OPTIMAL POLICIES
FOR HOME COUNTRY

ENDOWMENT OF HOME COUNTRY	FISCAL INSTRUMENTS AVAILABLE: Discriminatory Case (Unlimited Discriminatory Taxes and Subsidies)	Non-Discriminatory Case (No Discriminatory Taxes or Subsidies Available)
Zone 1: Home Country is Relatively Poorly Endowed with Both Mobile Factors ("Resource Rich")	- both mobile factors immigrate - immigration of both may be free or restricted - inflow of at most one factor may be subsidized	- both factors immigrate if they move at all (by assumption in this case) - free mobility of at least one factor occurs
Zone 2: Home Country is Relatively Well-Endowed with Both Mobile Factors ("Resource Poor")	- both mobile factors emigrate - emigration of both may be free or restricted - outflow of at most one factor may be subsidized	- both factors emigrate (by assumption in this case) - emigration of N, K or both may be free or restricted - no absolute prohibitions on outflows of factors
Zone 3: Home Country is Relatively Well-Endowed with K, Poorly-Endowed with N ("Traditional Case")	- all directions of flows except simultaneous K inflow and N outflow are possible - subsidies may be used either to export N or import K, but not both	- K emigrates and N emigrates (by assumption in this case) if they move at all - if K alone (the plentiful factor) moves, emigration is restricted below free mobility - if N alone (the scarce resource) moves, immigration is unrestricted

simultaneously--are incompatible with the basic model, and that the restrictions placed on optimal policies seem sufficiently strong (for example, resource rich countries without access to discrimination will always allow free immigration of at least one factor) to be, in principle, testable. Finally, the predictions of the expanded model in the case which corresponds to the basic model (Zone 3--the "traditional" case), are considerably more realistic than before and no longer involve complete absorption of the rest of the world by the policy-making country. While important extensions to the basic model, incorporating trade in goods, strategic behaviour and other possible national objectives are important avenues for future research, and while further work may reveal more predictions inherent in the structure of the current model itself, we feel the present analysis consitutes a useful step towards an implementable theory of factor flows.

Footnotes

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[1]Alternative hypotheses are that distributional effects of factor mobility are also considered by the policy-making country, or that it is domestic, rather than national income, that matters to the formulators of national policy. Relevant to the latter possibility is the literature on the "brain drain" (e.g., Berry and Soligo (1969), Bhagwati and Hamada (1979), and Rivera-Batiz (1982)), which considers effects of emigration on the income of remaining residents.

[2]This, of course, makes trade in products irrelevant. The interaction between trade and factor mobility policies has been developed by Kemp (1966), Jones (1967), Brecher (1982), and Wong (1983), among others.

[3]As long as factor proportions are equalized in the two countries, world output is invariant to where production takes place.

[4]Not only does this country never restrict factor flows, it also never discriminates against any foreign factors by only paying them their opportunity wage.

[5]Unless, by chance, the endowment falls on the diagonal OO*.

[6] By "discriminatory" we mean simply that tax proceeds (costs of the subsidy) are redistributed only to (borne only by) nationals. Taxes or subsidies which violate this condition are labelled nondiscriminatory and are not considered here. Note that under our definition of discrimination, which is the usual one, it is immaterial whether, say in the case of taxes on immigrants, only immigrants pay the tax, or a uniform tax is applied to all labor employed in the home country. This is because the part of the tax that falls on nationals is purely redistributive.

[7] In formulating their "discriminatory" model, Jones et al. (1984) implicitly assume such subsidies are possible. Note, however, that at the home-country optimum, they will not be used, because factor prices are equalized at that point. This will not generally be true in the present model.

[8] The possibility that discriminatory taxes or subsidies can be applied to one mobile factor and not the other is not considered here.

[9] At W, $F_N = F_N^*$, $F_K = F_K^*$, and $F_S = F_S^*$. Because F is homogeneous of degree one and strictly quasiconcave, this implies that the input ratios, in the two countries are the same, i.e. $\exists\ \alpha \in R+$, such that $K^* = \alpha K$, $N^* = \alpha N$, $S^* = \alpha S$ at W. Since F_N and F_K are homogeneous of degree zero, we must have $F_{NN}(\alpha K, \alpha N, \alpha S) = 1/\alpha\ F_{NN}(K,N,S)$, and similarly for F_{NK} and F_{KK}, $\forall K,N,S$. But then, at W, $F_{NN}^* = \alpha F_{NN}$, $F_{NK}^* = \alpha F_{NK}$, and $F_{KK}^* = \alpha F_{KK}$, which produces the desired equality.

[10] While W, the point of maximum world income, is unique by strict quasiconcavity of F, the loci $F_N = F_N^*$ and $F_K = F_K^*$ might intersect at another point where $F_S \neq F_S^*$. For simplicity, we ignore this possibility here. A sufficient condition to rule this out is that the sub-production function

$F(N,K)$, for fixed S, be homogeneous (of degree less than one) in N and K and that $F_{NK} \geq 0$. Note also that the loci will intersect the axes, as shown, only if the inputs N and K are not "necessary" for production. If instead, $F_N \to 0$ as $K \to 0$ or $F_K \to 0$ as $N \to 0$, the loci will approach the relevant axes asymptotically. On the other hand, if $F_{NK} = 0$, the $F_N = F_N^*$ and $F_K = F_K^*$ loci will coincide with AA* and BB* respectively.

[11]Some allocations might yield negative Y, but this is of no concern to us here, since Y itself is being maximized.

[12]Jones _et al_ termed the gain from difference in marginal products the '"volume of trade" effect' and the change in return to the migrant factor the '"terms of trade" effect'.

[13]While all factor movements against the price gradient require subsidies, it is useful to note that subsidies may be required even when factors move _with_ the price gradient. This occurs when the optimal policy involves mobility in the "right" direction, relative to the endowment point, but to a degree in excess of that required by free mobility. See Section 4.1 for an example.

[14]A case in which the country would choose to import both factors but would not need to subsidize either occurs when the endowment lies in Zone 3 but the optimum is in Zone 1. Thus, though at the endowment point capital earns less at home than abroad, the optimal immigration of labor is sufficiently large to make the actual return to capital relatively higher in the home country.

[15]In Figure 4a, nn' represents the locus of points along which (11) = 0, and similarly for kk' and (12). The following are easy to demonstrate. The point E is a local minimum of Y. Both nn' and kk' pass through E, have

positive slopes, and cannot intersect for $\hat{K}$, $\hat{N} > 0$. At E, nn' is steeper than kk'. Finally, along the axis (E,K'), small amounts of immigration actually <u>lower</u> Y (and similarly for (E,N') and capital inflows). In other words, a small positive inflow of either factor, in the presence of large inflows of the other factor, is actually <u>harmful</u>: it induces only a negligible decline in payments to foreign owners of that factor, but a large increase in payments to the other immigrant factor.

[16]Analysis of Zone 4 would be symmetrical to that of Zone 3 and so, for the sake of brevity, is omitted.

[17]Exceptions to this occur when E in Figure 4c is to the right of W, or below W, in which case some very specific allocations along the borders of zones that violate these conditions are also feasible. For example, W must always be feasible, but can lie to the left of E, implying labour emigration despite $F_N < F_N^*$.

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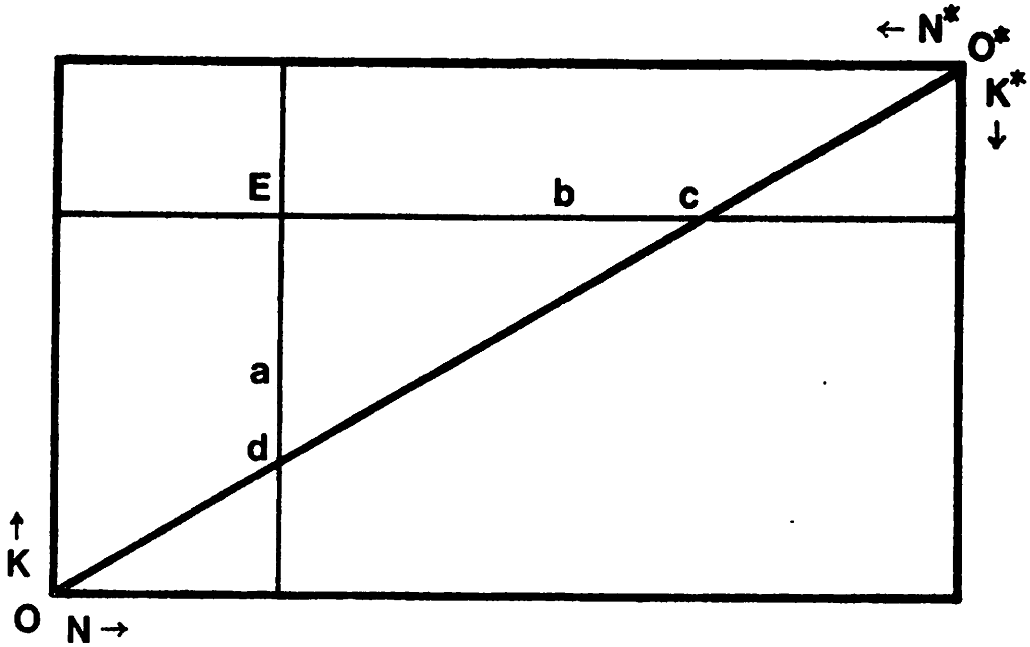


FIGURE 1

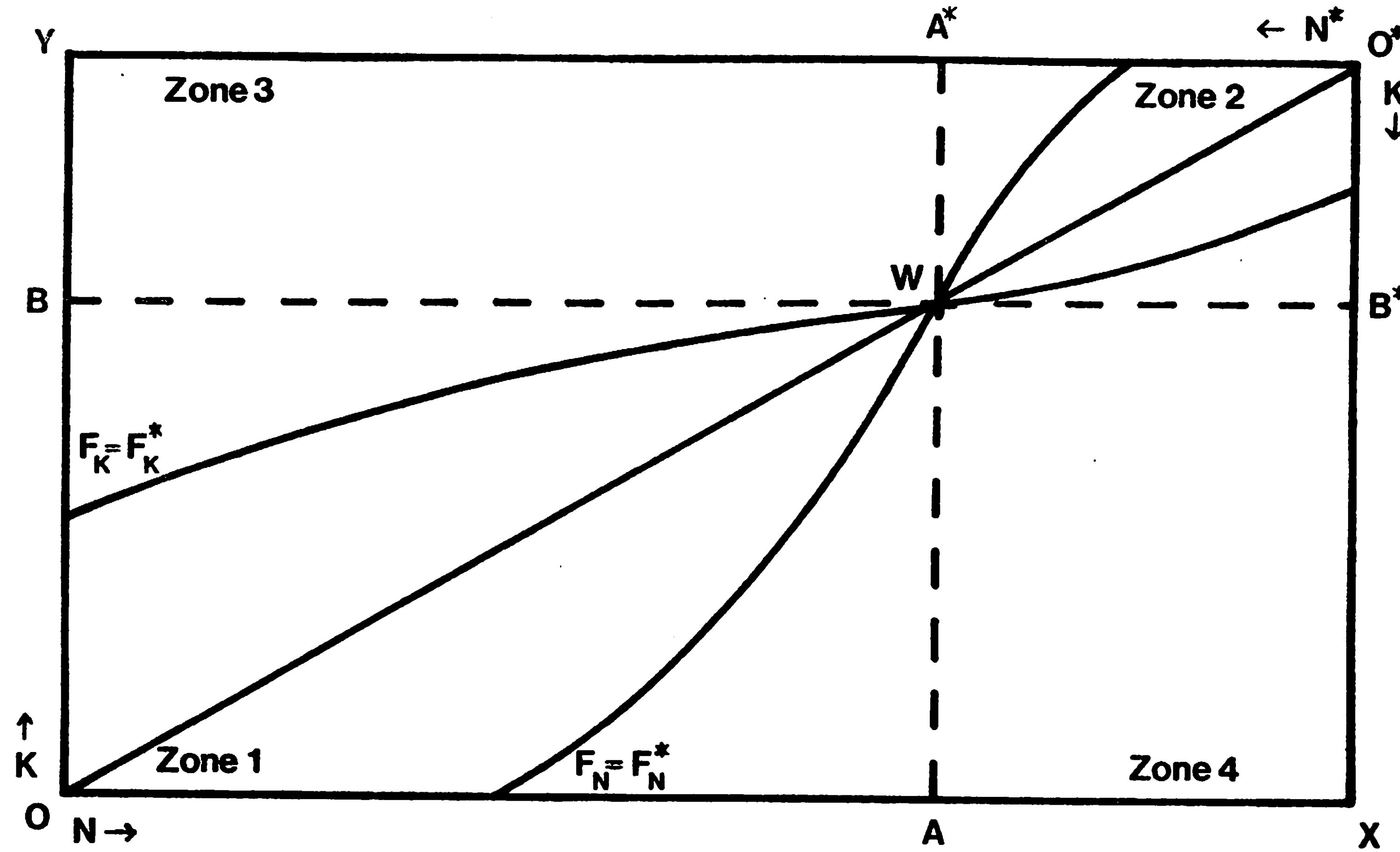
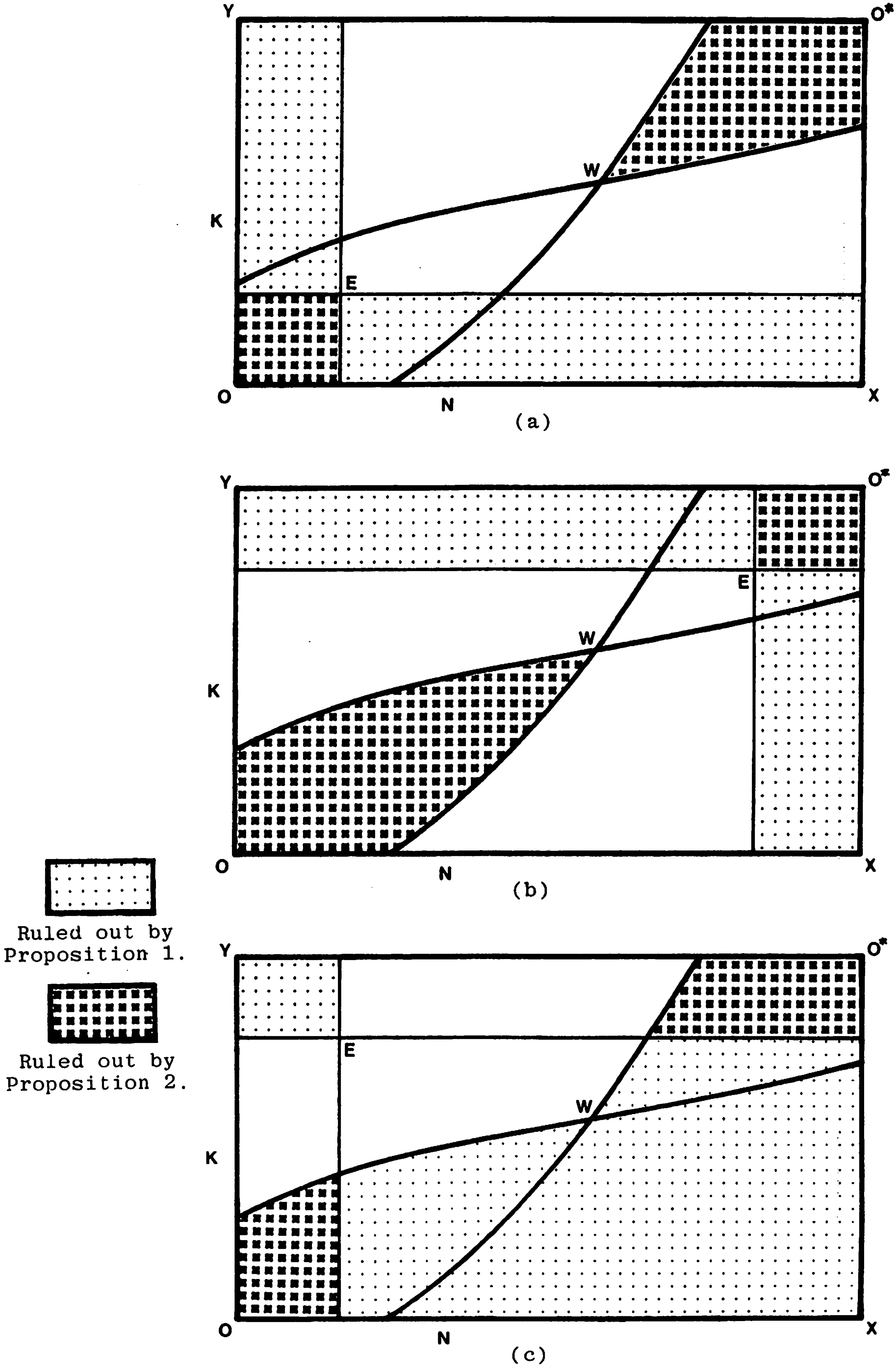


FIGURE 2


Y
O*
K
W
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N
X
(a)
Y
O*
E
W
K
O
N
X
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Ruled out by Proposition 1.
Ruled out by Proposition 2.
Y
O*
E
W
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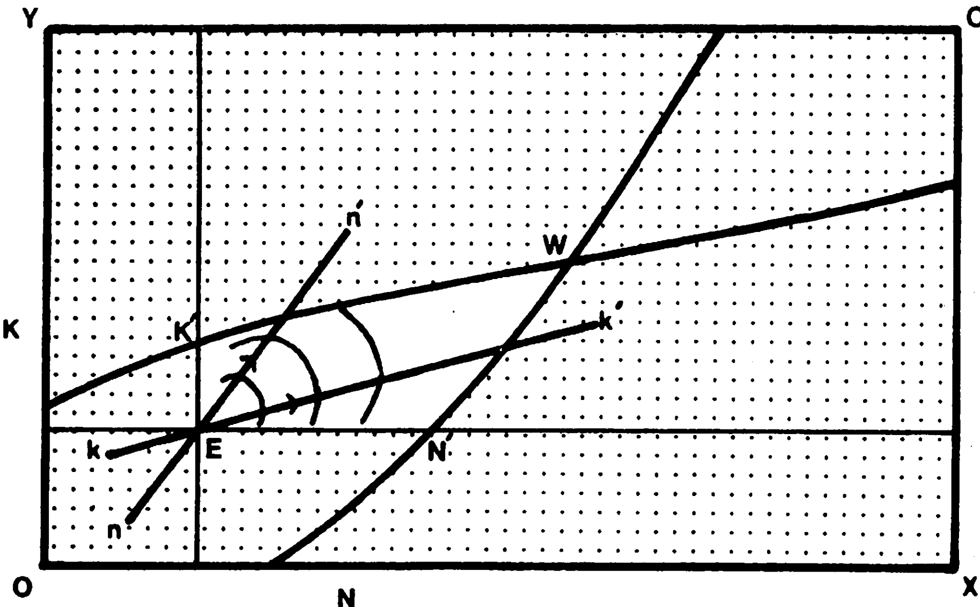
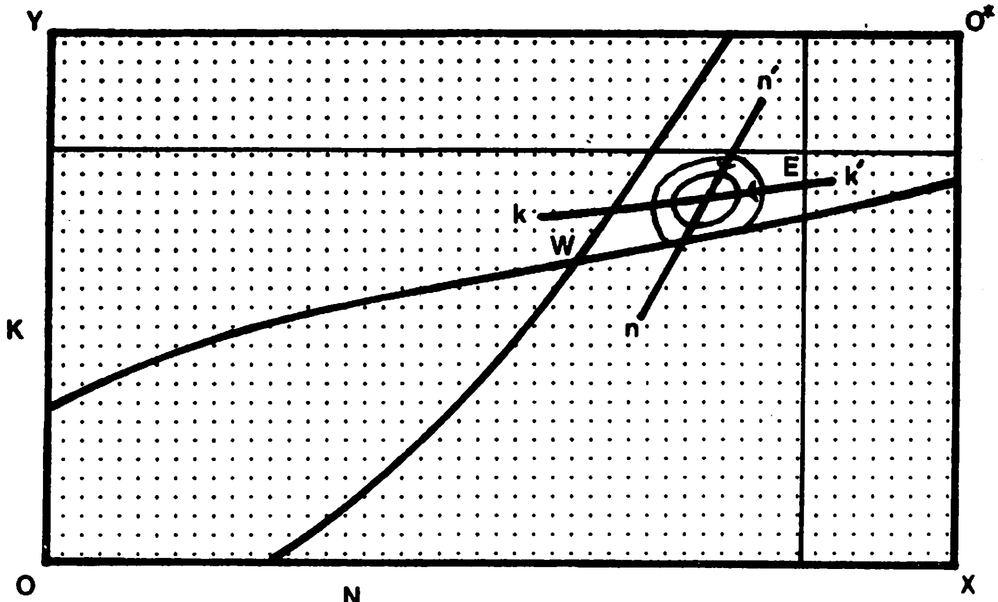
X
(c)

FIGURE 3



(a)



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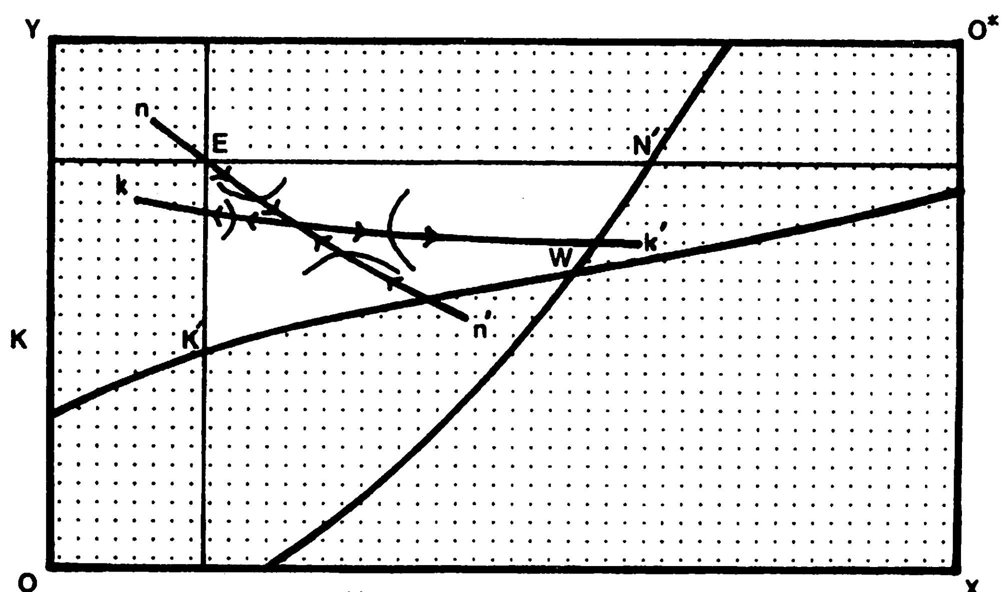

(c)

FIGURE 4