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AN ALTERNATIVE THEORY OF THE BRAIN DRAIN

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This paper departs from the standard welfare-theoretic analyses [see Bhagwati and Rodrigues, (1975)] of the brain drain by returning to its original definition, viz., the migration of professionals such as doctors, nurses, academics, etc., whose services may be treated as non-tradable consumption goods. It is shown that such brain drain not only reduces the welfare of non-emigrants, but, in addition, the migrant professionals may not always succeed in compensating the non-emigrants and remain as well off as before.

Most theoretical literature on the brain drain [see Bhagwati and Rodriguez, (1975)] treats the services of all migrant labour, skilled and unskilled, as inputs into a production process whose output is regarded as tradable. It will be readily perceived that many of the migrant professionals such as doctors, nurses, academics, engineers, architects, artists, actors, sportsmen and others, provide services which may be regarded as non-tradable.[1] We, therefore, propose to redefine brain drain as the loss of a specific category of human capital whose services, taken in themselves or combined with those of physical capital, are to be treated as non-tradable consumption goods.[2] Using this definition, we investigate the effects of brain drain on the welfare

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[1] Harry Johnson (1967, pp. 403-405) recognized this character of the brain drain: "For the case of doctors, in particular, and possibly some other professions, it is *more appropriate* to conceive of them as providing services directly to the consumer (emphasis mine)." In fact, Johnson proceeds to evaluate the welfare loss associated with brain drain, as defined in the quote, using a partial equilibrium framework. He concludes that the non-emigrants are impoverished in the short run by the loss of professionals, while in the long run their welfare remains unchanged.

[2] Our model may easily be applied in reverse to study the implications of the immigration of professionals on the welfare of non-immigrant population. The welfare of non-immigrants will improve unambiguously.

of non-emigrants.[3] It is found that brain drain reduces the welfare of non-emigrants. It is also shown that the migrant professionals may not always be able to compensate the non-emigrants and remain as well off as before. This latter result may be of some interest in view of the current discussions on the feasibility of taxing the brain drain.

The argument of this paper develops as follows. Section one specifies the model employed. The next section works out the effects of a finite and once-for-all migration of professionals on the assumption that professionals do not cooperate with any physical capital to produce professional services. Section three considers, in terms of the model of section two, whether migrant professionals may compensate the non-emigrants and remain as well off as before. Section four extends the exercises of sections two and three to include the case where professionals cooperate with the services of physical capital to produce professional services.

I. The Model

Our analysis is of necessity cast in a general equilibrium framework since, the services of migrant professionals being non-tradable, an important effect of the brain drain is to alter the relative price of professional services. Two sectors are defined, X_S, producing non-tradable professional services, and, X_T, producing a tradable commodity. The production functions for X_S and X_T are characterized by constant returns to scale, and may be represented as:

$$1) \qquad X_S = F(K_S, L_S), \quad F_K, F_L > 0, F_{KK}, F_{LL} < 0$$

and

$$2) \qquad X_T = G(K_T, L_T), \quad G_K, G_L > 0, G_{KK}, G_{LL} < 0$$

where K and L represent capital and labour respectively and the subscripts S and T represent the sectors X_S and X_T to which they are allocated. Our analysis in sections two and three assumes that *all the capital in X_S is embodied in L_S and also owned by them.* In section four the model is gene-

[3]This is not to imply that the services of these professionals may not serve as inputs in production processes whose outputs are tradable. But for our analysis we are abstracting from this aspect of the services of the professionals which has already been studied in the literature.

ralized and the assumption is made that *only a fraction of* K_S *is embodied in* L_S *and owned by them;* the remaining fraction is held as physical captial not owned by L_S. The model is completed on the demand side by assuming that all members of the economy have homothetic utility functions and (1) either identical tastes or (2) an unchanged income distribution.[4]

Assuming the existence of perfect competition in all markets and also assuming perfect factor mobility in the long run, the production side of the economy may be represented by a concave transformation curve such as AB in Figure 1. Before the brain drain, the economy is assumed to exist in

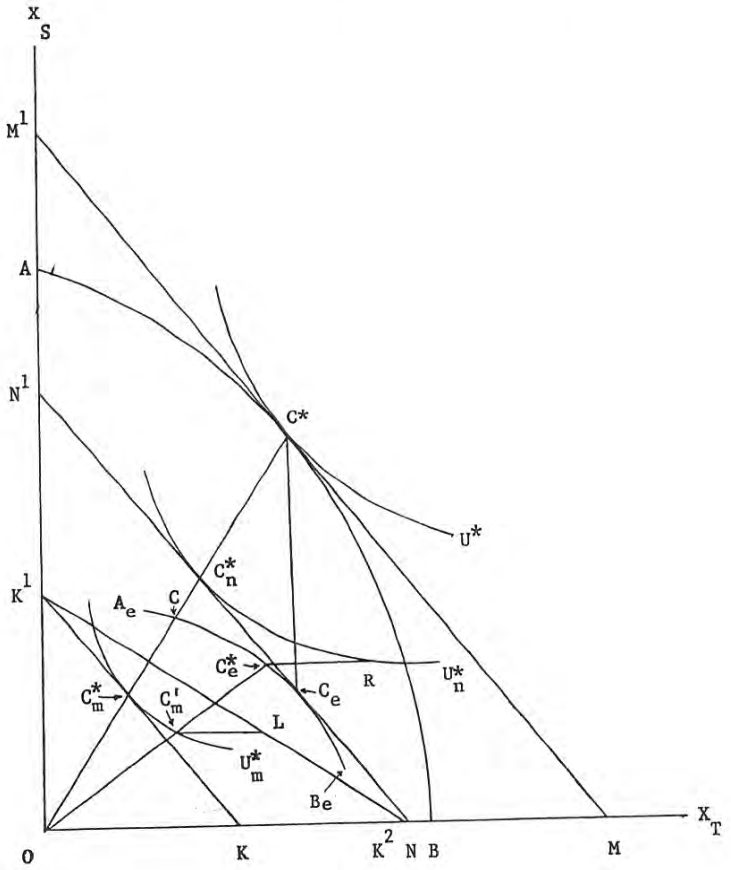

Figure 1

[4]We need this assumption to make welfare comparisons; we cannot use *per capita* income, the criterion used in the literature, because of the presence of relative price effect.

a position of long run equilibrium at C^* where the community indifference curve, U^*, is tangential to AB. The comparative-static exercise of this paper consists in allowing a finite and once-for-all outflow of professionals from this position of long run equilibrium, C^*, and then investigating the impact of this outflow on the long run equilibrium of the economy.[5] Two questions are studied with respect to this long run equilibrium. First, we consider whether the non-emigrants as a group are better or worse off in the latter equilibrium *vis a vis* their position at C^*. Second, we examine whether the emigrants can compensate the non-emigrants for their losses and remain as well off as before. These questions are taken up in the rest of this paper.

II. Welfare of Non-Emigrants

Consider a finite and once-for-all migration of professionals corresponding to which the economy loses C^*C_e professional services in Figure 1. Draw through C_e a line, N^1N, parallel to M^1M whose slope represents the domestic relative price of X_S; it may be seen that N^1N represents the budget constraint of the non-emigrants before the brain drian. Given our assumption that all members of the economy have identical and homothetic tastes, the welfare of the non-emigrants before the brain drain is represented by U_n^* which must be tangent to N^1N at C_n^* where OC^* and N^1N intersect. In order to determine the impact of the brain drain on the welfare of the non-emigrants, we must determine the equilibrium of the economy after the brain drain. It will first be shown that C_e in Figure 1 must lie on the economy's reduced transformation curve resulting after the brain drain.

Consider Figure 2 where O_TLO_SK represents the factor-box of the economy before the brain drain. Let $O_SQ^*O_T$ represent the economy's contract curve on the assumption that X_S is capital intensive. Production takes place at Q^* on this contract curve corresponding to C^* in Figure 1. Draw an isoquant S_e for the sector X_S such that Q^*Q_e represents the loss of X_S resulting from the brain drain. The brain drain reduces the factor-box of the economy, and since brain drain in this section is defined as the loss of fac-

[5]This comparative-static exercise needs some explanation, given the presence of human (embodied) capital in our model. In the idealized world of theory, the movement of the economy from one long run equilibrium to another is achieved under the assumption of homogeneous and perfectly mobile capital. But in the real world, much of capital assumes specific forms both as physical and human capital, and their transformation from one shape/sector to another assumes a process of depreciation and replacement which is not dealt with explicitly in the standard trade models. Thus capital embodied in humans may be transformed to physical capital by redirecting resources from education and skill-formation to making machinery.

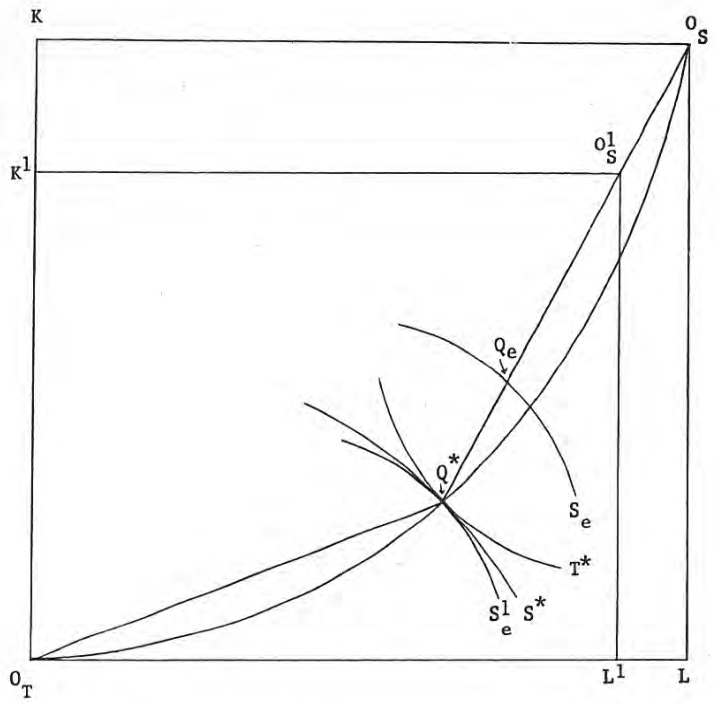

Figure 2

tors in the same proportion in which they are employed in X_S (i.e. labourers in X_S leave with the capital embodied in them), the origin O_S of the X_S isoquants slides down along $O_S Q^*$ to O_S^1 such that $O_S O_S^1$ is equal to $Q_e Q^*$. It may be seen that the isoquant S_e has also moved along $O_S Q^*$ through a distance equal to $Q_e Q^*$ (equal to $O_S O_S^1$), its new position being given by S_e^1. Since S_e^1 is tangential at Q^* to T^*, Q^* must represent a point on the contract curve of the economy in the context of the reduced factor-box $O_T L^1 O_S^1 K^1$. In other words, C_e in Figure 1 which corresponds to Q^* in the context of the reduced factor-box, must lie on the reduced transformation curve of the economy.

It can also be shown that the slope of the reduced transformation curve at C_e in Figure 1 is identical to the slope of AB at C^*. Referring to Figure 2, it may be seen that the relative factor prices at Q^* are the same in the context of both the original and reduced factor-box diagrams. Thus, it follows from the assumption of homogeneity in production that the slope of the reduced transformation curve must be the same as the slope of AB at C^*. Since we know that the reduced transformation curve must be concave

to the origin, it follows from the above that it must be tangential to N^1N at C_e. Let A_eB_e represent a segment of our reduced transformation curve drawn tangential to N^1N at C_e. We are now ready to analyze the welfare implications of the brain drain for the non-emigrant population.

At the very outset it can be seen that the reduced transformation curve lies below N^1N except at C_e. On the other hand, U_n^* lies above N^1N except at C_n^*. Since C_e cannot coincide with C_n^*, it follows that every point on the reduced transformation curve must be inferior to U_n^*. It may, therefore, be concluded before investigating the new equilibrium of the economy that brain drain reduces the welfare of the non-emigrants.

It can be easily shown that brain drain increases the relative price of X_S. This may be seen to follow from the fact that the equilibrium after the brain drain must lie to the left of C_e on A_eB_e in Figure 1. Given the homotheticity of community indifference curves, it will be seen that the slope of the community indifference curve (not drawn) through C_e at C_e is less steep than the slope at C^* of U^* and, hence, the slope of AB at C^*. We have already shown that the slope of A_eB_e at C_e is the same as the slope of AB at C^*. It, therefore, follows that the slope of A_eB_e at C_e is steeper than the slope of the community indifference curve (not drawn) through C_e at C_e. From this it follows that equilibrium will occur on A_eB_e above C_e at which point the relative price of X_S will have increased.[6] It can in fact be shown that this equilibrium will lie at some point like C_e^*, between C and C_e.

The impact of the brain drain on the welfare of non-emigrant labour and capital is easily determined. On the assumption that X_S is capital intensive, the increase in its relative price (*vide* Stolper-Samuelson Theorem) ensures an increase in the welfare of capital owners and a decline in the welfare of labour. Thus, capital gains despite the overall loss of welfare to all non-emigrants. Obviously, these welfare implications would be reversed if we assumed X_T to be the capital intensive good.

One further question will be answered before we conclude this section. What happens to the capital intensity of X_S after the brain drain? Looking back to Figure 2, we know that we have one point, Q^*, on the new contract curve of the economy corresponding to the reduced factor-box $O_TL^1O_S^1K^1$. The capital intensity of X_S at Q^* is the same as it was before the brain drain. However, Q^* does not represent the economy's equilibrium after the brain

[6]This result could easily be established without the use of community indifference curves. Assuming that both X_S and X_T are normal goods in the consumption of all individuals, it will be seen that the consumption bundle of non-emigrants before the brain drain must lie to the left of C_e on N^1N. Now if the equilibrium terms of trade after the brain drain is equal to the slope of N^1N, the equilibrium output as we have shown already must lie at C_e on A_eB_e. There will thus exist at relative prices given by N^1N, an excess demand for X_S which will push up its relative price in the new equilibrium.

drain. Since the new equilibrium lies above C_e (corresponding to Q^* in Figure 2) on A_eB_e in Figure 1, the equilibrium in the context of Figure 2 must lie at some point on the contract curve nearer to O_T than Q^*. It follows that in the new equilibrium the capital intensity in the professional sector will decline as a result of the brain drain.

III. Compensating the Non-Emigrants

It will be shown here, in terms of the analysis of the previous section, that the emigrant professionals may not always be able to compensate the non-emigrants for their loss of welfare and remain as well off as before. This result, it will be seen, follows directly from the fact that compensation can be made only in terms of the tradable commodity.

First, we will demonstrate that the minimum compensation the non-emigrants require to be as well off as before will vary directly with the elasticity of substitution in consumption between X_S and X_T. Since X_S is non-tradable, compensation must be calculated in terms of the tradable good X_T. Draw through C_e^* in Figure 1 a line parallel to the x-axis and interesecting U_n^* at R. C_e^*R then represents the minimum compensation, in terms of X_T, that non-emigrants require to be as well off as before. It will be seen that the magnitude of C_e^*R will depend, among other things, on the elasticity of substitution in consumption. Clearly, as this elasticity increases there need be no upper limit to the magnitude of C_e^*R.

Let us now determine the maximum amount of X_T the emigrant professionals can part with and remain as well off as before. Mark off a length OK^1, equal to C^*C_e, representing the output of migrant professionals. Draw K_1K_2 representing the terms of trade the migrant professionals enjoy in the country to which they have migrated; the slope of K_1K_2 must be either equal to or flatter than the slope of A_eB_e at C_e^*, the domestic terms of trade, otherwise reverse migration will occur.[7] Also draw K^1K parallel to N^1N to represent the domestic terms of trade before the brain drain. Before the brain drain, the emigrant professionals consume at C_m^* where U_m^* is tangent to K^1K; C_m^* must lie on OC^*. Let OC_e^* intersect U_m^* at C_m' and draw $C_m'L$ parallel to the x-axis. Then, it will be seen that $C_m'L$ represents the maximum compensation emigrants can make and still be on U_m^*. Thus, given the slope of K^1K^2, $C_m'L$ must be finite. On the other hand, C_eR may tend towards

[7] For this condition to hold we assume that production functions in the domestic economy and the country to which migration occurs are the same.

infinity and, hence, exceed C'_mL.[8] We may, therefore, conclude that emigrants may not always succeed in compensating non-emigrants and remain as well off as before.

IV. A Generalization

This section generalizes the exercises of sections two and three to include in the X_S sector capital neither owned by, nor embodied in the professionals. As before, brain drain is defined as the migration of human capital from the sector producing the non-tradable commodity X_S. It will be shown here that the generalization undertaken does not affect any of our welfare conclusions, though now, brain drain may lower the relative price of X_S.

Consider Figure 3 which reproduces from Figure 1 the information re-

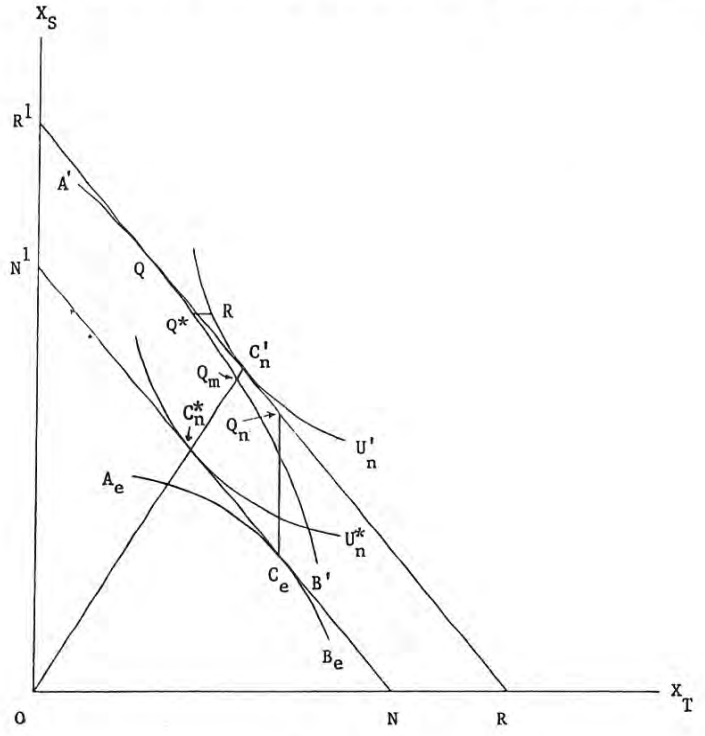

Figure 3

[8]It may be noted that the slope of K^1K^2, since it must be equal to or flatter than the slope of A_eB_e at C^*_e, is not unrelated to the elasticity of substitution along U^*_n. But C^*_eR may be varied by changing the elasticity of substitution along U^*_n to the left of OC^*_e (extended) in which case the position of C^*_e and the slope of A_eB_e at C^*_e remains unchanged.

levant to our current purpose. N^1N, as before, represents the income of non-emigrants when all the capital in X_S is embodied in, and owned by, L_S. Now we assume that some fraction of the capital in X_S is not embodied in, or owned by L_S; let us assume that this fraction of capital not embodied in, or owned by, migrant professionals is given by N^1R^1 in terms of X_S (and NR in terms of X_T) before the brain drain. Thus, the income of non-emigrants before the brain drain is now given by R^1R. Their welfare before the brain drain, therefore, may be given by U_n' which is tangential to $R'R$ at C_n', the point of tangency being given by the intersection of R^1R and OC_n^* extended. We must now determine the welfare of the economy after the brain drain. This, as before, entails determining the equilibrium of the economy after the brain drain.

It will first be shown that the reduced transformation curve of the economy under the present assumptions will be tangential to R^1R and, in addition, must lie entirely outside A_eB_e. Because of the assumed homogeneity of production, the income of the non-emigrants, before and after the brain drain must be the same at terms of trade given by R^1R. Hence, the reduced transformation curve must be tangential to R^1R. Further, the reduced transformation curve must lie outside A_eB_e because the economy has more capital and the same amount of labour. It can easily be seen that with a capital intensive X_S sector, the reduced transformation curve must be (*vide* Rybczynski Theorem) tangential to R^1R at some point to the left of Q_n where Q_n is given by drawing through C_e a line parallel to the y-axis.

When the reduced transformation curve is tangential to R^1R at some point between Q_n and C_n', we have a situation identical to that in sections two and three, and all previous welfare conclusions will hold. We now need to explore the welfare implications in a situation where the point of tangency is to the left of C_n'.

It will be seen that when the reduced transformation curve, of which $A'B'$ represents a segment, is tangential to R^1R at Q to the left of C_n', equilibrium will be given at some point like Q^* on $A'B'$ between Q and Q_m where Q_m is given by the intersection of OC_n' and $A'B'$. At Q_m the slope of $A'B'$ is steeper than the slope at Q_m of the community indifference curve (not drawn) through Q_m. Hence, equilibrium must lie to the left of Q_m on $A'B'$. Again, at Q the slope of $A'B'$ is less steep than the slope at Q of the community indifference curve through Q. Hence, equilibrium must lie to the right of Q on $A'B'$. Thus, equilibrium must lie at some point like Q^* between Q and Q_m. It is clear that at a point like Q^* welfare of non-emigrants has declined. At Q^*, it may be noted, the relative price of X_S has gone down.[9]

[9]In this case, brain drain increases the disparity between the relative price, at home and abroad, of

In this latter case too, it will be shown that emigrants cannot always compensate the non-emigrants and remain as well off as before. First, note that the minimum compensation, Q^*R, non-emigrants require to be as well off as before is independent of the relative price of X_S in the country to which migration occurs. On the other hand, the maximum compensation which emigrants can make and still remain as well off as before is directly related to this relative price. Thus, in Figure 1, if K^1K^2 is sufficiently close to K^1K, C'_mL may be made as small as possible. It follows, therefore, that Q^*R in Figure 3 may easily exceed C'_mL, and compensation is rendered impossible.

If X_T is the capital intensive commodity, the reduced transformation curve, $A'B'$, will be tangential to R^1R at some point below Q_n.The situation is identical to that in sections three and four and all the corresponding results follow.

V. Conclusion

Our results on the welfare implications of the brain drain may now be compared with those in the existing literature. First, on the basis of our definition, brain drain in a small open economy reduces the welfare of non-emigrants. This may be contrasted with the result of Kenen (1971) whose analysis of labour migration in a trade-theoretic framework shows that welfare of non-emigrants is not affected by migration. Kenen's analysis of migration when extended to human capital gives identical results. Clearly, the divergence in results stems from the difference in definitions of brain drain employed. Our definition introduces a non-tradable sector, producing professional services, into the economy. This makes the relative price between tradables and non-tradables endogenous, leading to the divergence in results. However, it must be pointed out that the endogeneity of the price of migrants' services may result from other circumstances as well, e.g.,imperfections of market, which our study does not analyze.

We have, in addition, shown that emigrant professionals may not necessarily be able to compensate the non-emigrants for their loss of welfare. If we include in the calculations of the migrant professionals their cost of transportation, our conclusion would come out stronger as this calculation would reduce the maximum compensation which emigrant professionals can pay. This result tends to detract from the value of recent discussions on the feasibility of taxing the brain drain.

X_S. It is, thus, going to provoke further migration and it is conceivable that this process may completely drain the economy of capital and labour.

Finally, it may be mentioned that the definition of brain drain adopted for this paper may be regarded as more closely descriptive of the phenomenon as it has been experienced by many third world economies. Even so our analysis does not exhaust the possible losses from the type of brain drain that has been our concern here. Clearly, we have ignored the externalities associated with professional services. In addition, the prestige value associated with many professional services is not a trivial argument in the utility function of the residents of third world economies. It is, therefore, clear that the inclusion of losses from these last two sources would increase the welfare loss inflicted on non-emigrants by brain drain.

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References

Bhagwati, J. and C. Rodriguez, 1975, Welfare-theoretical analyses of the brain drain, Journal of Development Economics 2, 195-222.

Johnson, H., 1967, Some economic aspects of the brain drain, Pakistan Development Review 7, 378-411.

Kenen, P.B., 1971, Migration, the terms of trade and economic welfare in the source country, in: J. Bhagwati, R. Jones, R. Mundell and J. Venek, eds., Trade, balance of payments and growth (Amsterdam: North-Holland).