

WELFARE-THEORETICAL ANALYSES OF THE BRAIN DRAIN*

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The paper reviews and synthesises the theoretical analyses of the brain drain in the earlier literature and in the present symposium in the *Journal* on the subject. Static analysis and dynamic analysis are distinguished, critical issues are raised relating to how welfare changes should be discussed in the context of migration, and possibilities of fruitful future research are outlined.

1. Introduction

This paper reviews the literature on the theoretical analysis of the welfare effects of the brain drain. The different theoretical analyses, with their occasionally divergent conclusions, can be illuminatingly classified according to whether: (i) they deal with comparative-static or dynamic formulations; (ii) they assume a perfectly competitive model or one with endogenous market or policy-imposed distortions; and (iii) they address themselves to the welfare of the country of emigration or of immigration, or take a world-welfare viewpoint.

In the following review, we begin (section 2) briefly with a discussion of the last set of issues distinguished above, namely, whose welfare should be considered and how welfare should be defined. We next turn, in section 3, to the early, theoretical literature which has focussed on comparative-static analyses in perfectly competitive models. In section 4, we turn to analyses which allow for distortions: policy-imposed (e.g., educational subsidies) and endogenous (e.g.,

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rigid or sticky real wages). Finally, in section 5, we review the dynamic analyses of the effects of the brain drain.¹

In reviewing the literature, we naturally synthesise and marginally extend it. Also, we provide an analytical taxonomy into which the theoretical contributions in this volume can be, and are, appropriately fitted, and hence their relationship to the foregoing contributions and to one another is more readily assessed by the reader.

2. Welfare: Whose and how defined

2.1.

A central problem in the analysis of migration relates to the question: whose welfare is being assessed? Even if we assume away intergenerational welfare problems (such as those raised by Rawls (1971) recently), the modern migration of skilled personnel raises in an acute form the question as to whether the welfare of these migrants is to be considered part of the welfare of the LDC (or, for that matter, as in a recent UNCTAD study (1974), part of the welfare of the DC).

If migration were permanent, so that the immigrant could be taken to have left the LDC and arrived in the DC on a for-ever basis, then it would make some sense to consider the question as to what has happened to 'LDC welfare' as identical to the question as to what has happened to the 'welfare of those left behind in the LDC'. However, skilled (PTK in U.S. immigration terminology: professional, technical and kindred) migrants today – including those who take permanent-residence visas in the DC of immigration and are immigrants in the juridical sense as well as in popular parlance – typically move to and fro between the LDC of origin and the DC of destination (and indeed, en route, to other DCs and LDCs at times). Hence, PTK immigrants are not really permanent migrants in many cases.

However, even in the case of permanent, for-ever migrants, it is not entirely clear that they should be excluded altogether from the definition of 'LDC welfare'. Skilled immigrants today enjoy low transport costs which permit frequent returns to the LDCs of origin and hence retention of LDC loyalties and affiliations. Their job opportunities also now tend to cut across different DCs, increasing their capacity to resist the assimilative pressures of the DC in which they reside – a passionate immigrant into the UK, who will not adapt to British phlegm, may be able to migrate to the back-slapping friendliness of the U.S. or to a convex combination of the two cultures in Canada. The identification with the DC of

¹We should enter the caveat explicitly that our review is by no means exhaustive but touches rather on what appear to us to be interesting contributions from the viewpoint of our focus in this paper. Furthermore, we confine ourselves to explicitly theoretical analyses, using formal models in one way or another: hence we do not review early writings of interest such as Johnson's (1965) article on the Canadian brain drain.

destination is not quite so inevitable in consequence. Furthermore, the melting pot now has itself melted in the U.S., the principal DC of immigration: ethnic diversity is encouraged and Dr. Kissinger finds his Realpolitik hamstrung by ethnic groups whose political and emotional affiliation to countries of emigration is considered a thoroughly acceptable part of the domestic political process.

Thus, several factors have combined to make a continuing link to LDCs of origin and failure to fuse into DCs of destination important aspects of modern, PTK migration from LDCs to DCs. This observation, plus the fact of extensive 'to-and-fro' migration, make it somewhat implausible to assert that, if one is interested in LDC welfare, one must exclude the welfare of the migrants from the analysis. Identically, any procedure which defines 'DC welfare' as inclusive of the PTK immigrants' welfare runs into the same difficulties plus the additional fact that, despite the selective regulation of immigration in the national interest by the legislative and executive branches of DC governments, the average citizen of a DC is more likely to regard the immigrant's welfare as a 'favour' to the immigrant at the DC-citizens' 'expense' than as an augmentation of DC welfare!

It is best therefore to analyse the welfare issues separately for three groups: (i) LDC nonmigrants; (ii) migrants; and (iii) DC non-immigrants. Then, depending on what is appropriate for the analysis of any specific situation, one can add together any of the three components to arrive at what is considered to be 'LDC welfare' or 'DC welfare': clearly, no general rules will apply to all situations.

Among the other implications of to-and-fro migration by migrants, we might also note one consequence of some analytical interest. While the *theoretical* models to be reviewed presently allow for migration from the LDC to the DC in the context of a variety of models of the LDC, none of them allow for the 'return of the native'. Once the return migration is allowed for, one can open up interesting possibilities for theoretical analysis: the modelling of the DC, implying possible learning effects for the (temporary) migrant, for example, could become relevant so that the two-way migration relates to the same (physical) migrant but implies unequal flows in the two directions from the viewpoint of welfare analysis. A 2-period analysis of the welfare impact of such to-and-fro migration would then be called for and would involve the effect of changing locations on the efficiency and wealth of the migrant in an essential way.

2.2.

Next, we ought to distinguish explicitly between the conventional economist's objective function, which admits only goods and services, and augmented objective functions, which allow 'noneconomic' arguments in the objective function as in the analysis of optimal policy intervention to achieve noneconomic objectives in Bhagwati and Srinivasan (1969).

The explicitly theoretical literature to be presently reviewed is exclusively focussed on the conventional objective function. However, the fact that societies

may value the presence of technical personnel per se in the interest of modernisation or the possibly associated increase in the size of the 'modern', industrial sector's activity level is manifestly an important aspect of societal concerns, and the economist evaluating the welfare effects of the brain drain must come to terms with these traditionally political, sociological, 'noneconomic' objectives. This is indeed what McCulloch and Yellen (1975) do when they discuss the possible 'demodernisation' effect of an emigration tax in their model of the brain drain at the Bellagio conference.

2.3.

At a different level, the economic analyst may not be able to continue using a well-ordered social utility function because there are no fiscal policy instruments by which incomes can be redistributed in the desired manner. In this event, explicit attention to the (actual) income distributions before and after migration is required for welfare analysis. Thus, in Hamada's (1975) Bellagio contribution, incomes *can* be redistributed but, in the absence of lump-sum taxation as a feasible alternative, only via the income tax: hence income distribution and per capita income levels are *both* to be analysed for examining the welfare consequences of emigration.

2.4.

Similarly, if we depart from the assumption of full employment of factors of production, then the effect of emigration on the unemployment levels (or rates) could well be an additional, 'economic' argument in the objective function: as is done in the Bhagwati-Hamada (1974) paper.

2.5.

Finally, we may note that dynamic welfare analyses would necessarily take the theorist into intertemporal optimisation: and, in this case (as is evident from our detailed analysis in section 5), the welfare presumptions established from static, welfare analysis do not necessarily carry over.

3. Static, welfare theorising without distortions

The focus of most theoretical analyses has been on LDC nonmigrants' welfare, using comparative statics and models without distortions, and assuming permanent migration. These contributions can be reviewed in ascending order of complexity.

3.1. Model 1: One-product, one-factor-emigration model

The simplest neoclassical model which has been used for analysing the impact

of migration on the welfare of the LDC nonemigrants is the one-product model with just one factor (labour) migrating at the margin in a closed economy.

In this model, used by Grubel and Scott (1966), it was argued correctly that, for infinitesimal changes, the emigrant will neither harm nor help the nonemigrants: the emigrant will have been contributing his marginal product to national income and earning it as well, so that his presence or absence is irrelevant to the nonemigrants' welfare. To put it graphically, the emigrant will be merely sailing away with his own marginal product.

However, for *finite* changes, as was noted by Berry and Soligo (1969) and later independently by Tobin (1974), there is the familiar 'surplus' that the nonemigrants lose. This is seen readily in fig. 1, where the marginal product of labour (MPL) curve is drawn, falling as a consequence of the usual concave production

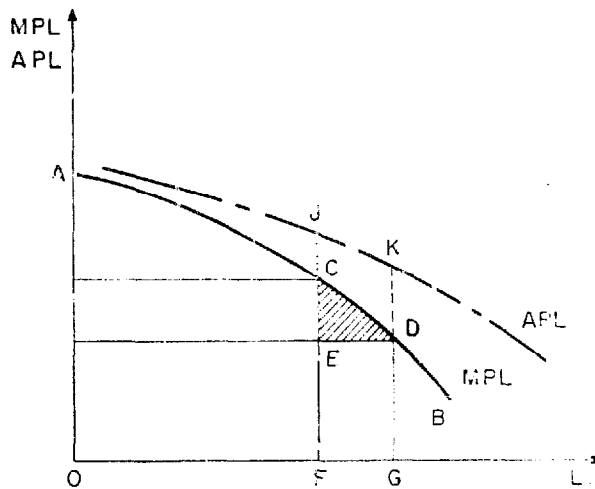


Fig. 1.

function. The finite emigration of FG amount of labour then results in a loss of surplus of the shaded area CDE .

Note one more point that is sometimes the source of critical confusion. If we draw in an average product of labour (APL) schedule, it is clear that, for both infinitesimal and finite changes, the *per capita income* of the *economy* will rise (from KG to JF in fig. 1) with emigration as a simple consequence of the assumed diminishing returns. How does this reconcile with the conclusion that the infinitesimal migration does not affect the welfare of those left behind? The paradox is only apparent. The emigrant earns not the per capita income in the pre-migration situation, but rather the marginal product. The per capita income comparison, to be a correct welfare index of the impact on those left behind, would have to presume that the migrant earned average, rather than marginal, product: in this case, since the average exceeds the marginal product, the migrant

was contributing less to national income than earning and making demand on it, so that his migration helps those left behind.²

3.2. Model 2: Two-product, two-factor, one-factor-emigration model

The extension of the preceding analysis of one-factor-emigration to the standard trade-theoretic model of two products and two primary factors has been carried out by Kenen (1971) in the Kindleberger Festschrift. Its substance can be readily derived as follows.

For a closed economy, start with given equilibrium. When labour migrates infinitesimally, the Rybczynski theorem implies that, at constant commodity prices, the output of the labour-intensive commodity will fall and that of the capital-intensive commodity will rise. Since domestic income and expenditure fall, however, the assumption of noninferiority in consumption, combined with stability, will yield in the post-emigration, full-equilibrium situation a reduced (relative) commodity price for the capital-intensive commodity. Next, turn to fig. 2a, which sketches the production possibility set of the nonmigrants as AB . In the before-migration situation, the commodity price-ratio is PQ and the welfare of the nonmigrant group is at U_a . With the emigration, the commodity price-ratio shifts, as just argued, to SR and the nonmigrants get worse off ($U_b > U_a$). It is easy to see the source of this loss: the 'trade opportunity' of the

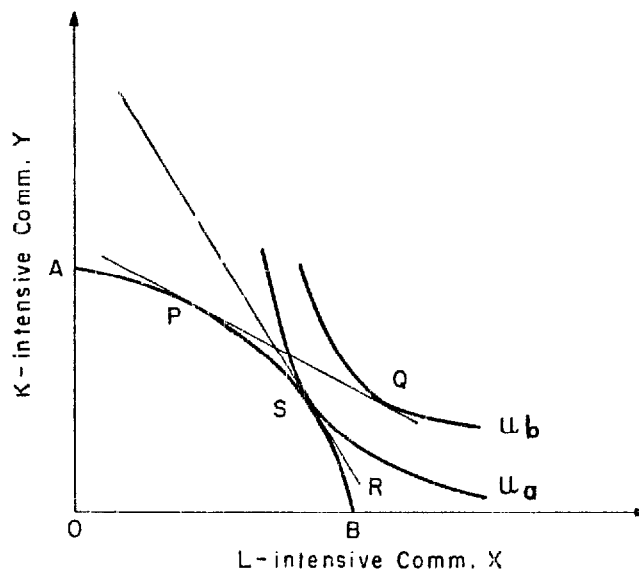


Fig. 2a.

²For those familiar with peasant-family-farming models in the Lewis-type literature on dualism, where average product rewards to family members are assumed, the per capita income of the farming sector would become the relevant welfare index. It does not seem relevant, however, to the problem of international migration.

the unchanged commodity price-ratio, the nonmigrants are left as well off as before ($U_b = U_a$). The presence or the absence of the migrant group in the population implies the same terms of trade, and hence the same trade opportunity, for the nonmigrants: hence the no-impact result (for infinitesimal *and* finite migration).

If the terms of trade can vary, however, it follows similarly that the welfare of the nonmigrants will improve or worsen according as the terms of trade improve or worsen.³ In the case illustrated in fig. 2a, the nonmigrants export commodity X for commodity Y and the after-migration improvement in the terms of trade improves their welfare ($U_a'' > U_b$).

Note finally that this strict relationship between the terms of trade behaviour and the nonmigrants' welfare will not hold for Model 1, for finite emigration, because whereas the emigration at constant prices implies in Model 2 a constant marginal product for labour owing to the Rybczynski theorem, recall that in the one-good Model 1 we have a *declining* marginal product to labour schedule. Hence, for Model 1, we have to set off the loss of the surplus (CDE in fig. 1) against the terms of trade gain, if any, to arrive at the net impact of the migration on nonmigrants' welfare. Thus, in fig. 2c, OA represents the production possibility set of the nonmigrants, with specialisation throughout on producing X as required by Model 1; AC represents the production attributable to the potential migrants; and AB represents the surplus (CDE in fig. 1) that accrues to the non-emigrants. Thus, prior to emigration, with terms of trade BR , we have non-emigrants' welfare at U_b . With the migration, the terms of trade improve to AQ but the surplus is lost so that the nonmigrants' budget line is now anchored on A rather than B . Fig. 2c shows that $U_b > U_a$, i.e., that the terms of trade gain is outweighed by the loss of the surplus. The contrary possibility also exists and could equally well have been illustrated.

3.3. Model 3: One-product, two-factor, two-factor-emigration model

A different extension of the closed-economy Model 1, retaining the one-product framework but permitting two factors to emigrate in a two-factors framework, is due to Johnson (1967). It is derived, in turn, from the Berry-Soligo paper and is best set out in terms of fig. 3.

Assume two groups: nonemigrants (1) and emigrants (2). The former group has K_1 and L_1 units of capital and labour whereas the latter has K_2 and L_2 such units. The overall wage-rental ratio (ω/γ) is a function of the overall K/L ratio, k , where $K = K_1 + K_2$ and $L = L_1 + L_2$. In fig. 3, we then have the post-emigration-of-group-2 equilibrium at Q and $(\omega, \gamma)_{k_1}$ is the wage-rental ratio tangent

³ This conclusion naturally holds only insofar as the trade pattern for the nonmigrant group is not reversed by the migration. This qualification, explicitly noted by Kenen, has its counterpart in our review of the dynamic analyses where the effects of dissimilar *savings* behaviour by migrants and nonmigrants are considered.

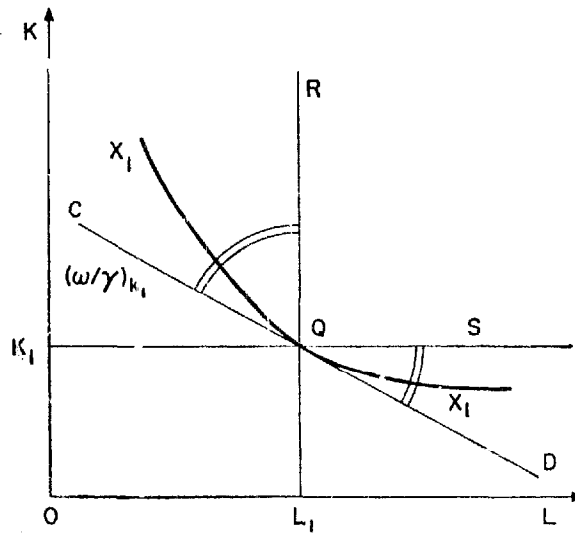


Fig. 3 .

to the X_1 isoquant. X_1 is therefore the post-migration income of group 1. How does this compare with the pre-migration income level? There are two possibilities to consider but both show a worsening of welfare (except for a singular case of no impact) from the migration. The entire range of feasible (ω/γ) ratios before migration can be divided into (i) the range spanned by QR and QC , which would materialise clearly if $k_2 > k_1$ (where $k_2 = K_2/L_2$ and $k_1 = K_1/L_1$) and thus $k > k_1$; and (ii) the range spanned by QS and QD which would materialise if $k_2 < k_1$. The singular case is where $k_2 = k_1 = k$ and therefore $(\omega/\gamma)_{k_1} = (\omega/\gamma)_k$. It follows immediately that, when $k_2 > k_1$, so that it is the richer group that emigrates, the wage-to-rental ratio will *fall* to $(\omega/\gamma)_{k_1}$; in the other case, where $k_2 < k_1$, it will *rise* to $(\omega/\gamma)_{k_1}$. In *either* case, the 'budget line' for group 1 will shrink in the relevant range and will imply *loss* of income. To read off this loss of income, all that one has to do, in the case where $k_2 > k_1$ for example, is to draw the $(\omega/\gamma)_k$ line through Q and take its tangency with respect to the X_k isoquant; clearly, $X_k > X_1$ and $(X_k - X_1)$ is the loss of income to group 1 from the migration of group 2.

It follows equally that the nonemigrant group 1 will become *better off* if the wage-rental ratio rises (falls) when $k_2 > k_1$ ($k_2 < k_1$). This can happen if, when $k_2 > k_1$ for example, the emigrants leave a sufficient amount of their capital behind to *raise* (instead of lowering) the overall capital-labour ratio, k , with emigration.

The same conclusions can be readily derived in the context of yet another familiar diagrammatic technique.⁴ Take fig. 4. It measures the capital-labour

⁴Asim Dasgupta suggested this diagrammatic treatment to us, independently of having seen fig. 5 in section 5, after seeing the preliminary draft of section 3.

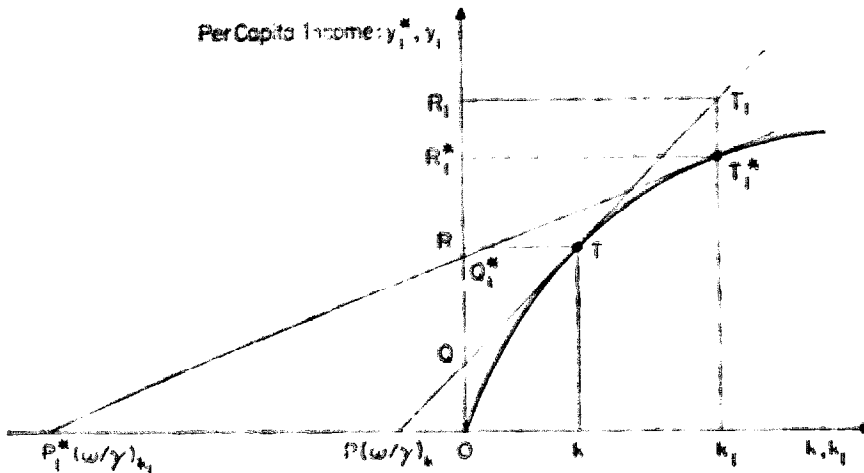


Fig. 4.

ratios along the horizontal axis to the right and per capita incomes y_1^* and y_1 (overall and group 1, respectively) on the vertical axis. Writing the aggregate, constant-returns-to-scale production function in the intensive form as $y = f(k)$, with $f' > 0$ and $f'' < 0$ as usual, we can easily show that the factor rewards, γ and ω , in the premigration situation are

$$\gamma = f'(k) = OQ/PO$$

and

$$\omega = f(k) - kf'(k) = OQ,$$

and therefore

$$\omega/\gamma = PO,$$

so that the wage-rental ratio can be measured as the length of the intercept, on the horizontal axis to the left, of the tangent to the $y = f(k)$ curve OTT_1^* in fig. 4.

Now, $y_1 = \omega(k) + \gamma(k) \cdot k_1$ before migration and $y_1^* = \omega(k_1) + \gamma(k_1) \cdot k_1$ after migration. In fig. 4, it is then readily shown that

$$y_1^* = OR_1^*$$

and

$$y_1 = y_1^* + T_1T_1^*,$$

so that the migration leads to a decline in the per capita income of the non-emigrant group 1 by $T_1T_1^*$. As with fig. 3, then, we can also think of two possi-

bilities: where $k < k_1$ and $k > k_1$. In the latter case as well, if fig. 4 is so redrawn, there will be a measure $T_1 T_1^*$ of per capita income loss for group 1.⁵

Finally, note that it should be possible to derive the results of Model 1 as a special case of Model 3: for Model 1 is where one may think of two factors emigrating, but with one factor (capital) taking zero value. With the emigrant group 2 then being labour-abundant, we have the case where $k < k_1$ and the wage-rental ratio rises after emigration: so we are in the range (*QS* - *QD*) in fig. 3 and in the configuration shown in fig. 4 and, in each instance of course, we get the expected loss of income for the nonemigrant group 1.

Consider next the extension to an open economy. For the simplest case (considered by Johnson) of a small country with fixed terms of trade, and staying within the Samuelson range of incomplete specialisation in production, it is immediately obvious that the emigration of group 2, for $k \cong k_1$, will leave group 1 no better or worse off than before the migration.

3.4. Model 4: One-product, three-factor, two-factor-emigration model

In his contribution to the Bellagio conference, Grubel (1975) works with a simple model where skilled workers, unskilled workers and capital combine to produce a single output and the skilled workers ('engineers') migrate with the capital embodied in their acquired skills. The main results of his geometrical analysis are readily derived, while relaxing his assumption that skilled and unskilled labourers must be used in fixed proportions, as follows. Thus, consider the system:

$$\theta = \theta(K_0, L_e, L_w), \tag{1}$$

$$\bar{L} = L_e + L_w, \tag{2}$$

$$\bar{K} = K_0 + kL_e, \tag{3}$$

where θ is output, L_e is the number of engineers, L_w the number of workers, \bar{L} the stock of total labour, \bar{K} the capital stock, k the units of capital required (i.e., used up) to train an engineer, and K_0 the capital left over to be employed with L_e and L_w to produce output θ .

Assuming that the system will work efficiently so as to maximise output, we can then easily determine the effect of emigration on per capita income. The implication of the efficiency assumption can be first spelled out simply by using the envelope theorem. Thus substitute the constraints (2) and (3) into $\theta(\cdot)$:

$$\theta = \theta(\bar{K} - kL_e, L_e, \bar{L} - L_e). \tag{4}$$

⁵The above results can also be simply derived by noting that $dy_1/dk = (k_1 - k)(dy/dk)$. From this it also follows that, for infinitesimal emigration, the cost of the emigration to the nonemigrant group goes to zero *in the limit* and may virtually be treated as zero.

For a maximum, it is necessary that

$$[\theta_1(-k) + \theta_2 + \theta_3(-1)] = 0, \quad (5)$$

where θ_i is the i th partial derivative and 1, 2, 3 refer to the first (K_0), second (L_e) and third (L_w) arguments in the function $\theta(\cdot)$.

3.4.1. First consider the emigration of unskilled labour. Now:

$$\begin{aligned} \frac{d\theta}{d\bar{L}} &= \theta_1(-k) \frac{dL_e}{d\bar{L}} + \theta_2 \frac{dL_e}{d\bar{L}} + \theta_3(-1) \frac{dL_e}{d\bar{L}} + \theta_3 \\ &= [\theta_1(-k) + \theta_2 + \theta_3(-1)] \frac{dL_e}{d\bar{L}} + \theta_3 \\ &= \theta_3 \quad (\text{using (5)}). \end{aligned} \quad (6)$$

Hence, if unskilled labour emigrates, the loss of national income will be equal to the marginal product of the labour; thus an infinitesimal move will not harm these left behind. Next, we may examine the impact of the emigration on per capita incomes:

$$\frac{d(\theta/\bar{L})}{d\bar{L}} = \frac{\bar{L}(d\theta/d\bar{L}) - \theta}{\bar{L}^2} = \frac{\theta_3}{\bar{L}} - \frac{\theta}{\bar{L}^2} = \frac{1}{\bar{L}} \left(\theta_3 - \frac{\theta}{\bar{L}} \right). \quad (7)$$

As one would intuitively expect, therefore, the per capita product will rise or fall according as the marginal product to labour (θ_3) falls below or exceeds the average product of labour (θ/\bar{L}).

3.4.2. Next, consider the emigration of an engineer, implying the 'loss' of the k units of capital *along with* a unit of labour.

Therefore,

$$\begin{aligned} \frac{d\theta}{d\bar{L}} &= \theta_1 \left(k - k \frac{dL_e}{d\bar{L}} \right) + \theta_2 \frac{dL_e}{d\bar{L}} + \theta_3 (1 - dL_e/d\bar{L}) \\ &= \theta_1 k + \theta_3 \quad (\text{again using (5)}). \end{aligned} \quad (8)$$

And then

$$\frac{d(\theta/\bar{L})}{d\bar{L}} = \{ \theta_3 + \theta_1 k \} - \frac{\theta}{\bar{L}}, \quad (9)$$

where, now, the bracketed term includes the marginal product of labour plus the 'lost' marginal product of the capital emigrating via the engineer. Again, we have the intuitive results on the impact of infinitesimal emigration of skilled labour on the national income (and hence zero-impact on those left behind) and on the per capita income of the society.

It is futile to talk of 'presumptions' of loss or gain from emigration. But the weight of the arguments above is that, except for the no-impact outcome for infinitesimal emigration, the different models seem to lead to a *prima facie* presumption of a loss to those left behind even under conditions of perfect competition. The *magnitude* of this loss is of course conditional on the production functions assumed for the analysis; and as every undergraduate student of economics now must know, 'high' or 'low' costs can emerge depending on whether the elasticity of substitution in production is assumed to be low or high, in turn.⁶

4. Static, welfare theorising with distortions

The theoretical literature embodying distortions, whether policy-imposed or endogenous (in Bhagwati's (1971) terminology), is rather sparse, although the awareness that such distortions can affect the welfare analysis of the brain drain is fairly widespread.

The first paper to consider distortions in a systematic, general-equilibrium framework was by Bhagwati and Hamada (1974). It considers two distortions: an educational subsidy (which is a policy-imposed distortion) and a sticky wage (which is an endogenous distortion). The model, in view of the sticky wage, permits unemployment in the Harris-Todaro (1970) fashion. At the same time, the model enables the authors to analyse the consequences of what is aptly called the 'emulation' effect: the possibility that migration of educated labour can raise the sticky wage as the LDC Joneses emulate and try to keep up with the DC Joneses.

An interesting variation on this model is provided by McCulloch and Yellen (1975) in their Bellagio paper. They modify the Harris-Todaro approach so as to enable the sticky wage to respond *partially* to the degree of unemployment; at the same time, as in one of the Bhagwati-Hamada (1974) variants, they assume that all educational costs are privately borne (i.e., that there is no policy-imposed distortion via an educational subsidy).⁷

⁶This must be kept in mind by any unsophisticated reader of Johnson's (1967, app. III) illustrative, 'small', cost calculations for the Cobb-Douglas case, even though one is only belabouring the obvious here. It is perfectly clear that, by assuming a different production function (e.g., the fixed-coefficients Leontief variety), one can generate 'large' losses. One important implication, again hardly unobvious, is that the cost of the brain drain could very well vary with the kind of professionals one is discussing.

⁷There are other points of difference between the Bhagwati-Hamada and the McCulloch-Yellen models which the readers can note for themselves; they are not pertinent to the discussion in the text.

Both papers lead to more complex welfare analysis than the models without distortions in section 2. They enable one to consider, for example, unemployment as an argument in the objective function. Moreover, there is no longer any necessary equality between the income lost to a country by migration and the wage that the (infinitesimal) migrant earns: the Grubel–Scott proposition is predictably invalid.

Finally, two important results from this type of analysis may be noted. First, it is often argued that if only the emigrant paid for the educational subsidy he had received, that would suffice to leave no adverse welfare impact on those left behind; the Bhagwati–Hamada analysis – of the cases where the educational cost is internalised, and where it is not but the country of immigration compensates the LDC for the educational cost of the immigrant – shows that this is not a valid conclusion.

Second, there is a school of thought which argues that the emigration of PTK manpower from LDCs, when there is unemployment, will not harm the LDCs: that, in fact, we have here an ‘overflow’ or ‘safety-valve’, rather than a ‘drain’, phenomenon. Graphically, as Walter Adams put it to the first author of this paper, ‘I saw doctors driving taxicabs in Manila; why should we worry about their migrating abroad?’ It is clear from the Bhagwati–Hamada analysis that the emigration, by raising the *expected* return to doctors, can cause further expansion of education and hence lead to loss of income; and that the emulation effect can make even *actual* returns to doctors higher than they might have been, thus reinforcing the loss in income.

Further, as the Hamada–Bhagwati (1975) analysis at Bellagio models the point at issue, it is not really meaningful to think of that doctor as driving taxicabs in Manila forever. He is almost certainly ‘waiting’ to clear his ECFMG to migrate to the U.S. If the possibility of migration to the U.S. were not available, he would at some stage stop wasting his skills and being a cabdriver and, since returns to being a doctor in Manila are clearly low, he would migrate internally: to the smaller cities where he could practice medicine. The external brain drain (from Manila to New York) therefore inhibits the (desirable) internal diffusion (out of Manila into the hinterland).⁸ And, even if one pretends that doctors earn the value of their marginal product (in and out of Manila, in the Philippines), the above argument shows that the social marginal product of the doctor who is ‘unemployed’ qua doctor is *not* zero, contrary to the argument of Adams.

In short, the assumption that PTK personnel who are unemployed at any one point of time can therefore emigrate at no loss of marginal product to their

⁸The diffusion of doctors from Manila into the hinterland is the slow, capitalist equivalent of the Maoist policy of ‘sending’ doctors to the countryside. In India, there is growing evidence that doctors in major cities are now opening offices in the adjacent towns, visiting there for periods such as one day a week, thus effectively ‘migrating’ partially to the hinterland: flirting is easier than marriage!

society is based on the faulty reasoning which assumes that they will forever so remain and omits taking into account the 'search process' aspect of the labour market. And, it ignores additional welfare implications which could follow from phenomena such as the Bhagwati-Hamada emulation effect.⁹

5. Dynamic analyses of international migration

The dynamic treatment of the consequences of migration, whether unskilled or skilled, is more recent; besides, the number of contributions in this framework is yet relatively small.

The dynamic models naturally divide into those which concentrate on steady-state analysis, such as Berry and Soligo (1969), McCulloch and Yellen (1974) and Rodriguez (1975a), and those which additionally or exclusively describe the transition of the economy outside the steady state, as in Mishan and Needleman (1968) and Rodriguez (1975b).

At the same time, their common dynamic feature is the explicit introduction of capital as a factor of production and the ability of the economy to change the level of its capital stock by means of savings: domestic or foreign. Furthermore, the papers addressed to the brain drain, as distinct from what might be called Ricardian labour migration of the purely unskilled variety, incorporate a second produced factor of production: education as human capital. Moreover, all the papers reviewed focus *not* on world-welfare effects, but on the welfare implications of the migration on the nonmigrant populations of the countries of immigration or emigration. Finally, in regard to the measures of welfare changes, the most widely used are the per capita income of native residents together with the relative factor rewards as indicators of the income distribution, although Berry-Soligo and Rodriguez (1975a) follow a utilitarian approach and proceed to evaluate the full changes in the levels of utility enjoyed, the former by means of consumer surplus analysis and the latter by the first-order change in the stationary level of utility enjoyed by each individual in the context of a life-cycle model of saving.¹⁰

Finally, we must note that, in contrast to the static analyses reviewed in earlier sections, labour mobility in a dynamic context can be analysed (i) as a once-and-for-all labor movement, or instead (ii) as a rate of migration per unit of time which may, in turn, be either constant or varying over time according to the changing domestic or foreign conditions.

⁹The precise implications of building these interpretations of unemployment into the model used for analysing the effects of brain drain will depend, of course, on how the rest of the model is put together. This should be obvious to the reader from contrasting the analyses in, say, Bhagwati-Hamada (1974), McCulloch-Yellen (1975) and Hamada-Bhagwati (1975).

¹⁰In none of the dynamic models either, therefore, is the issue of to-and-fro migration addressed: emigrants leave for good and the welfare of those left behind is what is considered.

In case (i), it is clear that a once-and-for-all labor movement will not affect any of the steady-state values of the relevant per capita variables, provided we assume that migrants have the same preferences as those of the indigenous population. Under those circumstances, the labor movement can be considered as a change in one of the initial conditions (i.e., initial population) such that the steady state of the economy (if it exists) will be unaffected by it. If, however, a steady state does not exist (as in one of the cases discussed by Mishan–Needleman because of their inclusion of Hicks-neutral technological progress in a Solow-type growth model), even a once-and-for-all inflow of labor with the same preferences as the indigenous population will have permanent effects on the long-run paths of the per capita variables. When migrants have different preferences from those of the rest, however, even a once-and-for-all migration will change the preference structure of the population and will thus have both short- and long-run effects on the economy (provided, of course, that those preferences are transmitted to their children). With the exception of McCulloch–Yellen (1974) and Mishan–Needleman, all the other articles reviewed here introduce differences in preferences in one way or another.

In case (ii), where migration is a continuous process through time, we again have to distinguish between two different problems: (a) a constant or variable migration rate will change the rate of population growth and thus the steady-state requirements of per capita savings, and (b) the preferences of the migrants may differ from those of the rest. In either case it is clear that a continuous migration process will affect both the transition and the steady-state behaviour of the economy.

5.1. The dynamic models of Ricardian labour migration

This subsection concentrates on the models that treat labour as a homogeneous input (contrary to those, discussed in the next subsection, which additionally consider skilled labour).

5.1.1. Of the analyses treating international migration in a dynamic context, the Mishan–Needleman paper is probably the one which provides the clearest link between the static and dynamic models. Their production structure is the same as that of the Solow-type growth model: one-sector, neoclassical technology with two inputs: capital and labor. Savings (equated to investment) are a constant fraction of income and population reproduces at a constant exponential rate. Immigrants have the same preferences (i.e., savings ratio) as the natives and are assumed to enter the country of immigration in a constant number per year. After the immigrant group of a given year enters the country, it starts reproducing itself at the same exponential rate as the natives. Since one of the main objectives of the analysis is to investigate the effects of immigration on the

welfare of the indigenous population, they incorporate those born to the immigrants (i.e., their descendants) into the stock of the immigrant population.¹¹

These simple assumptions provide an ideal framework to test in a dynamic model the static propositions that a discrete labor inflow (outflow) will decrease (increase) aggregate per capita income but raise (reduce) the per capita income of those who were previously in the country (left behind). In this case, of course, the focus of analysis is on the *time-paths* of the different measures of per capita income.

Mishan and Needleman do not solve explicitly their model in order to find out the qualitative properties of the growth path but rather they postulate a CES production function and, using various sets of parameters values presumably appropriate to the UK, they proceed to simulate the paths of the relevant variables for a thirty-year horizon. Some of their results seem to confirm those of the static analysis: for all of the 30 years aggregate income per capita falls short of that under no immigration, while the wage-rental ratio is consistently lower under the immigration regime. However, their results for the effects on the per capita income of the indigenous population do, in some cases (notably, when the production function is Cobb–Douglas), differ from what would be expected: in the Cobb–Douglas case the per capita income of the indigenous population falls short (instead of being in excess) of that under no immigration for the first 21 years. This seems an unusual conclusion in light of the neoclassical nature of the assumptions. We think, however, that a possible explanation for that lies in their treatment of overhead capital. They assume that a constant fraction of total savings is required for the formation of overhead capital, which is not directly productive; although in the text they assume that such savings are provided by the immigrants, the equations that they simulate do not show it but rather imply that the immigrants' savings for overhead capital are provided by the indigenous population at the expense of their own accumulation of physical capital, which of course tends to reduce their own per capita income [Mishan and Needleman (1968, eqs. 13 and 18)]. Furthermore, the moment the immigrant settles in the country there is an additional requirement for overhead capital, which is assumed to be provided by the indigenous population.

Abstracting from the formation of overhead capital and their assumption of a positive constant rate of technical progress, the effects of a once-and-for-all immigrant inflow in the Mishan–Needleman model can be described, in a perhaps more illuminating way, as follows.

Let $Q = F(K, L) = Lf(k)$ be the neoclassical production function for the composite good Q which can be either consumed or transformed into physical capital. The total labor force can be divided into that of indigenous origin, L_d ,

¹¹Again, there is room here for debate. Even where the immigrants are treated as different from the country of immigration, would it not be unrealistic to assume that those born of first-generation immigrants will still be 'second-class' citizens forever (in the unfolding of our dynamic model)?

and that of immigrant origin, L_m . Since both immigrants and indigenous residents have the same savings ratio, the capital-labor ratio of the economy changes through time according to the standard formula,

$$\dot{k} = s \cdot f(k) - n \cdot k, \quad (10)$$

where n is the rate of population growth. At time t_0 , when the once-and-for-all immigration takes place, there is a jump in the capital-labor ratio from $k_0 = K(t_0)/L_d(t_0)$ to $k_1 = K(t_0)/\{L_d(t_0) + L_m(t_0)\}$, where $L_m(t_0)$ is the size of the immigrant inflow. From t_0 on, immigration ceases but the initial immigrant population starts reproducing itself at the rate n , while at the same time they save the same fraction of their income as the rest of the population. In consequence, the capital-labor ratio of the economy, after the initial jump at t_0 , starts changing through time according to (10).

The amount of capital per head *owned* by the immigrant population then changes according to

$$(2)\dot{k}_m = s \cdot y_m - n \cdot k_m, \quad (11)$$

where y_m is the per capita income of the immigrant population and equals the sum of their wage earnings, $\omega(k)$, plus the earnings from the capital they own, $\gamma(k)k_m$. Notice that given competition and constant returns to scale the wage rate and the rental rate, ω and γ , are functions only of the economy's aggregate capital-labor ratio k . In fig. 5, per capita income and savings are represented on the vertical axis and ratios of capital to population on the horizontal axis. The curve $q = f(k)$ shows the aggregate per capita income as a function of the aggregate capital-labor ratio; the curve nk shows the steady-state investment requirements; and finally, the curve $sf(k)$ shows the aggregate per capita savings.

We assume that, before the immigration, the economy had reached the steady-state level of the capital-labor ratio k_0 . After the immigration, the capital-labor ratio falls instantaneously to k_1 and aggregate income per capita consequently falls to k_1B from the higher level k_0D . The reduction in the capital-labor ratio increases the rental rate and reduces the wage rate (which is now given by the distance OA along the vertical axis). Since initially immigrants have no capital, their income is equal to the wage rate OA , clearly lower than the aggregate per capita income which also includes the earnings from the capital stock. Even though the aggregate capital-labor ratio has been reduced, the per capita amount of capital *owned* by the indigenous population remains unchanged at k_0 . Thus, the per capita income of the indigenous population immediately after the immigrant inflow is equal to the new wage rate, OA , plus the rental rate (the slope of the line AC times their per capita holdings of capital, or the distance k_0C which exceeds the per capita income they had before the immigration by the

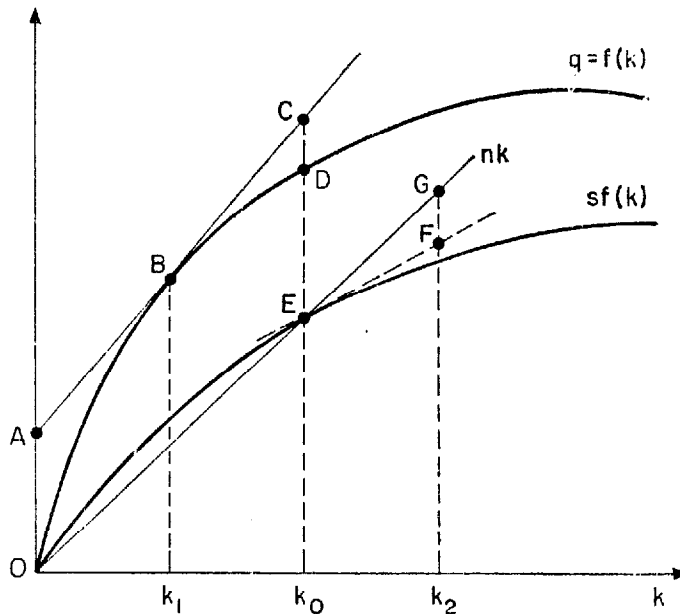


Fig. 5.

amount CD . Thus, the short-run effect of immigration is to raise the per capita income of the indigenous population.¹²

Following the impact effect, it is clear that for the new capital-labor ratio k_1 , aggregate savings exceed the amount of investment required to keep it at the same level and thus it will start rising, according to eq. (10), until eventually it will reapproach the pre-immigration steady-state value k_0 . There are thus no long-run effects on the aggregate per capita income or capital-labor ratio from a once-and-for-all immigrant inflow. Initially, however, the per capita income of the indigenous population has been increased above the original steady-state level; thus, their per capita savings will exceed the amount required to keep the amount of capital per-head they own constant. In consequence, the ratio of capital per head owned by the indigenous population, k_d , will start rising. It is clear that during the transition process for which $k < k_0$ it will also be $k_d > k_0$, and thus the per capita income of the indigenous residents will exceed its pre-immigration steady-state value. Eventually, however, the aggregate capital-labor ratio will approach k_0 and remain there. At this moment k_d may be also equal to k_0 or still larger. If it is equal, the income per capita of the indigenous population will be the same as the aggregate per capita income, and thus k_d will behave in the same way as k and will remain constant. If k_d still exceeds k_0 while $k = k_0$, then k_d must be falling and finally approaching k_0 : for the set of factor rewards implied by $k = k_0$, any k_d larger than k_0 implies that the per capita

¹²The reader may here profitably recall our analysis of fig. 4.

savings of the indigenous residents fall short of the investment required to keep it constant. For example, for $k = k_0$ and $k_d = k_2 > k_0$, per capita savings of the indigenous population are k_2F (the line EF is tangent to the function $sf(k_0)$ at the point k_0 ; thus the slope of the line is $sy(k_0)$) while the steady-state investment requirements are Gk_2 , which clearly exceed k_2F ; thus, k_d must be falling and eventually approaching the pre-immigration level k_0 .

To conclude, following a once-and-for-all inflow of foreign labor into the country, the basic assumptions of the Mishan–Needleman model imply that the income per capita of the indigenous population will be raised above the pre-immigration level and remain above it during all the transition period until the economy again reaches the pre-immigration steady-state level for all per capita variables.

5.1.2. To the extent that the assumption of equal tastes helped to rule out any steady-state effects of migration, the most natural extension at this point is to inquire about the nature of steady-state effects when the preferences of migrants differ from those of the rest (in particular, when the saving ratios differ). As it happens, this is precisely the question addressed by Berry–Soligo (1969) and Rodriguez (1975a), to whose analyses we now turn.

Both papers differ from Mishan–Needleman in at least two basic respects:

(1) Savings behavior is derived from the individual's maximisation of lifetime utility. This, in general, implies that the saving ratios are not constant but rather depend on factor rewards. Individuals do not all have the same utility function.

(2) Both papers are concerned with the effects of emigration on the welfare of those left behind rather than the effects of immigration on the welfare of the indigenous population of the receiving country; it is obvious, however, that both questions are different sides of the same coin.

Basically, their behavioral assumption is that of a life-cycle model of savings where individuals work when they are young and save for their retirement. In this context, the interest rate not only plays the role of being the return to the factor of production 'capital' but also determines the trade-off between present (working period) and future (retirement period) consumption. As proved elsewhere [Samuelson (1958), Diamond (1965)], a competitive market will in general fail to attain the optimal 'golden rule' level of the capital–labor ratio (for which the interest rate equals the rate of population growth) at which society's consumption potential is maximised and the optimal distribution of consumption among generations is attained. To the extent therefore that emigration or immigration changes the aggregate savings ratio of the population, and thus the steady-state level of the capital–labor ratio, there can be aggregate social gains or losses depending on whether the move is towards or away from the golden rule level of the capital–labor ratio.

For the members of each individual group (characterised by a set of preferences) these aggregate gains or losses must be modified to the extent that the individual differs from the average: the change in the steady-state capital-labor ratio brings about changes in relative factor rewards which in turn redistribute income in favor of the group which is relatively better endowed with the factor whose reward has increased in relative terms. For example, if there are only two groups of individuals, high savers and low savers, emigration of some members of the high-savers group will in general reduce the new steady-state capital-labor ratio (through the reduction in the aggregate savings ratio of the population). If the capital-labor ratio was initially below its golden rule level (i.e., the interest rate was larger than the rate of population growth), this move must decrease welfare in the aggregate. The lower capital intensity, in turn, decreases the wage-rental ratio and thus redistributes income towards those remaining members of the high-savers group (those with a higher preference for the ownership of capital) and away from the low savers. It follows that, on both counts, the members of the low-savings group tend to be worse off while the remaining members of the high-savings group may be either worse off or better off. When low savers emigrate, the capital-labor ratio will be increased and, if the movement is towards the golden rule ratio, there is a gain in the aggregate and a redistribution of income towards the remaining low savers (the wage-rental ratio rises). Thus, on both counts, the remaining low savers are better off while the effect on high savers is ambiguous.

It follows from the above analysis that if the capital-labor ratio is below its golden rule level, in the long run emigration of high savers (which decreases the capital-labor ratio even further) will make at least one group worse off, while emigration of low savers will make at least one group better off. If, however, the capital-labor ratio was above the golden rule level, those conclusions should be reversed since in this case reductions in the capital-labor ratio are beneficial in the aggregate.

5.1.3. To summarise, in this section we have concentrated on the description of dynamic models of labor migration where migrants may or may not differ from the rest of the population in regard to their preferences for the accumulation of physical capital. If everyone's preferences are identical and migration is a once-and-for-all phenomenon, there are in general no steady-state effects of migration; the gains of the population of the receiving country (or losses to those remaining in the country of origin) which appear in the static models also appear in this case, except that these gains (or losses) occur in the transitional period during which the economy approaches the original steady state. These transitional gains or losses are shown to depend critically on the per capita ownership of capital by the economic agents and the transitional change in the economy's factor proportions (and factor rewards) brought about by the migration.

When migrants differ from the rest of the population in their savings habits,

we have not merely the transitional gains or losses referred to above, but also the permanent changes in the steady state of the economy due to the now different aggregate savings behavior. These effects can be divided into two parts: (i) effects of movements in the steady-state capital-labor ratio towards or away from the golden rule ratio; and (ii) effects of changes in the steady-state distribution of income due to the new prevailing set of factor rewards and the different preferences of members of the population for the ownership of factors of production.

5.2. The dynamic models of the brain drain

We turn next to the brain drain models whose basic feature is that human capital, in addition to unskilled labor and physical capital, appears as a distinctive factor of production. Human capital is assumed to be accumulated through an educational process which uses up some of society's scarce resources.

To the extent that competition prevails everywhere, including the educational market, it is clear that allowing for the international mobility of educated people amounts to little more than an extension of the issues discussed in the previous section to the context of a three-factor model. Neither of the two papers in this area [McCulloch-Yellen (1974) and Rodriguez (1975b)], however, could be described as a straightforward three-factor extension of the models analysed so far. The main differences are:

(1) The educational market is not assumed to be perfect, either because education is not competitively supplied or because, thanks to the existence of capital market imperfections or information costs, the rates of return to physical and human capital are not equalised.

(2) Rather than considering an exogenous population movement or migration rate, the two papers consider as exogenous the foreign rewards of the internationally mobile factors and the migration preferences of those factors in response to the rates of return from international emigration. Since these rates of return depend not only on the foreign rewards but also on the domestic rewards and the costs of the move, it follows that the actual migration rates will be endogenously determined within the system.

(3) The Rodriguez (1975b) analysis also includes the case of labor market distortions of the type analysed in Harris-Todaro (1970), which were also discussed in a static framework in Bhagwati-Hamada (1974) and Hamada-Bhagwati (1975).

The paper which most closely approximates the other dynamic models previously discussed is McCulloch-Yellen (1974), which concentrates on the study of the steady-state effects on the distribution of income of migration of educated (skilled) people within the context of the following basic assumptions:

(1) Only one good is produced, with a constant-returns-to-scale technology and three factors: physical capital, skilled (educated) labor and unskilled labor.

(2) Education (the acquisition of skills) is carried on until the point where the skilled-unskilled wage differential equals the cost of acquiring the education which, in turn, increases with the fraction of the newly-born population getting educated. The educational cost may be either the marginal or average cost depending on the kind of market structure which prevails in this sector. For the purposes of making the comparison, they convert the once-and-for-all education cost into a constant flow per time unit, using an exogenously given discount rate.

(3) Migration is carried on until the foreign-domestic wage differential for skilled labor equals the flow-equivalent migration cost. Unskilled labor does not migrate.

(4) The domestic rate of return on physical capital is equalised with the foreign rate of return by assuming perfect international mobility of foreign capital at constant rental.

Given these assumptions and a constant rate of population growth, the result is, in general, a nonzero migration rate for skilled labor. This is so because there is no reason why the steady-state output of the educational sector will be consistent with the maintenance of that particular stock of skilled labor relative to the other factors which precisely generates a domestic skilled wage such that emigration or immigration is not attractive. There is, however, a band equal to the foreign skilled wage plus or minus the migration cost such that if the steady-state domestic skilled wage falls within it, no migration will occur.

The steady-state factor rewards for skilled and unskilled labor, migration rate and education rate will then depend on certain exogenous parameters, among them the foreign wage for skilled labor, the foreign rental on capital, the migration cost and the interest rate used for discounting investments in human capital or migration. In fact, reduced to its barest essentials, the basic assumptions of this model imply the following steady-state relationships. Assuming that the steady state is consistent with net emigration of skilled labor (a similar analysis follows easily in the case of immigration), the domestic skilled wage is pegged at the world level minus the migration cost (converted into a constant-flow equivalent). The thus-determined skilled wage *plus* constant rental on capital (equal to the world rental) suffice to determine all the steady-state factor proportions in production (the ratios of capital to skilled and unskilled labor) and therefore, by implication, the unskilled wage and also the skilled-unskilled wage differential. The wage differential, in turn, determines the fraction of the newly-born population acquiring education via assumption (2) above. Since for a steady state the growth rate of the skilled labor force must equal that of the total labor force (such that factor proportions remain constant), the equilibrium migration rate is then obtained as the difference between the growth rate in the stock of skilled people, implied by the already-determined equilibrium factor proportions and

the fraction of those newly-born getting educated, and the rate of population growth.¹³

From these relatively simple relationships it is then easy to derive the steady-state responses of several endogenous variables to changes in the exogenous parameters. For example, an increase in the cost of emigration (or equivalently, an emigration tax or a fall in the foreign skilled wage) reduces the domestic skilled wage by the same amount. Given the constant rental on capital and the constant-returns-to-scale technology, reductions in the skilled wage are associated with increases in the unskilled wage; thus the skilled-unskilled wage differential must unambiguously fall. The fall in the skilled-unskilled wage ratio makes skilled labor more attractive for use in production than unskilled labor and thus the ratio of skilled to unskilled labor is increased. Similarly, the lower wage differential makes education less attractive and thus the fraction of the newly-born getting educated falls. The lower output of the educational sector plus the higher steady-state requirement of skilled labor relative to the unskilled unambiguously implies a reduction in the rate of emigration.

The only other dynamic analysis of skilled migration is by Rodriguez (1975b). It concentrates on the *differential attitudes* of individuals regarding the decisions of capital accumulation, education and migration. Rather than postulating that education is carried on by everyone up to the point where the wage differential equals the (flow-equivalent) education cost, he assumes that all those born to educated (skilled) parents will get educated *irrespective of* costs and returns (at least within the relevant range), while only a fraction of those born to uneducated parents will seek education (this fraction depending on the pecuniary rate of return to education). Similarly, migration does not necessarily close the gap between foreign and domestic wages (allowing for the migration cost) but rather the fraction of the skilled population which chooses to migrate is assumed to be a function of the rate of return to such a move. It is further assumed that investment in physical capital is a constant fraction of profits earned. On the technology side, Rodriguez assumes two sectors whose outputs are traded at a fixed international relative price, as in Bhagwati-Hamada (1974) and McCulloch-Yellen (1975), but, and in contrast to both, physical capital is used in both sectors while only one type of labor (skilled or unskilled) is used in each sector. The mobility of capital between the sectors and the fixed terms of trade imply a

¹³Denote by S , U and $P = S + U$ the skilled, unskilled and total population, respectively; by g and e the gross rate of population growth and the fraction of those just born getting education; and by m the ratio of skilled migrants to total population. Then, the growth rates in the stocks of skilled labor and total population are

$$(1/S)(dS/dt) = (eg - m)(P/S),$$

$$(1/P)(dP/dt) = g - m.$$

Since both growth rates must be equal in the steady state, the equilibrium migration rate will be given by

$$m = -g(1 - e)(S/U) + ge.$$

technologically-determined *positive* relationship between the returns to both kinds of labor. This makes the income distribution predictions of this model essentially different from those of McCulloch–Yellen (1974), where the assumptions about technology and international mobility of capital implied a *negative* relationship between the skilled and unskilled wage rates. Education is assumed to be supplied by a third sector at a constant cost and capital goods are assumed to be imported from abroad or produced in one of the two domestic sectors.

The paper analyses the stability of the model, the nature of the steady-state solution and comparative statics, proceeding then a la Bhagwati–Hamada to analyse the long-run effects of sticky real wages in the context of a Harris–Todaro (1970) labor market, while also exploring the short- and long-run effects of the implementation of a migration tax on factor rewards and unemployment.

When wages are flexible, the most distinctive result of the model is the complete independence of all steady-state factor rewards from the costs of migration or the foreign wage and thus also from a migration tax. The reason for this result can be easily shown as follows. Denote by x the fraction of those born to unskilled parents who get educated, n the growth rate of population, U and K the stocks of unskilled labor and capital, and s and r the savings ratio out of profits and the interest rate, respectively. Then, the growth rate in the stock of the unskilled population equals

$$(1/U)(dU/dt) = n(1 - x), \tag{12}$$

and the growth rate in the stock of capital is

$$(1/K)(dK/dt) = s \cdot r. \tag{13}$$

In the steady state, both these growth rates must be equalised and thus, in the steady state, we must have

$$s \cdot r = n(1 - x) \tag{14}$$

Since x depends only on the constant education cost and the skilled–unskilled wage differential which, in turn, depends only on the interest rate r , it follows that the above condition by itself determines the steady-state interest rate and, by implication, all other factor rewards as functions only of the educational costs s and n . Since none of these three variables depends in any way on the foreign wage or the migration cost, it follows that steady-state factor rewards are independent of these two variables. Notice, however, that if workers were also to save, the rate of growth of the capital stock would *also* depend on their savings ratio and the shares of the different factors in national income. Since these shares will depend on the ratios of the different factor endowments (which

are endogenous variables in the steady state), the above steady-state condition would not suffice to determine all factor rewards which will now depend also on the other parameters of the system, including the foreign wage and the migration cost.

As for the short run, Rodriguez returns to the original assumptions, showing that the steady-state independence of factor rewards from a migration tax does *not* prevail in the short run and that, following the imposition of such a tax, the returns to *both* types of labor will fall during the transitional period while the return to capital is increased.

In conclusion, Rodriguez notes for the sticky-wage variant of his model that, with this amendment, it is rather the long-run rate of unemployment that is independent from the foreign wage or the migration cost. However, in the transitional period, following an increase in the migration cost, the unemployment rate is increased; note, however, that since Rodriguez shows that the model is always unstable when there is a minimum wage for skilled labor, this result strictly applies only to unskilled wages and unskilled unemployment.

6. Concluding remarks

Clearly, the preceding review suggests that the theoretical analysis of the brain drain, once dormant after the Grubel-Scott-Berry-Soligo-Johnson phase, has received a fresh lease on life with the analysis of distortions (beginning with Bhagwati-Hamada) and of explicitly dynamic formulations (in Rodriguez). The explicit examination of policy options, in general-equilibrium formulation, is also recent: especially the Bhagwati-type surtax on migrants has been examined, for its welfare impact, in several of the recent papers.

Where can we suggest fruitful avenues for future theoretical work? The following would seem to be rewarding areas for general-equilibrium analysis:

(1) The welfare of the nonmigrants may be examined for to-and-fro migration (as noted earlier) by permitting the migrant to acquire skills, wealth, etc., during the migration to the DCs.

(2) The case of the migration accentuating distortions (e.g., through the emulation effect in Bhagwati-Hamada) may be extended to the case where migration *reduces* distortions (e.g., if a state monopsony is under-remunerating the emigrants' skills, the migration could reduce the monopsonistic power).

(3) The possibility that the migration could affect the foreign trade possibilities (i.e., the foreign offer curve) via its effect on the LDCs overall national income, and hence on its bargaining power in a world of unequal partners or via the efforts exerted by the migrants in their DCs of destination on behalf of their LDCs of origin (e.g., Greek PTK emigrants influencing the U.S. Congress in favour of Greece in matters of importance to Greece), may also be formalised.

References

- Berry, R. and R. Soligo, 1969, Some welfare aspects of international migration, *Journal of Political Economy*, 77.
- Bhagwati, J., 1971, The generalized theory of distortions and welfare, in: J. Bhagwati, R. Jones, R. Mundell and J. Vanek, eds., *Trade, balance of payments and growth* (North-Holland, Amsterdam).
- Bhagwati, J. and T.N. Srinivasan, 1969, Optimal intervention to achieve non-economic objectives, *Review of Economic Studies*, 27-38.
- Bhagwati, J. and W. Dellalgar, 1973, The brain drain and income taxation, *World Development* 1, no. 1.
- Bhagwati, J. and K. Hamada, 1974, The brain drain, international integration of markets for professionals and unemployment: A theoretical analysis, *Journal of Development Economics* 1, no. 1.
- Diamond, P.A., 1965, National debt in a neoclassical growth model, *American Economic Review* 55, December.
- Grubel, H., 1975, Evaluating the welfare effects of the brain drain from developing countries, paper presented at the Bellagio Conference on Brain Drain and Income Taxation, Bellagio, Italy.
- Grubel, H. and A. Scott, 1966, The international flow of human capital, *American Economic Review*, May.
- *Hamada, K., 1975, Efficiency, equality, income taxation and the brain drain: A second-best argument, paper presented at the Bellagio Conference on Brain Drain and Income Taxation, Bellagio, Italy.
- *Hamada, K. and J. Bhagwati, 1975, Domestic distortions, imperfect information and the brain drain, paper presented at the Bellagio Conference on Brain Drain and Income Taxation, Bellagio, Italy.
- Harris, J. and M. Todaro, 1970, Migration, unemployment and development: A two-sector analysis, *American Economic Review*, March.
- Johnson, H.G., 1965, The economics of the 'brain drain': The Canadian case, *Minerva*.
- Johnson, H.G., 1967, Some economic aspects of brain drain, *Pakistan Development Review* 3.
- Kenen, P., 1971, Migration, the terms of trade and economic welfare in the source country, in: J. Bhagwati, R. Jones, R. Mundell and J. Vanek, eds. *Trade, balance of payments and growth* (North-Holland, Amsterdam).
- McCulloch, R. and J. Yellen, 1974, Factor mobility and the steady state distribution of income, Discussion paper no. 369 (Harvard Institute of Economic Research, Cambridge, MA).
- *McCulloch, R. and J. Yellen, 1975, Consequences of a tax on the brain drain for unemployment and income inequality in LDCs, paper presented at the Bellagio Conference on Brain Drain and Income Taxation, Bellagio, Italy.
- Mishan, E.J. and L. Needleman, 1968, Immigration: Some long-term economic consequences, Part A and part B, *Economia Internazionale* 21, nos. 2 and 3.
- Rawls, J., 1971, *A theory of justice* (Harvard University Press, Cambridge, MA).
- Rodriguez, C., 1975a, On the welfare aspects of international migration, *Journal of Political Economy*, forthcoming.
- *Rodriguez, C., 1975b, Brain drain and economic growth: A dynamic model, paper presented at the Bellagio Conference on Brain Drain and Income Taxation, Bellagio, Italy.
- Samuelson, P.A., 1958, An exact consumption-loan model of interest with or without the social contrivance of money, *Journal of Political Economy*, December.
- Sjaastad, L., 1962, The costs and returns of human migration, *Journal of Political Economy*, October (supplement).
- Tobin, J., 1974, Notes on the economic theory of expulsion and expropriation, *Journal of Development Economics* 1, no. 1.
- UNCTAD, 1974, The reverse transfer of technology: Economic effects of the outflow of trained personnel from developing countries (brain drain), Trade and Development Board, Intergovernmental group on transfer of technology, Third session, Geneva, July 15.

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