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# SKILLS AND THE PATTERN OF INTERNATIONAL MIGRATION

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## Abstract

This paper develops a simple two-country model of international migration. By distinguishing individuals in terms of their ability and age, the model enables us to examine not only the equilibrium flow of migrants and the pattern of factor rewards in the two economies, but also the factors which determine the skill and age profile of those who migrate. In addition, the effects of both qualitative and quantitative restrictions on immigration are analysed within a general-equilibrium framework. The role of an emigration tax and how it interacts with the immigration policy of the labor-importing country is also considered.

## I. Introduction

International migration has played a crucial role in determining the path of social and economic development throughout the world. Although non-economic factors often exert an important influence on an individual's decision to migrate, it is widely agreed that the economic motivation for moving from one location to another has historically been the dominant one. Just as centuries ago people migrated from one piece of land to another which was more fertile, individuals in the modern world tend to move internationally in order to improve their economic well-being when other factors of production possess a lower degree of international mobility.

The present paper attempts to study this phenomenon in the context of a model which highlights one feature of international migration that has been of particular concern to the countries of emigration. These countries find that it is often their most capable citizens who seek employment abroad. Moreover, while some individuals migrate during the early phase of their working life, others decide to move only after having accumulated a substantial amount of work experience. In order to deal with these aspects of international migration, our model distinguishes individuals in terms of their ability and age. This enables us to analyse not only the equilibrium flow of migrants and the distribution of income in the involved countries, but also the factors which determine the age and skill profile of those who migrate. It is the primary concern with this second issue which distinguishes the present paper from other contributions to the literature on the "brain-drain" problem.[1]

Another objective of the paper is to study the role of impediments to international labor mobility in the context of a two-country model. Both qualitative and quantitative restrictions on immigration are explic-

itly introduced into the analysis. The effects of such restrictions on the size and the composition of the migrant labor force, as well as on the pattern of factor rewards in the two economies, are examined in a general-equilibrium setting. The role of an emigration tax is also considered, with particular emphasis on the welfare implications of such a tax in the presence of alternative immigration policies in the labor-importing country.

The remainder of the paper is organized as follows: Section II develops the structure of a simple two-country model. Section III opens the two economies to international migration. Section IV studies the long-run effects of changes in certain parameters of the model on the allocation of labor between the two countries. It is designed to acquaint the reader with the workings of the model before proceeding to the more complex problems involving immigration and emigration policies. These policies are the subject of Section V, which explores the relationship between barriers to international labor mobility on the one hand, and the pattern of migration and income distribution on the other. Finally, Section VI offers some concluding remarks and suggestions for further research.

## II. The Model

The analysis of this paper is conducted within a two-country model of international migration. Let us call the two countries Evropa (E) and Mediterrania (M), and assume that wages in country E are higher than those in M. In addition, suppose that E and M are small in relation to the rest of the world which, in turn, consists of two types of countries: those to which workers would like to migrate (because wages are higher than in E) and those which workers would like to leave (because wages are lower

than in M). Without being overly unrealistic, I assume that immigration into the former and emigration out of the latter set of countries is prohibited. Moreover, in order to sharpen the focus of our analysis on the problem of international labor mobility, I initially assume that physical capital is immobile internationally. Later in the paper, I consider the case in which capital is perfectly mobile between the rest of the world and E, although the possibility of capital flowing into M continues to be ruled out.[2]

In order to simplify the analysis even further, the dynamic problems involving capital accumulation and population growth are not addressed in the paper. Instead, it is assumed that countries E and M are endowed with fixed stocks of physical capital, $K_e$ and $K_m$, and that during each unit of time a constant number of individuals is born in each economy, $N_e$ and $N_m$, respectively. Moreover, every individual works for a period consisting of $T - \Theta$ units of time, where $T$ is the retirement age and $\Theta$ the minimum working age in both countries.

Let us turn our attention to country M. In the spirit of Atkinson (1973) and Bhagwati and Hamada (1982), assume that each newborn individual differs from other members of his age group in his capacity to develop productive skills. In addition, suppose that $N_m$ is sufficiently large so that, as an approximation, we may treat every age group as a continuum of individuals. Using an approach similar to that of Grossman (1983), let us index each individual by $i \in [0, 1]$, such that his capacity to acquire skills, measured by a continuous function $s(i)$, is increasing in $i$. Also assume that each generation is an exact replica of the previous one so that the distribution of aptitudes for skill formation within the population is constant over time.

In what follows, skills are viewed as experience (accumulated in school, at work, as well as in everyday life) which makes an individual more productive. Furthermore, unlike some of the other authors who have written on the problem of human capital and labor mobility,[3] I assume that an individual's productivity is fully retained even if he moves between countries and industries. The amount of this general skill accumulated by individual $i$ at the age of $t$ is assumed equal to

$$Q(i,t) = s(i)q(t), \tag{1}$$

where $q'(t) > 0$ and $q''(t) < 0$. Since one individual of type $i$ is born during each unit of time, there exist at any instant $T - \Theta$ such workers, each of a different age. In the absence of international labor mobility the total quantity of productive skill available to firms in $M$, or what we shall call the <u>efficiency</u>-labor endowment of that country, can then be expressed as

$$L_m = N_m \int_0^1 \int_\Theta^T s(i)q(t)dt\, di. \tag{2}$$

Similarly, let $L_e$ denote the <u>efficiency</u>-labor endowment of country $E$ in the absence of international migration.

For simplicity, I assume that each economy produces a single commodity. $E$ specializes in the production of $X$; $M$ specializes in the production of $Y$. Output in both countries is produced competitively with the aid of capital and efficiency labor according to constant returns to scale production functions with the usual properties (i.e., the marginal productivity of each factor is positive but diminishing and increased utilization of one factor raises the marginal productivity of the other). Denoting by $x$ and $y$ the

levels of output per unit of efficiency labor in E and M respectively, we may express the production functions of the two countries in their intensive form as

$$x = u(k_e), \tag{3}$$

$$y = v(k_m), \tag{4}$$

where $k_e = K_e/L_e$ and $k_m = K_m/L_m$. The real wage (measured in terms of good Y) received by workers in E and M per unit of efficiency labor is given by

$$w_e(k_e,p) = p[u(k_e) - k_e u'(k_e)], \tag{5}$$

$$w_m(k_m) = v(k_m) - k_m v'(k_m), \tag{6}$$

respectively, where p is the relative price of X in terms of Y. By the small-country assumption, this relative price is exogenous to the model. In order to set the stage for international migration, let us suppose that $w_e(k_e,p) > w_m(k_m)$. Moreover, assume that the international wage differential is sufficiently large relative to the cost of migration to induce at least some citizens of M to seek employment in E.

## III. International Migration

In analysing the pattern of migration from M to E, we shall use a number of simplifying assumptions. First, let us suppose that all individuals who migrate from M to E continue to work in E until their retirement age of T. Second, assume that the migrants in country E receive the same wage per unit of efficiency labor as do the native workers.[4] Finally, although on-the-job discrimination against the migrants is ruled out, it is assumed that they are subject to discrimination at the time of

entry into country E. In particular, let us suppose that citizens of M are required to have at least $\overline{Q}$ units of skill in order to qualify for work in E. Such qualitative limitations on immigration are often used by countries in an attempt to prevent all but the most productive foreign workers (or those with particular skills which are in short supply) from joining the economy's labor force. This and the next section of the paper treat the minimum-skill requirement $\overline{Q}$ as exogenous. Section V examines the more interesting case in which $\overline{Q}$ is adjusted, as necessary, in order to maintain the quantity of migrant labor in country E at a certain desired level.

Since each member of any given age group in M has a different aptitude for skill formation, each of them will have attained the level of skill $\overline{Q}$ at a different point in life. By setting $s(i)q(t) = \overline{Q}$ in (1), we obtain an inverse relationship between i and the age $\alpha$ at which individual i becomes qualified for work in E.

$$\alpha = \psi(i,\overline{Q}), \quad \psi_1 < 0, \quad \psi_2 > 0. \tag{7}$$

This is depicted by the $\overline{Q}\overline{Q}$ schedule in figure 1. We observe in the figure that citizens of M indexed by $i \geq i'$ become qualified for work in E at various stages of their working life. However, those with an index lower than i' never qualify for work abroad.

The problem faced by every citizen of M who qualifies for work in E is whether or not to migrate. Clearly, that decision must be made on the basis of a cost-benefit comparison. It is generally agreed that the costs of moving to work in another country tend to rise with the age $\tau$ of the moving individual. For simplicity, I assume that for each migrant these costs (including the present value of any costs incurred in the future) consist of a fixed component $\overline{c}$ and another component $c(\tau)$ which is intended

to reflect both the psychic and economic costs of moving to a new environment. Thus, the moving costs of each individual are given by

$$c = \bar{c} + c(\tau), \quad c'(\tau) > 0. \tag{8}$$

As for the benefits from moving to E, I assume that they are equal to the difference between the present value of an individual's income stream in E and that in M. In a stationary equilibrium, the gain for individual i from moving at the age $\tau$ may then be expressed as

$$(\tilde{w}_e - \tilde{w}_m)s(i) \int_{\tau}^{T} q(t)e^{-\delta(t-\tau)}dt = \beta(i, \tau, \tilde{w}_e, \tilde{w}_m, \delta), \tag{9}$$

where $\tilde{w}_e$ and $\tilde{w}_m$ are the steady-state wage rates prevailing in the two countries in the presence of migration and $\delta$ is the (constant) rate of discount applied by citizens of M in evaluating the present value of future benefits.[5] Thus, for individual i, the net benefits from moving at the age $\tau$ are given by

$$\nu(i, \tau, \tilde{w}_e, \tilde{w}_m, \delta, \bar{c}) = (\tilde{w}_e - \tilde{w}_m)s(i) \int_{\tau}^{T} q(t)e^{-\delta(t-\tau)}dt - \bar{c} - c(\tau). \tag{10}$$

It can easily be verified that $\nu(\cdot)$ is an increasing function of i and $\tilde{w}_e$, and a decreasing function of $\tilde{w}_m$, $\delta$, and $\bar{c}$. Moreover, I assume that $\partial\nu(\cdot)/\partial\tau = \delta\beta(i, \tau, \tilde{w}_e, \tilde{w}_m, \delta) - (\tilde{w}_e - \tilde{w}_m)s(i)q(\tau) - c'(\tau) < 0$ for all values of $\tau$ for which $\nu(\cdot) \geq 0$. In other words, I assume that no migrant would ever find it in his interest to postpone his departure for E to a later date. The moving age $\tau$ of each migrant must then be the same as his qual-

ifying age $\alpha$. Thus,

$$\tau = \psi(i,\bar{Q}). \tag{11}$$

Let $i^*$ correspond to the index of the individual who is the oldest at the time of migration. Since each migrant moves as soon as he qualifies for work abroad, the individual indexed by $i^*$ must also be the one with the lowest aptitude for skill formation among the citizens of $M$ employed in $E$. For any given values of $i^*$ and $\bar{Q}$, it is possible to solve for the stationary stock of migrant labor residing in country $E$. To determine the magnitude of this stock we note the following: if it pays for individual $i^*$ to migrate at the age of $\psi(i^*,\bar{Q})$, it must be the case that all individuals indexed by $i > i^*$ (who attain $\bar{Q}$ units of skill at a still earlier age) benefit even more from migration. Their lower moving age and higher productivity at each age magnifies the benefits from moving in relation to the costs, given the wage differential between $E$ and $M$. Consequently, each individual indexed by $i \geq i^*$ will migrate at his corresponding moving age $\tau = \psi(i,\bar{Q})$. Since there is a total of $T - \psi(i,\bar{Q})$ migrants of type $i$, each of a different age, country $E$'s stock of foreign labor, measured in efficiency units, may be expressed as

$$N_m \int_{i^*}^{1} \int_{\psi(i,\bar{Q})}^{T} s(i)q(t)dt\,di = \mu(i^*; \bar{Q}), \quad \mu_1 < 0, \quad \mu_2 < 0. \tag{12}$$

The efficiency-labor endowments of $E$ and $M$ in the presence of migration become $\tilde{L}_e$ and $\tilde{L}_m$, where

$$\tilde{L}_e = L_e + \mu(i^*; \bar{Q}), \quad \text{and} \tag{13}$$

$$\tilde{L}_m = L_m - \mu(i^*; \bar{Q}). \tag{14}$$

Because these endowments are functions of $i^*$ and $\overline{Q}$, so must be the wages per unit of efficienty labor in both countries. We may express the equilibrium wage rates of $E$ and $M$ in the presence of migration as

$$\tilde{w}_e = f(i^*; \overline{Q}, K_e, p), \quad f_1, f_2, f_3, f_4 > 0, \tag{15}$$

$$\tilde{w}_m = g(i^*; \overline{Q}, K_m), \quad g_1, g_2 < 0, \quad g_3 > 0. \tag{16}$$

After substituting (15)-(16) into (10) we are in a position to raise the following question: For an arbitrarily-chosen value of $i^*$ (and the given values of the exogenous variables), what is the precise moving age which makes this hypothetical marginal migrant indifferent between moving to $E$ and remaining in $M$? That value of $\tau$, call it $\tau^*$, must satisfy the following equation:

$$[f(i^*; \overline{Q}, K_e, p) - g(i^*; \overline{Q}, K_m)]s(i^*) \int_{\tau^*}^{T} q(t)e^{-\delta(t-\tau^*)}dt - \overline{c} - c(\tau^*) = 0. \tag{17}$$

That is, the net benefit from moving must be equal to zero for the marginal migrant. We observe that the higher the arbitrarily-chosen value of $i^*$, the greater the wage differential in favor of country $E$, as well as the productivity at each age of the marginal migrant. Both factors tend to increase his benefits from migration. For the net benefits to remain equal to zero, his moving age must be higher. Thus, there exists a positive relationship between the index of the marginal migrant and the age at which he is just indifferent between moving to $E$ and remaining in $M$. This relationship is

depicted in figure 1 by the CB schedule. The point of intersection between the schedules CB and $\overline{Q}\overline{Q}$ determines the index $i^*$ of the marginal migrant and his moving age $\tau^*$. All citizens of M indexed by $i > i^*$ also migrate as soon as they qualify for work in E. Their qualifying age can be read off the $\overline{Q}\overline{Q}$ schedule. Consequently, each point covered by the shaded area in figure 1 describes one of the migrants. Individuals indexed by $i < i^*$ either never qualify for work abroad, or qualify only after it no longer pays for them to migrate.[6]

## IV. Comparative Statics

This section examines the long-run effects of changes in certain parameters of the model on the pattern of migration between the two countries.[7] We begin by considering the effects of an increase in the relative price of X, the good produced in country E. For given values of $i^*$ and $\overline{Q}$, an increase in p raises $\tilde{w}_e$ in the same proportion. This widens the gap between the wage rates of the two countries and increases the age $\tau^*$ at which the marginal migrant, indexed by $i^*$, is indifferent between moving to E and continuing to work in M. The rise in the value of $\tau^*$, for each hypothetical $i^*$, shifts the CB schedule to C'B' in figure 2. In the new steady state, represented by point Z, the equilibrium value of $i^*$ is lower and the marginal migrant's moving age higher than at the old equilibrium point A.

Because an increase in p lowers $i^*$ (without affecting the moving age of those who would have migrated in the absence of a rise in p), it must be the case that the number of migrants, as well as the efficiency stock of foreign labor residing in country E, is higher in the

new steady state. Moreover, the newly-induced migration involves individuals with a higher moving age and less skill at any given age relative to those who migrated when the equilibrium was at A. As a result, the average migrant is now less skilled and older. The fall in the stationary value of $i^*$ and the rise in that of $\tau^*$ also imply that the average remaining resident of M is now less skilled and younger.

The greater outflow of labor from M increases $\tilde{w}_m$. However, the rise in $\tilde{w}_e$ must be even larger in spite of the increase in migration. This can easily be ascertained by recalling that the index $i^*$ of the marginal migrant is lower and his moving age $\tau^*$ higher in the new steady state. As was argued in Section III, a <u>larger</u> wage differential is required in order to induce an individual with a <u>lower</u> aptitude for skill formation to migrate at an <u>older</u> age.

Consider next the effects of an increase in the cost of migration due, for example, to the imposition of a head tax that a migrating individual must pay to the government of M (i.e., an increase in $\bar{c}$). This shifts the CB schedule to the left. That is, for any given $i^*$, the marginal migrant must be younger at the time of migration so as to reduce his moving costs in relation to the benefits to the point where the net benefits are once again equal to zero.

Let us suppose that this leftward shift of the CB schedule moves the stationary equilibrium point from Z to A in figure 2. It immediately follows that the qualitative effects of an increase in the cost of migration on the stationary stock of migrant labor, as well as on the age and skill profile of those who migrate, are exactly the opposite of those resulting from an increase in p. With respect to wage-rate effects, however, the two disturbances are not symmetrical. The increase in $\bar{c}$

reduces the stock of migrant labor, lowering $\tilde{L}_e$ and raising $\tilde{L}_m$. This moves $\tilde{w}_e$ and $\tilde{w}_m$ in opposite directions. On the other hand, as we have seen earlier, a change in $p$ moves both wage rates in the same direction. Nonetheless, both an increase in $p$ and an increase in $\bar{c}$ widen the international wage differential. This is in spite of the fact that in the former case the flow of migrants increases and in the latter it declines.

The effects of an increase in the physical capital endowment of country $E$ on the pattern of migration are qualitatively the same as those of an increase in $p$. The only difference is that in the former case $\tilde{r}_e$, the rental rate on capital of country $E$ declines, while in the latter case it rises. Alternatively, an increase in $K_m$ raises the equilibrium value of $i^*$, lowers that of $\tau^*$, and narrows the wage differential between the two countries by raising $\tilde{w}_m$ more than $\tilde{w}_e$.

Let us finally consider the effects of a reduction in $\bar{Q}$, the minimum-skill requirement. This makes it possible for citizens of $M$ to qualify for work abroad at a lower age, shifting the $\bar{Q}\bar{Q}$ schedule to the left to $\bar{Q}'\bar{Q}'$ in figure 3. The reduction in the qualifying age of the individual indexed by $i_o^*$ (who <u>was</u> the marginal migrant), as well as that of his fellow countrymen indexed by $i > i_o^*$, enables all of them to migrate earlier in life and work abroad for a longer period of time. As a result, the efficiency stock of migrant labor residing in $E$ increases for any given value of $i^*$. Thus, as stated in (15)-(16), corresponding to each $i^*$, the value of $\tilde{w}_e$ must now be lower and that of $\tilde{w}_m$ higher. This narrowing of the international wage differential lowers the moving age at which any hypothetical marginal migrant is indifferent between moving to $E$ and remaining in $M$. Consequently, the $CB$ schedule also shifts to the left.

The equilibrium value of $\tau^*$ must therefore be lower in the new steady state. However, since the leftward shift of the CB schedule may be either greater or smaller than that of the $\bar{Q}\bar{Q}$ locus, the stationary value of $i^*$ may either rise or fall.[8] In figure 3, the two possibilities correspond to the new equilibria at points Z" and Z', respectively.

It is interesting to observe that if the equilibrium moves to Z", a reduction in $\bar{Q}$ entails an improvement in the "quality" of the migrant labor force in the following sense: migrants who were the least promising before the cut in $\bar{Q}$ no longer find it in their interest to seek employment in E. It is not difficult to understand this seemingly paradoxical result. By allowing each of the relatively more promising migrants to work in E for a longer period of time, a reduction in $\bar{Q}$ increases the number of such migrants residing in E at each instant. This raises the amount of efficiency labor supplied by such migrants and, by lowering $\tilde{w}_e - \tilde{w}_m$, makes migration unattractive for some of their less promising countrymen (i.e., those indexed by $i \in [i_0^*, i_1^*]$ in figure 3). This in turn implies that the "quality" of country M's labor force also improves in the sense that the most promising of the remaining residents is now more productive at each age than before the reduction in $\bar{Q}$. Alternatively, if the steady state moves to Z', we observe the opposite effects on the quality of the labor force in both countries.

It can also be shown that, regardless of whether the stationary value of $i^*$ rises or falls, a reduction in $\bar{Q}$ narrows the wage differential between the two economies.[9] This in turn implies that $\mu$, the efficiency stock of migrant labor residing in country E, must be higher in the new steady state (i.e., $d\mu/d\bar{Q} = \mu_1(di^*/d\bar{Q}) + \mu_2 < 0$).

However, it is possible for this increase in $\mu$ to be accompanied by a decline in the gross flow of migrants. If the new equilibrium point is at $Z''$, this flow declines from $N_m(1 - i_0^*)$ to $N_m(1 - i_{1''}^*)$. Hence, by reducing the minimum-skill requirement, country $E$ may actually improve the quality of its migrant labor force and at the same time reduce the gross flow of migrants. Alternatively, if the new equilibrium moves to $Z'$, the gross flow of migrants rises from $N_m(1 - i_0^*)$ to $N_m(1 - i_{1'}^*)$.

## V. The Role of Immigration and Emigration Restrictions

It has been demonstrated by Bhagwati and Srinivasan (1983) that, in the absence of a discriminatory tax on migrant labor, income maximization for citizens of $E$ requires a policy of unrestricted immigration. However, given the relationship between the stock of migrant labor and the distribution of income in that economy, it seems reasonable to assume that the lobbying activities of the native workers would give rise to at least some quantitative restrictions on immigration. In our analysis up to this point, the presence of a binding $\overline{Q}$ reflects the existence of a qualitative restriction which also limits (implicitly) the quantity of migrant labor in $E$.

The purpose of the present section is to relax the assumption that $\overline{Q}$ is fixed, treating it instead as an immigration-policy instrument which is always set at the level that gives rise to a certain desired stock of migrant labor. Let this stock be measured in efficiency units and denoted by $\overline{\mu}$. In general $\overline{\mu}$ would not be constant, but rather a function of the

degree of labor scarcity, as well as of the amount of influence that each of the concerned factions has in the political process which determines country E's immigration policy. For simplicity, I assume that

$$\bar{\mu} = \bar{\mu}(p, K_e), \quad \bar{\mu}_1 \gtrless 0, \quad \bar{\mu}_2 > 0. \tag{18}$$

Thus, in response to an increase in p, country E may wish to contract ($\bar{\mu}_1 < 0$) or expand ($\bar{\mu}_1 > 0$) its endowment of migrant labor, depending on whether the workers or the owners of capital have a greater say in how the economy's gains from a terms-of-trade improvement are to be divided between them. In the borderline case of $\bar{\mu}_1 = 0$, immigration policy may be called "conservative" in the sense that it keeps the wage-rental ratio in country E constant. Turning to the effects of an increase in the economy's capital stock, it presumably leads to a less restrictive immigration policy (i.e., $\bar{\mu}_2 > 0$). However, the exact magnitude of $\bar{\mu}_2$ depends, once again, on the outcome of the bargaining process in which the various concerned factions participate.[10] In the case of the "conservative" immigration policy, $\bar{\mu}_2 = \tilde{L}_e/K_e$, so that wages and rentals in country E remain constant along a path of capital accumulation. Because such a policy does not lower the welfare of any major interest group, it has considerable practical significance and will be treated accordingly in the discussion below.

Changes in the Terms of Trade and the Pattern of Migration

Let us begin by examining the effects of a change in p on the pattern of migration in this new setting where $\bar{Q}$ is endogenously determined. We have seen in the previous section that for a given $\bar{Q}$, an increase in

p raises country E's stock of migrant labor measured in efficiency units. The magnitude of this increase is $\mu_1 \, di^*/dp$, where $\mu_1 < 0$, as defined in (12), and $di^*/dp < 0$, as stated in the Appendix. If $\mu_1 \, di^*/dp > \bar{\mu}_1$, then $\bar{Q}$ must be raised in order to prevent what is deemed to be an excessive inflow of migrant labor. The consequences of this increase in $\bar{Q}$ on the pattern of migration have already been analysed in the previous section. Alternatively, if $\mu_1 \, di^*/dp < \bar{\mu}_1$ (as when the owners of capital have an overwhelming influence over immigration policy), an increase in p is accompanied by a reduction in $\bar{Q}$, resulting in a further increase in $\mu$.[11]

Although it might be interesting to examine the effects of a change in p under alternative assumptions about $\bar{\mu}_1$, the analysis below is limited to the case of the "conservative" policy response (i.e., $\bar{\mu}_1 = 0$). As we have seen, this policy requires an increase in $\bar{Q}$ which insulates $\mu$ from the effects of a rise in p. However, even though $\mu$ remains fixed, the <u>composition</u> of the migrant labor force is altered.

We recall that an increase in p shifts the CB schedule to the right and that an increase in $\bar{Q}$ shifts both the CB and the $\overline{QQ}$ schedules to the right. Consequently, $\tau^*$ must be higher in the new steady state. Moreover, if $\mu$ is to remain unchanged, equation (12) implies

that an increase in $\bar{Q}$ must be accompanied by a fall in $i^*$. Thus, under the "conservative" immigration policy, an increase in $p$ raises the age and the skill level of the average migrant. Along with the fact that $\mu$ is held constant, this implies that the number of migrants residing in country $E$ declines. Alternatively, under the constant-$\bar{Q}$ policy, we have seen that the number of migrants rises with $p$, as does the average migrant's age, although his skill level declines.

Effects of Capital Accumulation

Consider next the effects of an increase in $K_e$ in the presence of the "conservative" immigration policy. Since the object of this policy is to keep $\tilde{w}_e/\tilde{r}_e$ constant, it calls for an increase in $\tilde{L}_e$ which is proportional to that of $K_e$ (i.e., $\bar{\mu}_2 = \tilde{L}_e/K_e$). Recalling that an increase in $K_e$ raises $\tilde{w}_e$ and lowers $\tilde{r}_e$ when $\bar{Q}$ is fixed, it immediately follows that the "conservative" immigration policy entails a relatively larger increase in $\mu$, and thus a reduction in $\bar{Q}$.

By holding $\tilde{w}_e$ and $\tilde{r}_e$ constant, this policy deprives the native workers in $E$ of any benefits from growth. At the same time, all workers who are citizens of $M$ are made better off. To see that each of them does in fact gain, it is useful to divide the citizens of $M$ into three groups: 1) those who remain employed in $M$ throughout their working life, 2) those who would have migrated to $E$ even in the absence of a rise in $K_e$ and the associated decline in $\bar{Q}$, and 3) those for whom migration becomes attractive only after the rise in $K_e$ and the fall in $\bar{Q}$. Clearly, each member of group 1 benefits as $\tilde{w}_m$ rises in response to a larger outflow of labor from country $M$. All members of group 2 also benefit because the reduction in $\bar{Q}$ permits them to migrate earlier in

life, raising the present value of their net lifetime income. Finally, all members of group 3 necessarily gain even more than those of group 1 since they have chosen to leave group 1 and become members of group 3.[12]

It is also interesting to consider the effects of capital accumulation in country M. If $\bar{Q}$ is held constant, an increase in $K_m$ tends to draw labor towards country M. Alternatively, under the "conservative" immigration policy, any tendency for $\mu$ to fall is offset by a reduction in $\bar{Q}$ in order to keep $\tilde{w}_e$ and $\tilde{r}_e$ constant. However, even though $\tilde{w}_e$ is unchanged, both the migrants and the workers who remain in M benefit from an increase in $K_m$. The migrants benefit because the reduction in $\bar{Q}$ enables them to migrate earlier in life, while the workers who remain in M benefit from an increase in $\tilde{w}_m$. Interestingly, in the presence of the "conservative" immigration policy in country E, the only workers not to benefit from capital accumulation in either of the two economies are the native workers of country E.

The Policy of Taxing Emigration

The effects of an emigration tax for a given value of $\bar{Q}$ have been examined in Section IV. Because country M has monopoly power in the international market for labor services, it can use such a tax to limit migration and thereby improve the welfare of its citizens. Let us suppose that the emigration tax is in the form of an exit tax amounting to $\varepsilon$ units of good Y. Assume further that the policy objective is to maximize the excess of income of citizens of M (including the migrants) over the cost of exporting labor to country E. Moreover, the proceeds of the tax are evenly redistributed to all citizens of M in form of a lump-sum transfer.

In the absence of moving costs, the solution to this problem is well-known. The emigration tax must be set at the level which maintains

equality between the wage in M and the marginal revenue from labor exports, $\tilde{w}_e + (\partial \tilde{w}_e/\partial \mu)\mu$. However, if the process of moving labor internationally absorbs resources, emigration should be restricted to the point where

$$\tilde{w}_m + MCM = \tilde{w}_e + (\partial \tilde{w}_e/\partial \mu)\mu. \tag{18}$$

The term MCM represents the marginal cost of moving a unit of efficiency labor from M to E. In the present model

$$MCM = \frac{\bar{c} + c(\tau^*) - \varepsilon}{\int_{\tau^*}^{T} s(i^*)q(t)e^{-\delta(t-\tau^*)}dt} = \gamma(\mu, \bar{Q}), \quad \gamma_1, \gamma_2 > 0. \tag{19}$$

It can be shown that both partial derivatives of $\gamma(\cdot,\cdot)$ are positive. For a given $\bar{Q}$, the higher is $\mu$, the lower must be the value of $i^*$ and the higher that of $\tau^*$. Because a fall in $i^*$ raises MCM, as does an increase in $\tau^*$, it follows that $\gamma_1 > 0$. Similarly, if $\mu$ is to remain constant, a rise in $\bar{Q}$ must be accompanied by a decline in $i^*$ and an increase in $\tau^*$. Consequently, $\gamma_2$ is also positive. Observe, in addition, that $\tilde{w}_m$ is increasing in $\mu$, while $\tilde{w}_e$ is inversely related to $\mu$.

These relationships are depicted in figure 4. Along the horizontal axis, the length of which represents country M's efficiency-labor endowment in the absence of migration, the distance from the origin O' measures $\tilde{L}_m$ and the distance from the origin O measures $\mu$. For a given value of $\bar{Q}$, say $\bar{Q}_o$, the optimal labor-export policy for country M is to limit the stock of migrant labor to $\mu^*$, the level of $\mu$ corresponding to the point of intersection between its marginal revenue and marginal cost schedules in the international market for labor services. These schedules are labelled $\tilde{w}_e(\mu) + (\partial \tilde{w}_e/\partial \mu)\mu$ and $\tilde{w}_m(\mu) + \gamma(\mu, \bar{Q}_o)$, respectively. The gain from in-

ternational migration for citizens of M is then given by the area EBRJ and for citizens of E by the area ABE. The international wage differential is represented by the distance EI.

In the absence of an emigration tax, and with $\overline{Q}$ set at $\overline{Q}_o$, the equilibrium value of $\mu$ is determined by the point of intersection between the <u>average</u> revenue schedule, $\tilde{w}_e(\mu)$, and the marginal cost schedule, $\tilde{w}_m(\mu) + \gamma(\mu, \overline{Q}_o)$. The gain from migration for citizens of M is then somewhat smaller (GDJ) and for those of E greater (ADG). The international wage differential is narrower (DU) and the stock of migrant labor larger ($\mu_o$).

Consider next the case in which country E uses $\overline{Q}$ as an instrument in order to maintain a certain desired stock of migrant labor, say $\mu_o$. Assuming that the two countries are initially in equilibrium at point D (where $\varepsilon = 0$, $\overline{Q} = \overline{Q}_o$, and $\mu = \mu_o$), how would a small increase in $\varepsilon$ affect the welfare of the citizens of M? We have seen that an emigration tax tends to reduce $\mu$; thus, if country E is to keep $\mu = \mu_o$, it must respond to an increase in $\varepsilon$ by lowering $\overline{Q}$. The decline in $\overline{Q}$ reduces the marginal cost of moving a unit of efficiency labor from M to E at each value of $\mu$, shifting the $\tilde{w}_m(\mu) + \gamma(\mu,\overline{Q})$ schedule down and to the right. As $\varepsilon$ is raised further, corresponding reductions in $\overline{Q}$ eventually lower the minimum-skill requirement to the level where it is no longer binding. At that point the schedule representing the marginal cost of supplying migrant labor is given by the curve $\tilde{w}_m(\mu) + MCM_{min}$. Along this curve the cost of moving is minimized for any given value of $\mu$. That is, each migrant moves at the age $\Theta$, as in the absence of a minimum-skill requirement. The gain for country M from forcing E to eliminate its qualitative restrictions on immigration by using $\varepsilon$ in this manner is given by the area JDTK.

Further increases in $\varepsilon$ enable M to attain an even higher level of welfare. If the stock of migrant labor is limited to $\mu^{**}$ units, as required by the optimal labor-export policy in the absence of immigration restrictions in country E, the gain for country M from the opportunity to export labor is given by the area FCSK. This exceeds the gain of EBRJ which is attainable under the optimal labor-export policy when the minimum-skill requirement in country E is maintained at $\overline{Q} = \overline{Q}_o$. Moreover, the gains from trade in labor services for country E are also larger in the absence of qualitative restrictions on immigration. That this is true regardless of whether country M follows the optimal labor-export policy or one of unimpeded emigration can easily be seen in figure 4.

Thus, qualitative restrictions on immigration lower the (potential) welfare of both countries. For citizens of the labor-exporting country, such impediments raise the cost of supplying any given stock of efficiency labor to the importing country; for the citizens of the importing country, they reduce the gains from trade in labor services relative to those attainable in the absence of immigration restrictions.

## VI. Conclusions

An attempt was made in this paper to focus on certain aspects of international migration which have largely been neglected in the literature. First, by distinguishing individuals in terms of their ability and age, we were able to analyse not only the equilibrium flow of migrants between the two economies, but also the composition of the migrant labor force. Secondly, both qualitative and quantitative restrictions on immigration were modelled explicitly. This enabled us to study the effects of parametric changes on the distribution of income and the pattern of migration in the presence of alternative immigration policies in the labor-importing

country. Finally, given the nature of such limitations on immigration, the role of emigration restrictions was examined.

A number of interesting results were obtained. For example, it was shown that, by relaxing qualitative restrictions on immigration (i.e., by lowering the minimum-skill requirement that must be met by migrant workers), the labor-importing country may in fact improve the quality of its labor force and also reduce the gross flow of migrants. It was also shown that the effects of changes in the terms of trade on the pattern of migration and income distribution differ substantially depending on whether the labor-importing country's immigration policy limits only the quality, or both the quality and the quantity of migrant labor permitted to work within its borders. Similar results were obtained with respect to changes in the capital endowments of the two economies. Finally, when qualitative restrictions on immigration are used as an instrument of the labor-importing country to attain a certain desired stock of migrant labor, imposition of an emigration tax by the labor-exporting country was seen to improve the welfare of its citizens by reducing the cost of exporting any given stock of migrant labor. Furthermore, restrictions on emigration also enable the labor-exporting country to exercise its monopoly power in the international market for labor services. However, the level of welfare enjoyed by the citizens of both economies in the presence of an optimal labor-export policy (as well as in the absence of an emigration tax) was shown to be a decreasing function of the degree to which the labor-importing country limits immigration through the use of qualitative restrictions.

In an attempt to simplify the analysis, a number of problems associated with international labor mobility have been left untouched. Among them is that of analysing the links between the pattern of migration and the rates of capital accumulation and technological progress in the

two economies within a dynamic framework. It would also be interesting to relax the full-employment assumption and allow, in addition to the international wage differential, the unemployment rates of the two economies to play an important role in the decision to migrate. Another possibility is to study the interaction between emigration and immigration policies of the two countries within a game-theoretic framework. Of related interest is the problem of analysing the political-economy aspects of immigration and emigration restrictions within each of the two economies.

## Footnotes

* I wish to thank the participants in a workshop at Columbia University, and Jagdish Bhagwati in particular, for helpful suggestions and comments on an earlier draft of this paper. I would also like to thank Richard Arnott, Russell Davidson, Frank Lewis, and Bentley MacLeod for helpful comments. Any remaining errors are my responsibility.

1. Many important contributions to the literature on the brain drain have been collected in Bhagwati (1976) and Bhagwati and Partington (1976). See also Grubel and Scott (1966), Johnson (1967) and Kwok and Leland (1982). A very useful survey of the theoretical work in this area has been provided by Bhagwati and Rodriguez (1975).

2. There are several justifications for this latter assumption. One possible barrier to capital flows into M may be the relatively greater degree of political uncertainty in M. In addition, the belief that the presence of foreign capital in the economy may eventually result in the loss of national independence has even led to the erection of legal barriers to international capital flows in some labor-exporting countries.

3. See,e.g., Diamond (1982) and Grossman and Shapiro (1982).

4. In Germany, for example, employers are required to pay to the migrants the same wages and benefits which are offered to the native Germans (see Bhagwati, Schatz and Wong [1983] and Mehländer [1980]).

5. Assuming, instead, that $\delta$ is equal to the rate of return on capital in M (which is an endogenous variable) would not alter the main results of the paper. Holding $\delta$ constant simplifies the exposition and enables us to bring into sharp focus the interaction among variables which are, in my view, more fundamental to the problem of migration.

6. Up to this point we have assumed that capital is internationally immobile. If capital is instead perfectly mobile between the rest of the world and $E$, the rate of return in $E$ is fixed at the world level and $\tilde{w}_e$ is determined independently of $\tilde{L}_e$ by the price-equals-unit-cost relationship. Thus, the link between $\tilde{w}_e$ and $i^*$ is cut. This rotates the $CB$ schedule in figure 1 counter-clockwise around point B. Other than that, the analysis is the same as under the assumption of capital immobility, which is retained in the remainder of the paper.

7. For a summary of the results, see the Appendix.

8. In the neighborhood of the steady state, the leftward shift of the $\overline{Q}\,\overline{Q}$ schedule is given by $\partial\tau^*/\partial\overline{Q} = q(\tau^*)/q'(\tau^*)\overline{Q}$. It depends only on the rate at which citizens of $M$ acquire skills at the age corresponding to the marginal migrant's moving age. The higher that rate, the smaller the reduction in the marginal migrant's qualifying age for any given cut in $\overline{Q}$. On the other hand, the leftward shift of the $CB$ schedule is given by $\partial\tau^*/\partial\overline{Q} = -\beta^*\eta_{\omega\overline{Q}}/\nu_{\tau^*}\overline{Q}$, where $\beta^* \equiv \beta(i^*, \tau^*; \ldots)$, $\omega \equiv \tilde{w}_e - \tilde{w}_m > 0$, $\eta_{\omega\overline{Q}} \equiv (\partial\omega/\partial\overline{Q})(\overline{Q}/\omega) > 0$, and $\nu_{\tau^*} \equiv \partial\nu(i^*, \tau^*; \ldots)/\partial\tau < 0$. Thus if the partial elasticity of the international wage differential with respect to $\overline{Q}$ is large, while the marginal migrant's net benefits from migration are not very sensitive to the timing of his move, a relatively large decline in $\tau^*$ is required (for a given cut in $\overline{Q}$) to keep the individual indexed by $i_0^*$ indifferent between migrating to $E$ and remaining in $M$. In this case the leftward shift of the $CB$ schedule may exceed that of the $\overline{Q}\,\overline{Q}$ schedule, resulting in a new equilibrium at a point such as $Z''$ in figure 3. Conversely, if the value of $\eta_{\omega\overline{Q}}$ is sufficiently small relative to that of $\nu_{\tau^*}$ and $q(\tau^*)/q'(\tau^*)$, the new equilibrium will end up at a point like $Z'$.

9. If the new equilibrium is at a point like Z", the marginal migrant is relatively more productive at each age and younger at the time of migration than he was at the old equilibrium point A. Since both of these factors tend to raise the net benefits from migration, it can readily be seen in (17) that $\tilde{w}_e - \tilde{w}_m$ must now be smaller. Alternatively, if the new equilibrium is at Z', then both $i^*$ and $\bar{Q}$ are lower. It immediately follows from (15)-(16) that at the point Z' the wage differential must be narrower than at either A or Z".

10. This bargaining process is assumed to be conducted outside of the present model. It would be most interesting, however, to go a step further and use the approach of Brock and Magee (1978) and Findlay and Wellisz (1982, 1983) to analyse explicitly how the economic and political factors interact within country E to determine its immigration policy.

11. The change in $\bar{Q}$ required to keep $\mu = \bar{\mu}$ is given by $d\bar{Q}/dp = [\bar{\mu}_1 - \mu_1(di^*/dp)]/[\mu_2 + \mu_1(di^*/d\bar{Q})] \gtrless 0$, as $\bar{\mu}_1 \lessgtr \mu_1(di^*/dp)$, where the values of $di^*/dp$ and $di^*/d\bar{Q}$ are given in the Appendix and, as shown at the end of Section IV, $\mu_2 + \mu_1(di^*/d\bar{Q}) < 0$.

12. It can also be shown that in relation to the constant-$\bar{Q}$ policy, an increase in $K_e$ under the "conservative" policy gives rise to a larger gain for each member of groups 1 and 3. However, some members of group 2 may be better off when $\bar{Q}$ is held constant. As for the owners of capital in M, they experience a decline in income which is larger than that under the constant-$\bar{Q}$ policy.

Appendix

This Appendix presents the long-run effects of changes in p, $\bar{c}$, $K_e$, $K_m$, and $\bar{Q}$ on the two key variables of the model: the index of the marginal migrant $i^*$ and his moving age $\tau^*$.

$$\frac{di^*}{dp} = - \frac{(\partial \tilde{w}_e/\partial p)\beta^* \gamma(\tau^*) \bar{Q}}{\omega\Delta} < 0,$$

$$\frac{d\tau^*}{dp} = \frac{(\partial \tilde{w}_e/\partial p)\beta^* \sigma(i^*) \bar{Q}}{\omega\Delta} > 0,$$

$$\frac{di^*}{d\bar{c}} = \frac{\gamma(\tau^*) \bar{Q}}{\Delta} > 0,$$

$$\frac{d\tau^*}{d\bar{c}} = - \frac{\sigma(i^*) \bar{Q}}{\Delta} < 0,$$

$$\frac{di^*}{dK_e} = - \frac{(\partial \tilde{w}_e/\partial K_e)\beta^* \gamma(\tau^*) \bar{Q}}{\omega\Delta} < 0,$$

$$\frac{d\tau^*}{dK_e} = \frac{(\partial \tilde{w}_e/\partial K_e)\beta^* \sigma(i^*) \bar{Q}}{\omega\Delta} > 0,$$

$$\frac{di^*}{dK_m} = \frac{(\partial \tilde{w}_m/\partial K_m)\beta^* \gamma(\tau^*) \bar{Q}}{\omega\Delta} > 0,$$

$$\frac{d\tau^*}{dK_m} = - \frac{(\partial \tilde{w}_m/\partial K_m)\beta^* \sigma(i^*) \bar{Q}}{\omega\Delta} < 0,$$

$$\frac{di^*}{d\overline{Q}} = -\left[\frac{\eta_{\omega\overline{Q}}\,\gamma(\tau^*)\beta^* + \nu_{\tau^*}}{\Delta}\right] \gtrless 0,$$

$$\frac{d\tau^*}{d\overline{Q}} = \frac{\left[\sigma(i^*)(1+\eta_{\omega\overline{Q}}) + \frac{\partial\omega/\partial i^*}{\omega}\right]}{\Delta}\beta^* > 0,$$

where $\Delta = \left[\sigma(i^*) + \frac{\partial\omega/\partial i^*}{\omega}\right]\gamma(\tau^*)\beta^*\,\overline{Q} - \sigma(i^*)\nu_{\tau^*}\,\overline{Q} > 0,$

$\sigma(i^*) \equiv s'(i^*)/s(i^*) > 0$ , $\gamma(\tau^*) \equiv q'(\tau^*)/\,q(\tau^*) > 0$, $\omega \equiv \tilde{w}_e - \tilde{w}_m > 0,$

$\eta_{\omega\overline{Q}} \equiv (\partial\omega/\partial\overline{Q})(\overline{Q}/\omega) > 0$, $\beta^* = \beta(i^*,\tau^*;\ \ldots)$, and

$\nu_{\tau^*} \equiv \partial\nu(i^*,\ \tau^*;\ \ldots)/\partial\tau < 0.$

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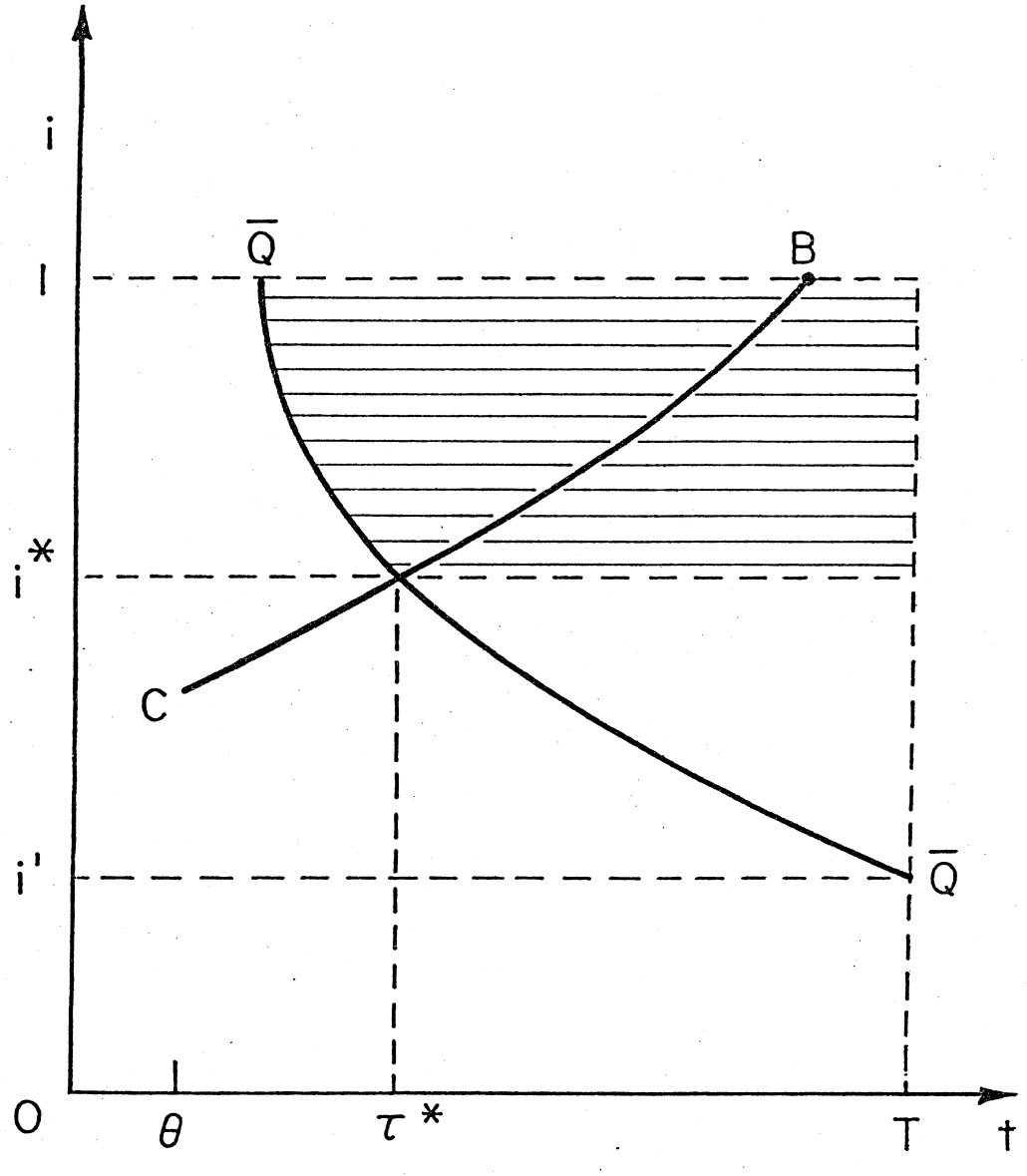



FIGURE 1

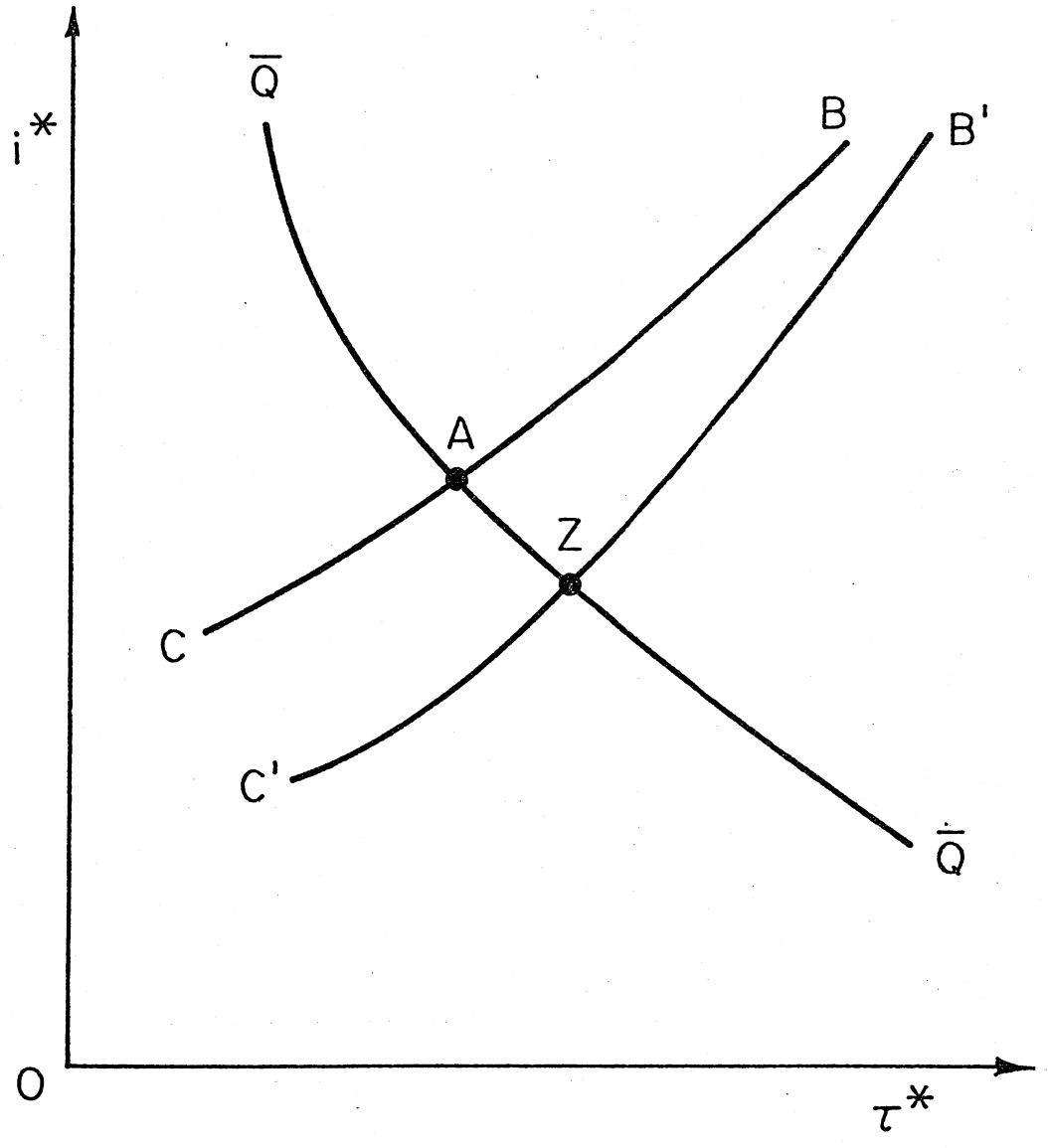



FIGURE 2

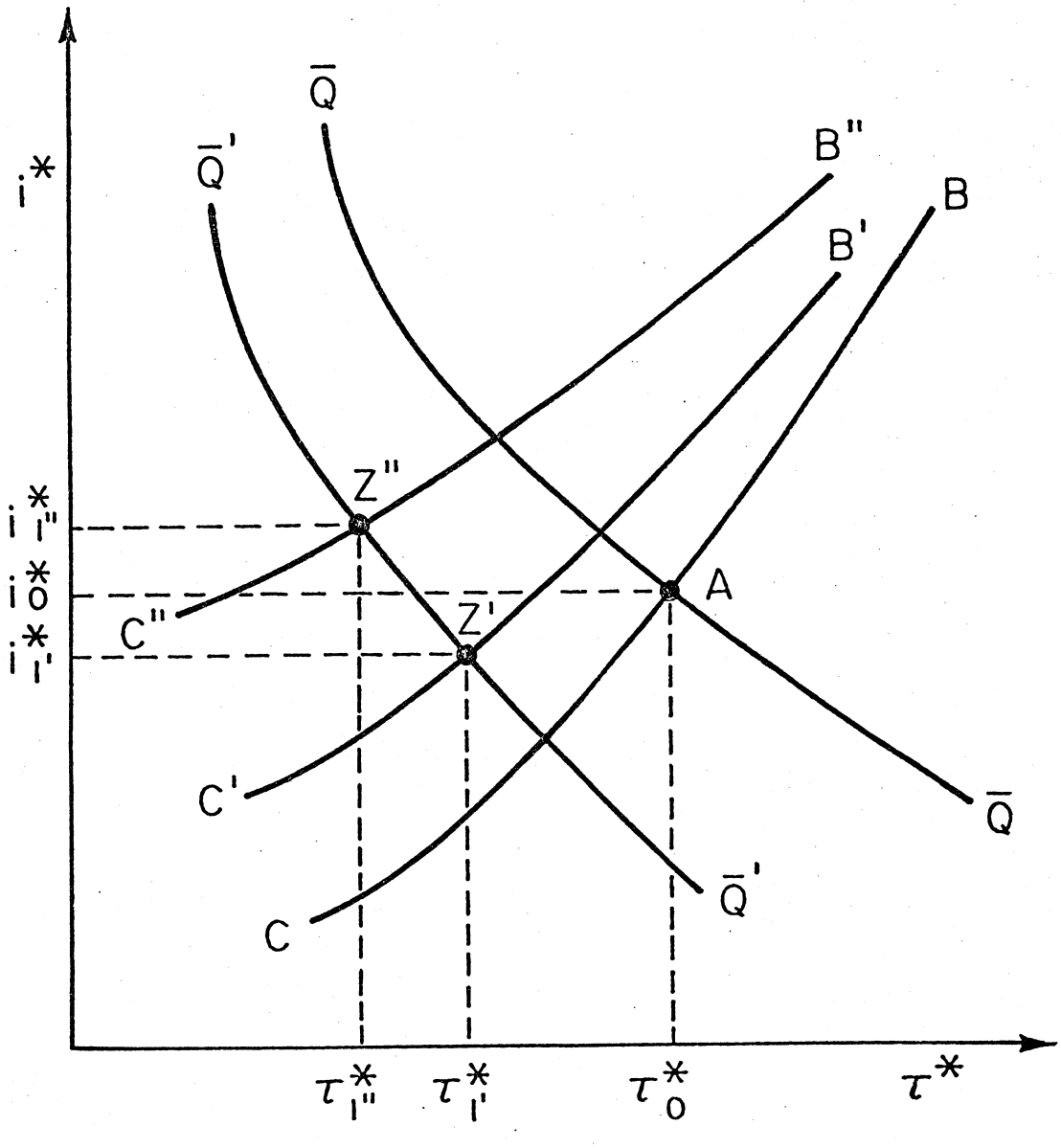
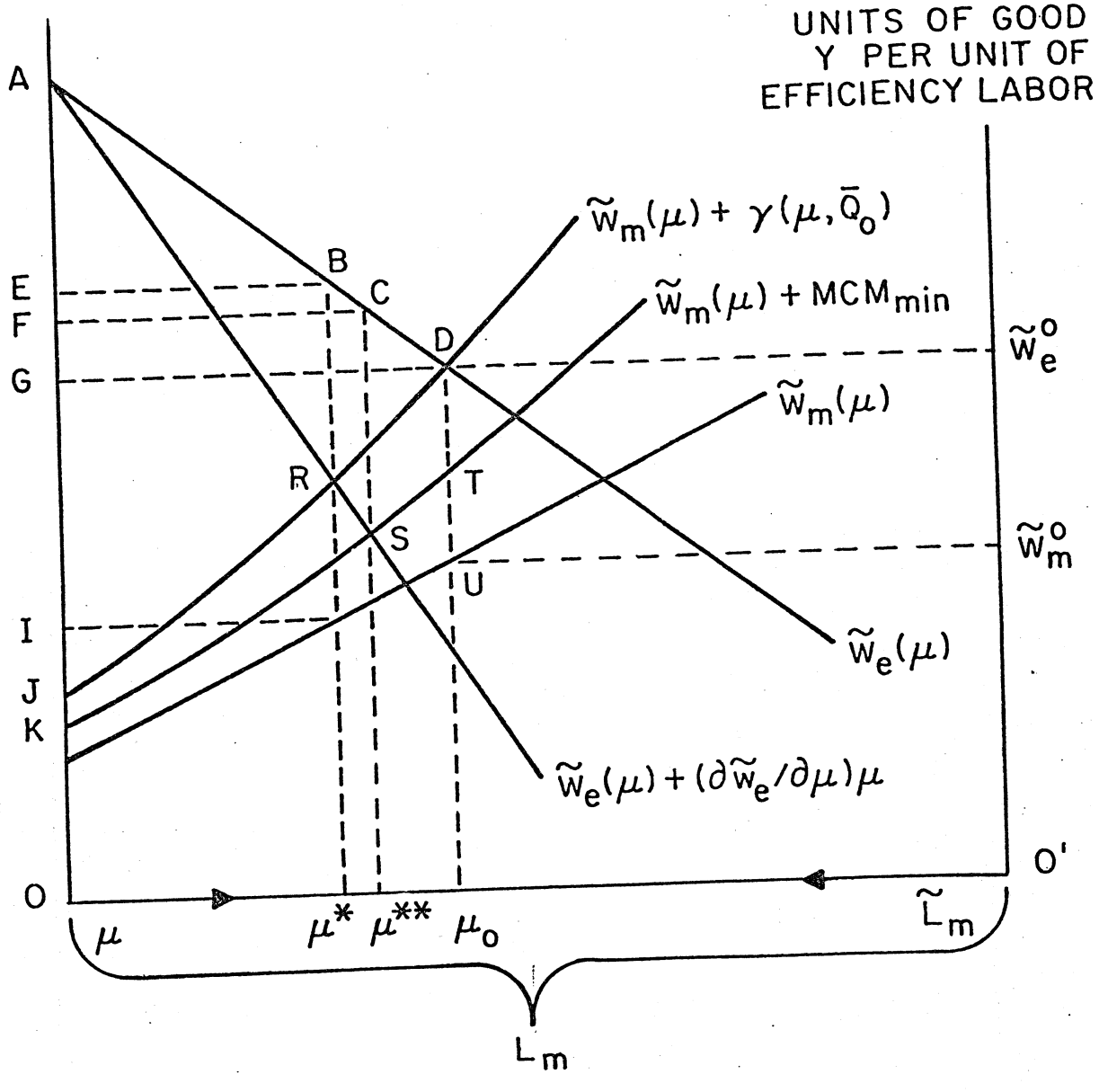



FIGURE 3


UNITS OF GOOD
Y PER UNIT OF
EFFICIENCY LABOR
A
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O
O'
$\tilde{w}_m(\mu) + \gamma(\mu, \bar{Q}_o)$
$\tilde{w}_m(\mu) + MCM_{min}$
$\tilde{w}_m(\mu)$
$\tilde{w}_e(\mu)$
$\tilde{w}_e(\mu) + (\partial \tilde{w}_e / \partial \mu)\mu$
$\tilde{w}_e^o$
$\tilde{w}_m^o$
$\mu$
$\mu^*$
$\mu^{**}$
$\mu_o$
$\tilde{L}_m$
$L_m$

FIGURE 4