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THE GENERATIONAL WELFARE ANALYSIS OF INTERNATIONAL LABOR MIGRATIONS

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We examine the pattern of international migration and the generational welfare implications of international labor migration by utilizing dual approach of overlapping generational model in the context of dynamic general equilibrium. Unlike the Galor (1986) bilateral migration is possible as well as unilateral migration when the two countries are characterized by dynamic efficiency. It turns out that Golden-Rule effect and terms-of-trade effect are major elements in determining the steady-state welfare implications. Unilateral migration, in contrast to traditional results, may immiserizes the welfare of non-migrant future generations in the immigration country but, unlike the Galor's result (1986), may improve it if the terms-of-trade effect dominates the Golden-Rule effect while making the non-migrant future generations in the emigration country at least as well off. Bilateral migration improves the welfare of the nonmigrant future generation in the high time-preference country but may improve or worsen the welfare of nonmigrant future generations in the low time-of-trade effect dominates the Golden-Rule effect or not. Short-run welfare analysis is also conducted.

I. INTRODUCTION

There are conflicting opinions with regard to the consequences of labor migration. When considering the development or expansion of an economy, the subject of autarky versus open economy is a very important issue in both developed and developing countries. Moreover, this issue is of great concern to all individuals, because the problem has been conceived as a sharp political conflict between workers and capital owners, between the young generation and the old generation, as well as between the current generation and the future generation. This paper serves to improve our understanding of the issue.

The simplest model for analyzing the consequences of international factor

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movements is the MacDougall-Kemp model, which is formulated upon the basic assumptions of two factors, one good, full employment, perfect competition, and constant returns to scale. Hobson (1914), Jasay (1960), MacDougall (1960) have used the model in order to analyze international capital mobility. Subsequent writers, such as Johnson (1965), Grubel and Scott (1966), and Berry and Soligo (1969) also utilized the model to analyze international labor migration. They were primarily concerned with gains and losses from factor mobility, and analyzed the consequences of factor mobility upon per capita income, wages, and interest rates by comparative static methods in the short run.

Other authors, such as Hamada (1966), by specifying saving as a constant fraction of disposable income, extended the MacDougall-Kemp model to the dynamic economy, using a small country assumption. Ruffin (1979) developed an international version of the Solow-type growth model in a general equilibrium context.

Although the assumption of constant propensity to save out of disposable income is common (Borts 1964, Neher 1970, Fisher and Frenkel 1974, Onisuka 1974, Hori and Stein 1977, Ruffin 1979), as well as very simple and powerful, it cannot hope to capture all the real properties of a dynamic economy because of the ad hocery of the assumption.

To overcome the ad hocery of the assumption, W.H. Buiter (1981) adopted the overlapping generation model with the assumption of international differences of time preference in order to analyze the consequences of international capital mobility. Oded Galor (1986) used the duality approach to analyze the pattern of labor migration and its welfare implications.

The OLG model retains all the assumptions of the MacDougall-Kemp model, except the saving assumption. Saving is generated by the intertemporal utility-maximizing behavior of economic agents, and capital formation is carried to the point where the marginal product of capital equals the interest rate. Thus, the OLG model is a fully choice-theoretic model. It is, therefore, very useful for analyzing the extended welfare implications of international factor mobility.

Duality approach in OLG model especially provides us with nice procedure to analyze this issue. Indeed Galor (1986) took this approach but heavy dependence on graphical procedure deterred him from adequate utilization of the dual approach and resulted in erroneous conclusions.

Yoon (1989) properly utilize nice properties of the overlapping generation model with the duality approach. There Yoon examined the generational welfare implications of the international capital movements.

We examine, here, the generational welfare implications of international labor migration by utilizing the same procedure in the context of general dynamic equilibrum. Unlike the Galor (1986) bilateral migration is possible as well as unilateral migration when the two countries are characterized by dynamic efficiency. It turns out that Golden-Rule effect and terms-of-trade effect are major elements in determining the steady-state welfare implications. Unilateral migration, in contrast to traditional results, may immiserizes the welfare of non-migrant future generations in the immigration country but, unlike the Galor's result (1986), may improve it if the terms-of-trade effect dominates the Golden-Rule effect while making the non-migrant future generations in the emigration country at least as well off. Bilateral migration improves the welfare of the nonmigrant future generation in the high time-preference country but may improve or worsen the welfare of nonmigrant future generations in the low time-preference country depending upon whether the terms-of-trade effect dominates the Golden-Rule effect or not. Short-run welfare analysis is also conducted.

II. AUTARKY

A. *The Supply of Capital*

Following the Diamond (1965) consider the economy in which each generation lives for exactly two periods. For each individual born in generation t, $(1+n)$ individuals are born in generation $t+1$.

The growth rate n is constant. Each individual works in the first period of life and retires in the second period. While "young" he earns a wage, consumes part of it, and saves for his old age. While old, the consumer lives entirely from his savings. For simplicity it is assumed that people born in one generation are exactly the same as people born in any other generations.

The amount of savings depends upon the level of individuals' income in their first period and the interest rate in their second period. Let w denotes the wage rate, r the gross return on one dollar saved for one period, c_1 consumption in the first period, and c_2 consumption in the second period of life. Each individual solves the program:

(1) Maximize: $u(c_1, c_2)$

(2) Subject to: $w - c_1 = c_2/r$.

The first order condition is:

(3) $u_1/u_2 = r$.

where $u_i = \partial U/\partial c_i$.

Saving is a function of w and r, Thus define

(4) $S(w, r) = w - c_1\ (w, r)$

Since saving is necessarilly positive, an inrease in the gross interest rate has a positive wealth effect, which increases current consumption and depresses current saving. The interst rate will have an ambiguous impact on saving. But we can assume, if consumptions in both periods are normal, that an increase in wage will increase saving, but the marginal propensity to save will be less than unity. Thus:

(5) $1 > (1\text{-}S_w) > 0$

The sign of S can be positive or negative.

The indirect utility function is:

(6) $v(w, r) = U\ [c_1\ (w, r),\ c_2\ (w, r)]$

By using (2) and (3), differentiating (6) shows that

(7) $v_w = u_2 r$
(8) $v_r = u_2 S.$

These results are intuitive: a higher wage increases utility in direct proportion to the rate of interest because another dollar saved has more punch; and a higher interest rate increases utility in direct proportion to saving. The factor of proportionality in each case is the marginal utility of consumption in the working years.

B. *The Demand for Capital*

Assume output is homogeneous and can either be consumed or saved as capital. As before, f(k) is the intensive form of the production function. Capital depreciates fully after one period. Thus, if capital is productive, $f'(k) = r > 1$ (r-1 is the interest rate in the usual sense). The amount of capital in period t+1 consists of the savings of young workers of generation t. Let r_{t+1} denote the rate of interest on the savings of generation t that bears fruit in the next period.

The wage and interest rate faced by a representative member of generation t are:

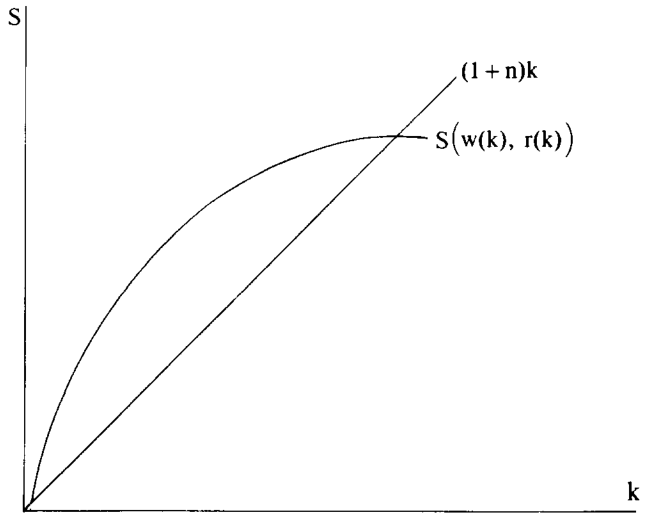
(9) $w_t = f(k_1) - k_1 f'(k_1)$
(10) $r_{t+1} = f'(k_{t+1}).$

The saving of each generation t worker is related to the capital stock per worker of the next period by:

(11) $S(w_t, r_{t+1}) = w_t\text{-}c_1 = k_{t+1}\ (1+n)$

Equations (9)-(11) determine the evolution of the economy through time. Indeed equation (11) plays the same role in the OLG model as $\partial k/\partial t =$ sy-nk in the Solow model.

The steady-state long run equilibrium is the sequence of momentary equilibria in which interest rates and wages are constant over time. In the steady-state solu-



[Figure 1]

tion, equation (11) reduces to:

(12) $S[w(k), r(k)] = k(1+n)$

Figure 1 shows the determination of the steady-state. Stability requires that the slope of S be less than slope of $k(1+n)$. Thus, the stability condition is (Diamond, 1965):

(13) $S_w\ \partial w/\partial k = S_r\ \partial r/\partial k = f''(k)\ (S_r\text{-}kS_w) < 1+n.$

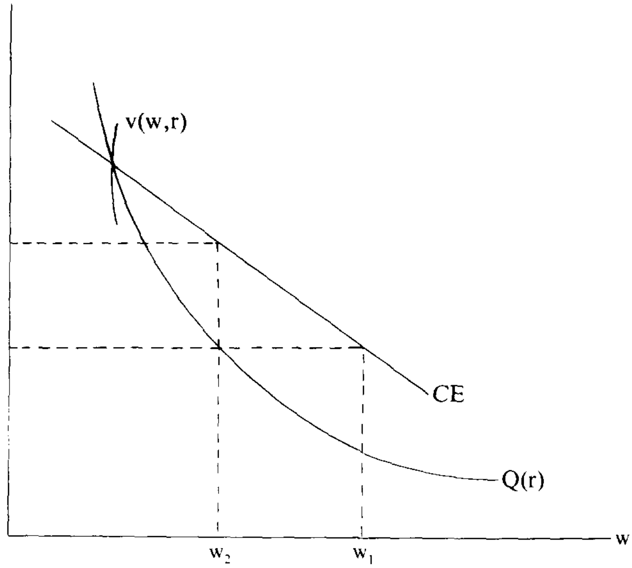
Note that the assumption that goods are normal $(0<S<1)$ and the assumption that an increase in the interest increases savings $(S_r > 0)$ are not sufficient to ensure stability.

In our perfect foresight model, we can trace out the time path of the wage rate of the interest rate by the following two equations: $r_{t+1} = f'(k_{t+1})$, $(1+n)\ k_{t+1} = S(w_t, r_{t+1})$. The fundamental equation governing the competitive dynamic path is:

(14) $r_{t+1} = f'\ [S(w_t, r_{t+1})/(1+n)].$

obviously, given w_t, one can determine r_{t+1} from (14) [see Diamond (1965)].

In figure 2 Q(r) denotes the factor price frontier and CE denotes the competitive dynamic path described in equation (14). Starting from the period 1, when the wage rate is w_1 the interest rate in the next period, r_2, is determined along the CE



[**Figure 2**]

curve. Once r_2 is determined, then w_2 is determined along the Q(r) curve. In this way, we can track all the time paths of factor prices from some time to the time when the steady-state at point e is attained. The interest rate, thus, goes up when it is below the steady-state value, and goes down when it is above the steady-state value. Above statements mean the CE curve is shaped relative to Q(r) as depicted in figure 2. Lemma 1 states this formally.

Lemma 1: Let $Q=\{(w, r): w=f(k)\text{-}rk,\ r=f'(k),\ (w, r)\in R^2_{++}\}$ and $CE=\{w_t, r_{t+1}): r_{t+1}= f'(k_{t+1}),\ k_{t+1}(1+n)= S(w_t, r_{t+1})\cdot(w_t, r_{t+1})\in R^2_{++}\}$. Then $\partial r/\partial w|_Q < \partial r/\partial w|_{CE} < 0$ if and only if the stability condition (13) is satisified.

proof:

$$\partial r/\partial w|_Q = -1/k \text{ and } \partial r/\partial w|_{CE} = f''S_r/(1+n\text{-}f''S_w).$$

By the dynamic local stability condition (13), $1+n\text{-}f''S_r > \text{-}kS_w f''$. By dividing both side by $1+n\text{-}f''S_r$ and k we get $f''S_w/(1+n\text{-}f''S_r) > \text{-}1/k$. Q.E.D.

Note that when the economy is not in steady state, the CE curve is the locus of the relevant factor price vector which determines the utility level.

Now we compare the steepnesses of the indirect indifference curve and the (r) in the steady state

From equatison (7) and (8),

(15) $\partial r/\partial w|_v = -r/S$

From equations (12) and (15), $-r/(1+n)k < -1/k = \partial r/\partial w|_Q$, that is,

(16) $\partial r/\partial w|_v < \partial r/\partial w|_{CE}$

This inequality means that the indirect indifference curve, v(w, r) is steeper than the Q(r) curve at the steady state.

This inequality and Lemma 1 together means the indirect v(w, r) is steeper than the CE curve at the steady state (see figure 3). In other words the welfare increases as interest rate, r, decreases and wage rate, w, increases along the CE curve and vice versa. This fact will be utilized when short run welfare implication of labor migration.

C. *Heterogeneous individuals*

Now suppose that individuals are homogeneous within countries but heterogeneous in their rates of time preference across countries.

The indifference curve of the high time-preference individual is steeper than that of the low time-preference individual because, to preserve the same utiiity as before, a high time-preference individual should be compensated for the reduction of a wage rate by a higher interest rate, than a low time-preference individual should be. It is clear that a high time preference means less saving at any factor price vector than a low time preference. With a heterogenous population, it follows that the higher the proportion of low time-preference individuals in the economy, the lower the steady-state interest rate will be. Lemma 2 states this formally.

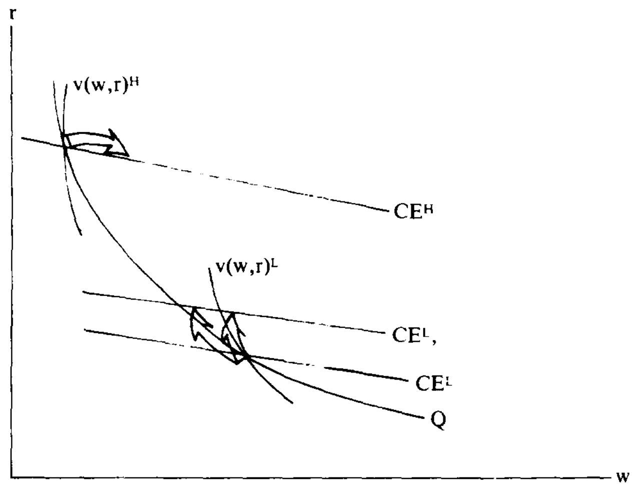
Lemma 2: Let m^i be the fraction of low time-preference individuals in country i, then $\partial k/\partial m^i > 0$, $\partial w/\partial m^i > 0$, and $\partial r/\partial m^i < 0$.

The stablity of the equilibrium for a heterogeneous population can be established by a similar way to that of the case of a homogeneous population as $1-f''(k)\ [S^{*i}/r^i\ S^{*i}\ (\partial S^{*i}/\partial w^i)] > 0$ where $S^* = m^i S^L + (1-m^i) S^H$ and supercript L, H denote the low time-preferene individual and the low time-preference individual respectively.

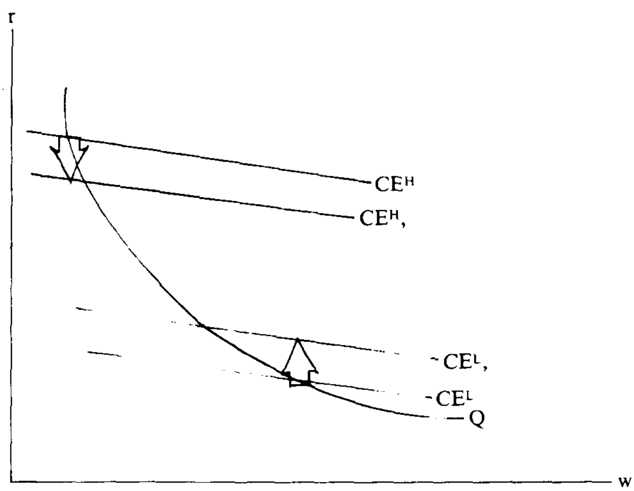
Lemma 2 can also be applied to an open economy equilibrium since the world can be considered as one country from the accumulation point of view. Thus, Lemma 2 describes not only an autarkic economy where heterogenous individuals reside, but also the world economy where capital or labor is allowed to move across countries.

D. *The Golden Rule*

The Golden Rule of accumulation is that rate of investment that maximizes



(a) The Case of Unilateral Migration



(b) The Case of Bilateral Migration

[Figure 3]

steady-state utility. Steady-state utility is:

(17) $U(k)=v[w(k),\ r(k)]$

Clearly, using (7), (8) and steady-state versions of (9) and (10), i. e.,

(9′) $w=f(k)\text{-}r(k)$,

and

(10′) $r=f'(k)$,

equation (18) follows:

(18) $U'(k) = vw'(k) + v'(k) = u[rw'(k) + Sr'(k)] = uf''(S-rk)$

From the steady-state condition that $S = (1+n)k$, it follows that

(19) $U'(k) = uf''k\ (1+n-r)$

Maximizing steady-state utility requires $r = 1+n$, that is, that the rate of interest equal the biological growth rate. As pointed out by Samuelson (1958) and Diamond (1965), in the competitive equilibrium r need not equal $(1+n)$. It is well-known that there is dynamic efficiency if $r>1+n$ and dynamic inefficiency if $r<1+n$ [see Starrett(1972)].

III. INTERNATIONAL MIGRATION

It is not possible, except in special cases, to make an unambiguous welfare comparison by comparing steady-state utility levels because the ranking of the stationary utility levels may not be the same as the ranking of the utility levels achieved during the transition from one steady-state to another. Yoon (1989) shows that in the case of small country, opening of international capital movements improves the welfares of the country not matter whether that country is capital-importing or capital-exporting. But here we analyze the intergenerational conflict of intersts in allowing international labor migration in the large countries.

In the steady state for the economy facing the fixed interest rate r,

(20) $s^i(Q(r),r] = (1+n)a^i,\ i = L,\ H.$

Equation (20) must hold because the saving of the young of one generation becomes the assets of the young (discounted by population growth) of the next generation in each type of individuals; but in the steady state the assets of each generation must be constant. In the economy which encompass two types of individuals, i.e., the low preference individuals and high time-preference individuals, however, the saving of the young of one generation becomes the capital of the young of the next generation with which to work regardless of types of individuals. Thus the steady state for the economy facing the fixed interest rate r is:

(21) $mS^L(Q(r),\ r) + (1\text{-}m)S^H(Q(r),\ r) + (1+n)k,$

where m is the fraction of low time-preference individuals in the economy.

Then the net lending of type i ($i = L,H$) individual to the other type of individuals discounted by population growth becomes;

(22) $z^i = a^i - k$, $i = L, H$.

Steady-state utility is:

(23) $U^i(r) = v^i [Q(r), r]$, $i = L, H$.

Taking the derivative, having in mind the Lemma 2, we find that

(24) $U^{i\prime}(r) = -v^i k + v^i$, $i = L, H$.

Using (7), (8), (21) and (22) we have

(25) $U^{i\prime}(r) = u^i_2 [a^i (1 + n - r) + rz^i]$, $i = L, H$.
(26) $U^{i\prime}(r) = 0$ if and only if $a = a^i (1 + n)/(a^i - z^i)\ r$, $i = L, H$.

There are two components to the change in steady-state utility expressed in (25): the Golden-Rule effect and the terms-of-trade effect. The terms-of-trade effect is most clearly seen in the vicinity of the Golden Rule, where the sign of $U^{i\prime}(r)$ is the same as z^i. Thus a lower interest rate improves the welfare of future generations in a immigration country if the immigrants are low time-preference individuals ($z^H > 0$); a higher interest rate improves the welfare of future generations in a immigration country if the immigrants are high time-preference country ($z^L > 0$). In other words, when the economy is sufficiently close to the Gloden Rule the main determinant of the welfare of future generation in the immigrant country is the terms-of-trade effect of a change in the rate of interest rate.

The Golden-Rule effect is the determining factor in the vicinity of autarky, where $z^i = 0$, and the sign of $U^{i\prime}(r)$ is the sign of $(1 + n - r)$. The Golden-Rule effect is the change in welfare due to moving closer to the Golden Rule. If there is dynamic efficiency, where $r > 1 + n$, $U^{i\prime}(r)$ is nonpositive. A lower interst rate benefits future generations; a higher interest rate hurts future generations. When a country begins to accept the low time-preference immigrants interest rate falls and the welfare of future generation unambiguously increase. When a country begins to accept the high time-preference the welfare of future generations falls unambiguously.

Now let us consider the pattern of migration. The incentive for migration from country i to country j exists if $U^{ij} (w^j, r^j) = U^{ij} > U^i(w^i, r^i)$, where $i = H, L$, and i is not equal to j, and U^{ij} is utility of a migrant from country i to country j.

The pattern of migration also follows from the inequality, (24) and (26).

The interst rate in the country of low time-preference individuals is lower than in the country of high time-preference individuals. If the high time-preference individuals immigrate into the country of the low time-preference individuals from their country, they face lower interest rate and they saves less than the low time-preference individuals resulting in their net borrowing ($z^H<0$) to the other types of individuals. Thus both the Golden-Rule effect and terms-of-trade effect favorably affect the immigrant's welfare. It follows that the high time-preference individuals in the high time-preference country have the incentive to migrate into the low time-preference country. On the other hand, to the low time-preference individuals who migrate from low time-preference country to the high time-preference country the Golden-Rule effect works unfavorably while the terms-of-trade effect works favorablyly for their welfare. If the Golden-Rule effect dominates the terms-of-trade effect, bilateral migration follows (case 1). If the terms-of-trade effect dominates the Golden-Rule effect, the unilateral migration from the high time-preference country to the low time-preference country follow (case 2).

When the incentive to migration disappears between the two countries, or when there are no people to migrate, as migration progress, migration equilibrium is attained. (restricted migration equilibrium can be defined as the state when no more migration is permitted). It is certain that the factor price vector should be the same across countries in migration equilibrium, since, if not so, some kind of migration will take place as seen above. Thus we can state the following proposition.

Proposition 1: Unrestricted Migration Equilibrium.

Consider the world economy $E= \{(U^i, L^i): i= L,H, (U^i, L^i) \in R^2_{++}: F\}$. If unrestricted international labor migration is permitted, the steady-state returns to every unit of capital and labor in the world economy are, respectively:

$$r= f'(k),\ r^L<r<r^H$$
$$w= f(k)-kf(k),\ w^L<w<w^H$$

where $k=mS^L + (1\text{-}m)S^H$, $m= L^L/ (L^L+L^H)$, L denotes population while the superscripts L,H,W denote the low time-preference country, high time-preference country and world respectively.

This migration equilibrium can be achieved if and only if production takes place in the immigration country in the case of unilateral migration. In the case of bilateral migration, migration equlibrium can be achieved if and only if the proportion of low time-preference individuals is the same across countries, since the capital accumlation depends upon that proportion, and the other conditions stated are the same across countries.

Now let us consider the effects of the migrations on the steady-state welfare, i.e., the welfare of future generations.

Remember that initially as migration takes place only Golden-Rule effect works. So in case 1, i.e., the case of unilateral migration from the high time-preference country to low time-preference country, the welfare of the future generation of the immigrant country, i.e., the low time-preference country worsens by allowing the international labor migration.

But as the immigration is further progressed the terms-of-trade effect begins to works favorably to the welfare of future generation in the immigrant country due to highed interst rate due to increased proportion of high time-preference individuals from 0 in the country ($z^L>0$). Thus the welfare of future generations falls if the Golden-Rule effect dominates (the country moves further away from the Golden Rule) and rises if the-terms-of-trade effect dominates.

Note that the welfare of future generation remains same with that of before since the proportion of high time-preference individuals in the country remains same i.e., 1.

In case 2, i.e., the bilateral migration it is clear that the direction of change in welfare of future generation in the low time-preference country is same but the speed of the change becomes higher than in case 1. The important difference from case 1 lies in the high time-preference country. In this case the high time-preference country not only sends the emigrant but also accepts the immigrant of low time-preference individuals. So the the proportion of low time-preference individuals increases from 0 and by Lemma 2 the interest rate becomes lowed. Then both the Golden-Rule effect and the terms-of-trade effect works to the welfare of future generation in the high time-preference country ($z^L>0$).

Short-Run Welfare Implications of Labor Migration

An individual will not migrate unless the migration is beneficial to him. The problem we shall address here concerns the welfare of remaining individuals in the emigration country and of nonmigrants in the immigration country. We shall assume that only the young generation migrates, and that migration is imperfect, or limited, in the short run; this is necessary in order to derive meaningful results for out problem.

In general, the current young generation and the old generation may be affected differently when migration takes place. The old generation of the immigration country always gains, since that country's current interest rate goes up due to an increase in the labor force; but, the old generation of the emigration country always loses, since the current interest rate goes down due to the decrease in that country's labor force. The welfares of young generations in both countries are affected ambiguously by labor migration since its welfare is affected by both w_t and r_{t+1}. The wage rate, w_t, in the immigration country goes down and the wage rate of the emigration country goes up. But the change of r_{t+1} is not easy to determine since it is determined by the capital market equilibrium condition of the next period in each country. In other words, the market for capital (supply and demand) in the next period of time is interrelated with the degree of migration in both the current period and the next period. If we permit migration to take place in this period only, but not in the next period, then, we get some interesting short-run results.

We consider, first, the case one i.e., unilateral migration from the high time-preference country to the low time-preference country takes place(see figure 3, a). We already know from Lemma 1 and inequality (16) that (1) the welfare of individuals improves (worsens) as $p(w_t, r_{t+1})$ moves southeast (northwest) along the CE curve because of the relative steepness of the CE curve because of the relative steepness of the CE curve and the indifference curve which passes through their autarkic steady-state factor prices; (2) the dynamic factor market equilibrium locus (the CE curve) moves up as the proportion of high time-preference individuals becomes higher in the economy.

In the emigration country, the CE^H curve does not move since the proportion of the high time-preference individuals remains at 1. But, the $p(w_t, r_{t+1})$ moves to the southeast along the CE^H curve in the emigration country as w_t increases as a result of labor emigration. Thus, the welfare of the remaining young generation improves, since the CE^H curve is relatively flatter than the indifference curve of the young generation which passes through their steady-state factor price. If, in the next period, some of the young generation emigrates, then, the interest rate in the next period would decrease, which makes the welfare effect of migration on the remaining young generation difficult to determine.

In the immigration country, w_t decreases as a result of the immigration. But, the interest rate goes up beyond the original CE^L curve as the CE^L curve moves up since the immigrants are high time-preference individuals. Thus in this case, the welfare of the nonmigrant young generation is affected ambiguously by permitting the migration. But, the higher the time-preference of the immigrants, the higher r_{t+1} would be, and thus, the more likely is the welfare of the young nonmigrant generation to improve. After all, the result would depend upon the elasticity of substitution in the relevant range of production and upon the degree of time preference of immigrants in the relevant range of their consumption. More specific conditions for each result can be stated in these terms.

If migration is permitted in next period also, r_{t+1} would go up even more. Then, the nonmigrant young generation's welfare would be more likely to improve.

In the case of bilateral migration (see Figure 3, b), the current factor prices w_t, r_t, do not change since the two countries are just swapping their labor forces if we assume that the two countries are similar in size. Thus, the old generation's welfare is not affected in either country. The welfare of the young generation in the high time-preference country, however, worsens since the r_{t+1} would go down below the r as CE^H goes down, due to the increase in the proportion of low time-preference individuals in that country. By a similar logic, the welfare of the young generation in the low time-preference country improves. The above results for bilateral migration would not change by the additional bilateral migration in next period, since that would not change factor prices of the next period.

IV. CONCLUSION

Our analysis shows that the steady-state welfare of the emigration country remains same and the steady-state welfare of the immigration country worsens if the immigrant are high time-preferenced when both countries are characterized by under-investment relative to the Golden Rule.

This result appears to be surprising, since the steady-state welfare in some country may worsen as a result of trade in factor or labor migration. However, the result actually reflects the intergenerational conflict of interest. In the case of unilateral migration, the old generation gains in the immigration country while the old generation loses in the emigration country. But, the young generation's welfare is affected ambiguously by the permitting of migration (except for the bilateral migration) when capital is movable in the short run.

These statements indicate that the permitting the international labor migration versus autarky constitutes a sharp political problem both between generations and between countries. Hence, without some proper redistribution scheme, the permitting international labor migration may either not take place. Because of these conflicts of interest, the government's role should be emphasized.

The present analysis may also be extended to incorporate uncertainty or imperfect information. Furthermore, it can be used to examine the public policy related to saving behavior in an international context.

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