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Migration, Human Capital Formation, and Long-Run Output

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Migration, Human Capital Formation, and Long-Run Output

1. Introduction

Interest in the effects of labor migration on the receiving economy has not produced ample insights regarding its long-run consequences. Important as it may be, the impact on wages and employment, especially on groups whose labor market characteristics are similar to those of migrants, could be transitory. With very few exceptions (e.g., Galor, 1986), the existing migration literature has not provided a coherent analysis confirming that any such effect could not be reversed in the long run. Conversely, the analysis of the transition and steady-state repercussions of migration that arise even if migration has no effect at all on standard labor market variables such as wages and employment is yet to be pursued. This paper takes a step in this direction. We focus on one particular characteristic of migrants, viz., the level of human capital, and explore its repercussions.

To begin with, suppose that human capital formation at a given period draws on private resources as well as on the average (economy-wide) prevailing level of human capital: The higher the average level, the higher the human capital resulting from a given private allocation. Subject to some modeling, the dynamic path of the economy's human capital formation can be drawn. Suppose further that the system is characterized by multiple steady-state equilibria and that the economy is on a path to a high per capita human capital steady-state equilibrium. Now, in common with other studies and real world behavior, consider the arrival of migrant workers whose human capital is lower than the average in the host country. Assume either that this migration is large or, if small, that the human capital differential between the past population and the migrants is large. The production of human capital in the host country will be affected adversely: as it deteriorates, the amount of private resources allocated to it will shrink, resulting in a lower average level of human capital at a subsequent period. Again, human capital formation will be affected adversely. The compounding effect of the single infusion of low-quality workers could then result in the economy being thrown into a point from which it will converge to a low

per capita human capital steady-state equilibrium. (Moreover, at any point in this process, the economy's per capita human capital will be lower as well.) Since these effects correlate positively with per member income and utility, the one-shot erosion of human capital can result in adverse production and welfare repercussions.

2. The Model

Consider a small open overlapping-generations economy that operates in a perfectly competitive world in which economic activity extends over an infinite discrete time. In every period the economy produces a single homogenous good using capital and labor measured in efficiency units in the production process. The good can be consumed, saved, or used as an input in the formation of human capital. The supply of capital in every period consists of the aggregate savings of individuals in the economy in addition to net international borrowing; capital is perfectly durable.¹ The supply of efficiency labor in every period is due to the aggregate investment in human capital in the preceding period.

a. The Production of Goods

Production occurs within a period according to a constant-returns-to-scale neo-classical production technology that is stationary over time. Output produced at time t , Y_t , is

$$[1] \quad Y_t = F(K_t, H_t) \equiv H_t f(k_t), \quad k_t \equiv K_t / H_t,$$

where K_t and H_t are the quantities of capital and efficiency labor used in production at time t . The production function $f: R_+ \rightarrow R_+$ is twice continuously differentiable, $f'(k_t) > 0$ and $f''(k_t) < 0$ for all $k_t > 0$, $\lim_{k_t \rightarrow 0} f'(k_t) = \infty$ and $\lim_{k_t \rightarrow \infty} f'(k_t) = 0$.

b. Factor Prices

Producers operate in a perfectly competitive environment. Given the wage rate and the gross rate of return to capital at time t , w_t and r_t , respectively, the producers' inverse demand for factors of production is given by the first-order conditions for profit maximization:

¹ The qualitative nature of the analysis will not be affected if other feasible rates of depreciation are assumed.

$$[2] \quad r_t = f'(k_t),$$

$$[3] \quad w_t = f(k_t) - f'(k_t)k_t \equiv w(k_t).$$

Suppose that the world rental rate is stationary at a level \bar{r} . Since the small economy permits unrestricted international lending and borrowing, its rental rate is stationary as well at the rate \bar{r} . Consequently, k_t , the ratio of capital to efficiency units of labor in every time period t , is stationary at level \bar{k} ,

$$[4] \quad k_t = f'^{-1}(\bar{r}) = \bar{k},$$

and the wage rate per an efficiency unit of labor, w_t , is

$$[5] \quad w_t = w(\bar{k}) = \bar{w}.$$

c. Individuals

In every period a generation of N individuals is born.² Within, as well as across generations, individuals are identical in their preferences and their production technology of human capital. Individuals live for three periods. In the first period, they borrow capital at the market interest rate. This capital, along with time, is invested in the formation of human capital. In the second period, the individuals supply their efficiency units of labor inelastically at the competitive market wage, saving the resulting income, net of loan repayments, for future consumption. In the third period, the individuals retire, utilizing savings for consumption.

Specifically, in the first period of their lives, individuals born at time t (generation t) form human capital. Human capital formation requires real resources. Having no income, the individuals borrow the necessary funds at the market interest rate \bar{r} . A member of generation t who is born in an economy with an average level of human capital h_t and who, at time t , invests x_t units of real resources in the formation of human capital, secures h_{t+1} units of human capital — his labor supply in the second period of his life:

$$[6] \quad h_{t+1} = \mu + g(h_t)x_t^\alpha,$$

where $\mu > 0$, $\alpha \in (0,1)$, and for $\beta \in (0,1)$

² For simplicity there is no population growth. The qualitative results of this paper are not sensitive to changes in this assumption.

$$[7] \quad g(h_t) = \begin{cases} h_t^\beta & \forall h_t < \tilde{h} \\ \tilde{h}^\beta & \forall h_t \geq \tilde{h}. \end{cases}$$

Thus, even in the absence of investment in human capital formation, a member of generation t will be endowed with some, $\mu > 0$, units of efficiency labor at time $t + 1$. The number of efficiency units of labor increases with the funds (capital) invested in the formation of human capital, x_t , and with the economy's average level of human capital, h_t , up to an upper bound \tilde{h} . This last assumption is invoked in order to account for the likelihood that the pulling up of the human capital externality wanes at high levels of average human capital.

Equations [6] and [7] capture the assumption that the average level of human capital creates an environment that facilitates more human capital output (for example, better schooling) for a given level of investment in human capital formation. This effect, captured by $g(h_t)$, increases with the economy's average level of human capital up to an upper bound \tilde{h} .³

The income of an individual of generation t at time $t + 1$, I_{t+1}^t , is therefore the wage rate per efficiency unit of labor at time $t + 1$, \bar{w} , times the number of efficiency units supplied by the individual, h_{t+1} :

$$[8] \quad I_{t+1}^t = \bar{w}h_{t+1}.$$

Since individuals who are born at time t do not derive utility from consumption at time $t + 1$, their entire labor income, net of loan repayments, is saved for consumption in period $t + 2$. The saving of a member of generation t at time $t + 1$, s_{t+1}^t , is therefore

$$[9] \quad s_{t+1}^t = \bar{w}h_{t+1} - (1 + \bar{r})x_t.$$

Consumption of individuals from generation t at time $t + 2$, c_{t+2}^t , is therefore the gross return on their savings from time $t + 1$. Given the international interest rate \bar{r} , this consumption is

$$[10] \quad c_{t+2}^t = (1 + \bar{r})[\bar{w}h_{t+1} - (1 + \bar{r})x_t].$$

³ Equation [6] is akin to other formulations used — and successfully tested for — in the production of human capital. For example, Borjas (1992) has a production function of human capital in children of a given ethnic group which has as arguments parental inputs and the average human capital stock of the group. Lucas (1988) uses an aggregate production function similar to [6] in order to capture the external effects of human capital in production. (See also Romer, 1986.)

Individuals' preferences are represented by the utility function $u(c_{t+2}^t)$, which is strictly monotone in c_{t+2}^t .⁴ Given \bar{r} , \bar{w} , and h_t , and recalling equation [6], a member of generation t chooses the level of investment in human capital, x_t , so as to maximize the utility function. Namely,

$$[11] \quad x_t = \arg \max u \left\{ (1 + \bar{r}) \left\{ \bar{w} \left[\mu + g(h_t)x_t^\alpha \right] - (1 + \bar{r})x_t \right\} \right\}.$$

Given the assumptions concerning the utility function and the production function of human capital, there exists a unique and interior solution to the maximization problem characterized by

$$[12] \quad x_t = \left(\frac{\alpha \bar{w} g(h_t)}{1 + \bar{r}} \right)^{\frac{1}{1-\alpha}} \equiv x(h_t),$$

where $x'(h_t) > 0$. Thus, a higher average level of human capital induces a larger investment in human capital formation.

d. The Evolution of the Economy

Following [6], [7], and [12], the evolution of the investment in human capital is governed by

$$[13] \quad h_{t+1} = \xi(h_t) = \begin{cases} \mu + \left[\frac{\alpha \bar{w}}{1 + \bar{r}} \right]^{\frac{\alpha}{1-\alpha}} (h_t)^{\frac{\beta}{1-\alpha}} & \text{if } h_t < \tilde{h} \\ \mu + \left[\frac{\alpha \bar{w}}{1 + \bar{r}} \right]^{\frac{\alpha}{1-\alpha}} (\tilde{h})^{\frac{\beta}{1-\alpha}} \equiv G & \text{if } h_t \geq \tilde{h}, \end{cases}$$

where h_0 is historically given.

As follows from equation [13], if the acquired level of human capital of the middle-aged generation is zero, the young generation does not invest in human capital either and hence has the minimal level of human capital μ . Furthermore, if the level of human capital of the middle-aged generation exceeds \tilde{h} , the level of human capital of the young generation is constant at level G . Namely,

$$[14] \quad \xi(0) = \mu,$$

⁴ Preferences for consumption in all three periods could be incorporated into the analysis. The qualitative nature of the results would not be altered by such a generalization.

and

$$[15] \quad \xi(h_t) = \mu + g(\tilde{h}) x(\tilde{h})^\alpha \equiv G \quad \forall h_t \geq \tilde{h}.$$

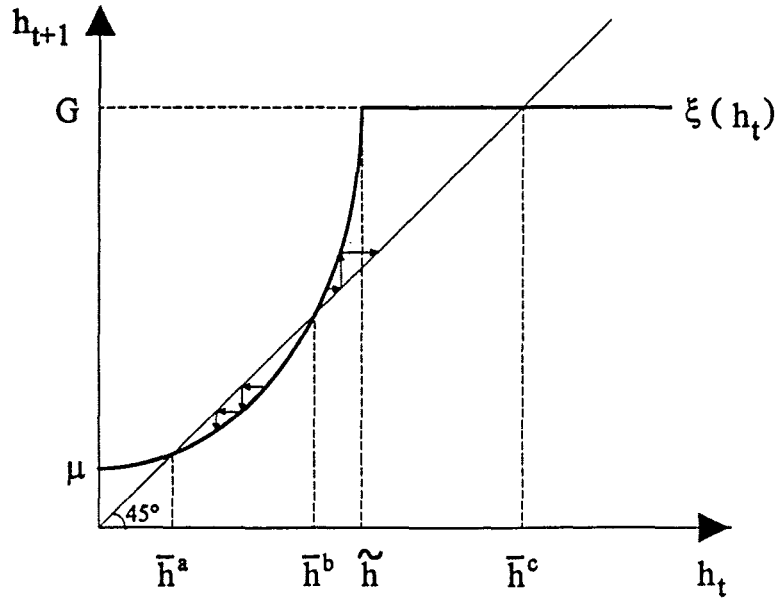
As long as $\beta > (1 - \alpha)$, $\xi(h_t)$ is strictly convex over the interval $(0, \tilde{h})$ and constant for all $h_t \in [\tilde{h}, \infty)$.

Furthermore,

$$[16] \quad \lim_{h_t \rightarrow 0} \xi'(h_t) = 0.$$

The dynamical system can be depicted diagrammatically. In Figure 1, where $\xi(h_t)$ is drawn for some level of μ , the system is characterized by multiple nontrivial steady-state equilibria:⁵ \bar{h}^a and \bar{h}^c are locally stable, whereas \bar{h}^b is locally unstable.

Figure 1 — Multiple, Locally Stable Steady-State Equilibria



⁵ Multiplicity of equilibria is not inconsistent with a neoclassical economy (that is, an economy without nonconvexities). See Galor and Ryder (1989).

3. International Labor Migration

Consider a world where one economy enjoys a technological superiority over another (see Galor and Stark, 1991) and thus, despite the unrestricted movements of capital, the wage rate per efficiency unit of labor is higher in the technologically advanced economy. If international labor migration is permitted, individuals in the technologically inferior economy will find it beneficial to migrate to the technologically superior economy, where the wage rate is higher and the rate of return to capital (and hence to savings) is equal to that in the home economy.

a. Implications for Human Capital Formation

Suppose that, at time t_0 , M individuals, each with an average of h^M efficiency units of labor, enter the technologically superior economy. Since capital is perfectly mobile internationally, the stock of capital in the domestic economy adjusts instantaneously so as to maintain the interest rate unchanged at the level \bar{r} . Consequently, the wage rate per efficiency unit of labor remains unchanged as well at level \bar{w} . Thus, migration does not have the commonly discussed and often feared effects on the wage rate. Migration does, however, affect the average level of human capital at t_0 as long as h^M differs from the average level of human capital among the past population, $h_{t_0}^N$. Consequently, investment decisions in human capital formation in all subsequent periods are affected.

In the aftermath of migration, the average level of human capital at time t_0 in the technologically superior country becomes

$$[17] \quad h_{t_0} = \theta h_{t_0}^N + (1 - \theta)h^M,$$

where $\theta \equiv N/(N + M)$ is the proportion of natives in the labor force, h_{t_0} is the postmigration average level of human capital at time t_0 , and $h_{t_0}^N$ is the level of human capital of the past population at time t_0 . We consider the case where $h^M < h_{t_0}^N$.

If, prior to migration, the technologically superior economy has a dynamical system that is characterized by multiple steady-state equilibria and is positioned to the right of \bar{h}^b , then, as depicted in Figure 1, migration affects the economy in one of the following ways:

(a) If $h_{t_0} < \bar{h}^b$, then migration reverses the evolution pattern of the economy. The economy steps onto a path that will ultimately lead to a lower average human capital steady-state equilibrium \bar{h}^a . Along the path the average human capital level at every point in time is lower than the level that would have been achieved in the absence of migration.

(b) If $h_{t_0} > \bar{h}^b$, then migration is not large enough (M is relatively small) or the average level of human capital of migrants is not sufficiently low so as to reduce the average level of human capital below \bar{h}^b . Then, compared to the alternative (no migration) path, migration reduces the average level of human capital at every point in time during the transition period, even though the long-run average human capital \bar{h}^c remains unchanged.

Thus, despite the fact that migration has no short-run effects on wages or on the interest rate, migration lowers the number of efficiency units of at least all transition generations and possibly those in the steady state as well.

As long as the population in the economy of origin is homogenous, migration will have neither short-run nor long-run effects on average human capital there. However, if migration is positively selected, it will lower the average level of human capital in the economy of origin, assuming that this economy is modeled the same way as the destination economy. Consequently, per capita human capital during transition to the old steady state will be lower, and possibly the steady-state equilibrium will be characterized by lower per capita human capital, provided the dynamical system is characterized by multiple steady-state equilibria. Note that migration of workers of a quality higher than the average at origin can be compatible with these same workers' being of lower quality than that of the workers at destination. This suggests that both economies could be pulled into inferior steady states.⁶

b. Implications for Income per Worker and Welfare

The net income per worker in period $t+2$, y_{t+2} , consists of the per worker wage income of the middle-aged generation minus loan repayment, $\bar{w}h_{t+2} - (1 + \bar{r})x_{t+1}$, in addition to the per worker interest income of the old generation, $(1 + \bar{r})[\bar{w}h_{t+1} - (1 + \bar{r})x_t]$. Thus, using [12] and [13], it follows that for all $h_t < \bar{h}$

$$[18] \quad y_{t+2} = (2 + \bar{r})\bar{w}\mu + \left[\frac{\alpha}{1 + \bar{r}} \right]^{\frac{\alpha}{1-\alpha}} \bar{w}^{\frac{1}{1-\alpha}} (1 - \alpha) \left[(1 + \bar{r}) h_t^{\frac{\beta}{1-\alpha}} + h_{t+1}^{\frac{\beta}{1-\alpha}} \right].$$

Since from [6] and [7] $\partial h_{t+1} / \partial h_t > 0$, it follows that

$$[19] \quad \frac{\partial y_{t+2}}{\partial h_t} > 0 \quad \forall h_t < \bar{h}.$$

⁶ If the quality of migrants is lower than the average at origin but higher than the average at destination, *both* economies could be pulled into a superior steady state.

The utility of a member of generation t , $u(c_{t+2}^t)$, is, as follows upon substitution of [12] and [13] into [10],

$$[20] \quad u(c_{t+2}^t) = \begin{cases} (1+\bar{r}) \left[\bar{w}\mu + h_t^{\frac{\beta}{1-\alpha}} \left[\frac{\alpha}{1+\bar{r}} \right]^{\frac{\alpha}{1-\alpha}} \bar{w}^{\frac{1}{1-\alpha}} (1-\alpha) \right] & \text{if } h_t < \tilde{h} \\ (1+\bar{r}) \left[\bar{w}\mu + \tilde{h}^{\frac{\beta}{1-\alpha}} \left[\frac{\alpha}{1+\bar{r}} \right]^{\frac{\alpha}{1-\alpha}} \bar{w}^{\frac{1}{1-\alpha}} (1-\alpha) \right] & \text{if } h_t \geq \tilde{h}. \end{cases}$$

Thus,

$$[21] \quad \frac{\partial u(c_{t+2}^t)}{\partial h_t} > 0 \quad \forall h_t < \tilde{h}.$$

Consequently, the short-run and long-run implications of migration on human capital formation are positively correlated with the short- and long-run implications for levels of income per worker and welfare. Namely, the reduction in the average level of human capital in the short run, and potentially in the long run as well, reduces income per worker and welfare in the short run, and potentially in the long run as well.

4. Concluding Comments

Our analysis identifies a potential concern but also points to a solution. This can be presented heuristically with the help of Figure 1. Suppose a destination economy, whose current per worker human capital, h_t , is to the right of \bar{h}^b , considers the entry of M relatively low-quality migrants. If all M migrants enter at period t , h_t will shift to the left of \bar{h}^b . Assume instead that in each of n successive periods M/n migrants will be admitted. M/n can be found by observing the constraint that the resulting *per period* left shift of h_t will leave h_t an $\varepsilon > 0$, $\varepsilon \rightarrow 0$ to the right of \bar{h}^b . The receiving economy will then be assured of convergence to the high-output steady-state equilibrium \bar{h}^c , even though all M migrants are admitted.

In modeling the human capital formation process, we take the view that the augmenting variable in human capital formation is average human capital, not total human capital. If the latter is the augmenting variable, obviously our results will not hold. Consider, however, the following thought experiment: Private resources are allocated to human capital formation. In one case, their conversion to human capital takes place when the surrounding population is highly

educated and well experienced. (Other children at school are better educated, other workers in the work place are highly experienced.) In a second case, the surrounding population is poorly educated and inexperienced, but larger. We hold the view that in the first case there is a pulling-up effect (for example, learning from others) that is essentially absent in the second case.

The analysis in this paper cannot possibly be interpreted as a wild cry that labor migration has (potentially) horrendous repercussions. There are many reasons both in the international trade and in the labor migration literature why a country may wish to admit migrant workers and will benefit from their entry. But based on the check-list of goods and bads, the long-run steady-state repercussions are conspicuously absent. This paper serves not only to identify one such repercussion, but perhaps also to highlight the need to pay closer attention to the long-run structural consequences of labor migration.

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