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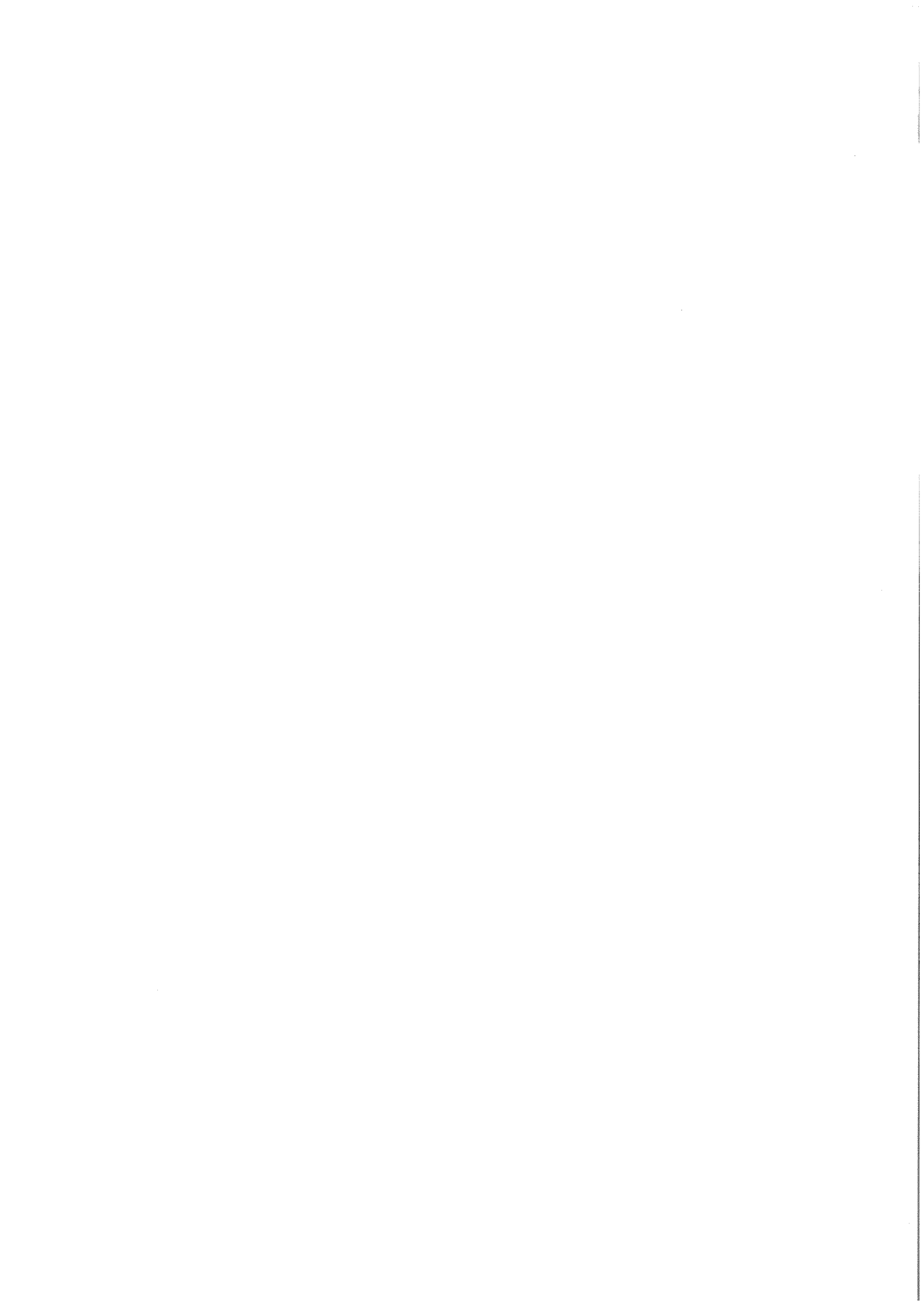
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Abstract

We specify conditions under which a strictly positive probability of employment in a foreign country raises the level of human capital formed by optimizing workers in the home country. While some workers migrate, "taking along" more human capital than if they had migrated *without* factoring in the possibility of migration (a form of brain drain), other workers stay at home with more human capital than they would have formed in the absence of the possibility of migration (a form of brain gain).

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Human capital formation, migration

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1. Introduction

There is a strong consensus that deficiency in human capital is a major cause of poor countries remaining poor. There is also a widely held view that the reason for the paucity of human capital in developing countries is that the incentives to form it are weak. Had optimizing individuals faced an incentive environment conducive to human capital formation, more human capital would have been formed. To render matters worse, when reasonable quantities of human capital are formed, some, and often more than a mere some, are lost through the migration leakage. No wonder then that the concern heretofore has been to contain the leakage. In the words of a recent World Development Report: "Can something be done to stop the exodus of trained workers from poorer countries?" (World Bank, 1995, p.64).

In this paper we question the conviction of the migration "culprit". The key idea is that compared to a closed economy, an economy open to migration differs not only in the opportunities that workers face but also in the structure of the incentives they confront; higher prospective returns to human capital in a foreign country impinge on human capital formation decisions at home. We investigate how a strictly positive probability of employment in a foreign country *raises* the level of human capital formed by optimizing individuals *in the home country* such that the migration prospect serves as a positive inducement device, plausibly contributing to economic development at home. Thus, not only do we associate a likely positive repercussion with migration, we also take a quite different view regarding the often held opinion that if there are gains to be reaped, they arise from remittances: "Remittances constitute the primary gain to developing countries from migration" (World Bank, 1995, pp.65, 66). In addition, we bystep the argument that the human capital gains associated with migration accrue from return migration upon the returnees bringing home new skills acquired abroad. Our key point is that additional human capital is formed at home in anticipation of probable migration, and thus prior to the realization of migration, rather than abroad subsequent to migration.

2. The Model

Consider a workforce in a closed economy. Members of the workforce live for two periods. In the first period they work and can engage in human capital formation. Work is rewarded by a competitive wage, w_H , per efficiency unit of labor. The cost of forming human capital is equal to forgone earnings.¹ Every worker is endowed with one unit of labor. Denoting by $l \in (0,1)$ the proportion of the unit endowment of labor that a worker chooses to allocate to human capital formation, first period earnings are $(1-l)w_H$. In line with Galor and Stark (1993), the amount of productive human capital, measured in efficiency units of labor, which is available to a worker in the second period of his life, is given by the continuously differentiable function

$$\phi(l), \quad \text{where } \phi'(l) > 0, \phi''(l) < 0 \quad \forall l \in (0,1). \quad (1)$$

Thus, the number of efficiency units available in the second period is increasing in the level of investment in human capital, but at a decreasing rate. Furthermore, we assume

$$\lim_{l \rightarrow 0} \phi'(l) = \infty \quad \text{and} \quad \lim_{l \rightarrow 1} \phi'(l) = 0. \quad (2)$$

The second period earnings of the worker are $\phi(l)w_H$. Per period utility, $U(x)$, is derived from periodic income.² The properties of $U(x)$ are

$$U(0) = 0, \quad U'(x) > 0, \quad U''(x) < 0 \quad \forall x \geq 0. \quad (3)$$

Assume now that a migration opportunity avails itself in the second period; workers can migrate from the home country, H , to a foreign country, F . To reflect the fact that the foreign country is rich and the home country is poor, it is assumed that the competitive wage per efficiency unit of labor in the foreign country, w_F , exceeds

¹ Direct outlays in connection with human capital investment are disregarded.

² We assume that workers consume their entire wage income $(1-l)w_H$ in the first period, and their entire wage income $\phi(l)w_H$ in the second period.

the competitive wage per efficiency unit of labor in the home country, w_H . Wages in H and in F are independent of migration (migration is relatively small) and human capital is perfectly transferable across countries.

Assume further that with probability $0 \leq p \leq 1$, an H country worker secures employment abroad, while with probability $1-p$ he or she fails to secure such an employment, in which case the worker remains in H . Given the second period migration opportunity, the worker's optimization problem involves choosing l such as to maximize his or her intertemporal utility:

$$\begin{aligned} \max_l & \left[U((1-l)w_H) + \rho \left[pU(\phi(l)w_F) + (1-p)U(\phi(l)w_H) \right] \right] \\ \text{s.t. } & l \in (0,1), \end{aligned} \quad (4)$$

where $0 < \rho \leq 1$ is the subjective time rate of discount. Note that equation (4) includes the worker's optimization problem in a closed economy as a special case with $p = 0$.

Given the properties of the production function of human capital, $\phi(\cdot)$, as given by (1) and (2), and the properties of the utility function, $U(\cdot)$, as given by (3), the time allocated to human capital formation, l , is strictly positive. From the Karush-Kuhn-Tucker conditions for optimizing (4) we have

$$\frac{U'((1-l)w_H)}{\rho \left[p \left[U'(\phi(l)w_F) \frac{w_F}{w_H} - U'(\phi(l)w_H) \right] + U'(\phi(l)w_H) \right]} = \phi'(l). \quad (5)$$

The assumptions pertaining to the strict concavity of the human capital production function and to the strict concavity of the utility function guarantee that an interior and unique solution of (4) exists.

Our interest is in finding out whether the presence of the migration opportunity leads to investment in human capital such that the H country is left with more human capital per worker than it would have had in the absence of migration.

3. A Result

Proposition: If $U'(\phi(l)w_F)w_F > U'(\phi(l)w_H)w_H$, the optimal level of human capital formed given an opportunity to migrate exceeds the optimal level of human capital formed in the absence of an opportunity to migrate.

Proof: Note, first, that as a function of l , the nominator of the left-hand side of (5) is strictly increasing in l ; the denominator, which can be written as $\rho \left[pU'(\phi(l)w_F)\frac{w_F}{w_H} + (1-p)U'(\phi(l)w_H) \right]$, is strictly decreasing in l . Therefore, the expression on the left-hand side of (5) is strictly increasing in l . Expressing the left-hand side of (5) as a function of l and p , (5) can be rewritten as

$$\psi(l, p) = \phi'(l), \quad (5')$$

and we thus have that $\frac{\partial \psi(l, p)}{\partial l} > 0$.

Second,

$$\frac{\partial \psi(l, p)}{\partial p} = - \frac{U'((1-l)w_H) \left[U'(\phi(l)w_F)\frac{w_F}{w_H} - U'(\phi(l)w_H) \right]}{\rho \left[p \left[U'(\phi(l)w_F)\frac{w_F}{w_H} - U'(\phi(l)w_H) \right] + U'(\phi(l)w_H) \right]^2} < 0, \quad (6)$$

where the inequality sign is due to the condition in the Proposition.

Third, implicit differentiation of (5') yields

$$\frac{\partial \psi(l, p)}{\partial p} + \frac{\partial \psi(l, p)}{\partial l} \frac{dl}{dp} = \phi''(l) \frac{dl}{dp}$$

or

$$\left[\frac{\partial \psi(l, p)}{\partial l} - \phi'(l) \right] \frac{dl}{dp} = - \frac{\partial \psi(l, p)}{\partial p}. \quad (7)$$

Since, as already shown, $\frac{\partial \psi(l, p)}{\partial l} > 0$, and since $\phi''(l) < 0$, the bracketed term on the left-hand side of (7) is positive. From (6) we have that $\frac{\partial \psi(l, p)}{\partial p} < 0$. Therefore, it must be that $\frac{dl}{dp} > 0$. Since $\phi'(l) > 0$, $\phi(l)$ associated with a larger l is larger. \square

Note that any function $U(z)$ that maintains $U'(z) + zU''(z) > 0$ meets the condition stated in the Proposition. For example, the utility functions $U(z) = \ln(z+1)$ and $U(z) = z^\alpha$, where $0 < \alpha < 1$, meet the condition.³ More generally, the condition is met by any utility function exhibiting relative risk aversion smaller than 1.

4. Conclusions

The opportunity to migrate from H to F impinges on the human capital formation decision of workers in H . A positive probability of becoming employed abroad alters workers' incentives such that the pre-migration per worker investment in human capital is larger than had the probability been zero.

While some workers migrate, "taking along" more human capital than if they had migrated *without* factoring in the possibility of migration (a form of brain drain), other workers stay at home with more human capital than they would have formed in the absence of the possibility of migration (a form of brain gain).

³ If $U'(z) + zU''(z) > 0$ then $zU'(z)$ is a strictly increasing function. Hence, for $z_2 > z_1$, we have that $z_2 U'(z_2) > z_1 U'(z_1)$. Setting $z_2 = \phi(l) w_F$ and $z_1 = \phi(l) w_H$, the inequality as stated in the Proposition holds. Indeed, for $U(z) = \ln(z+1)$, $U'(z) + zU''(z) = \frac{1}{(z+1)^2} > 0$, and for $U(z) = z^\alpha$, $U'(z) + zU''(z) = \alpha^2 z^{\alpha-1} > 0$.

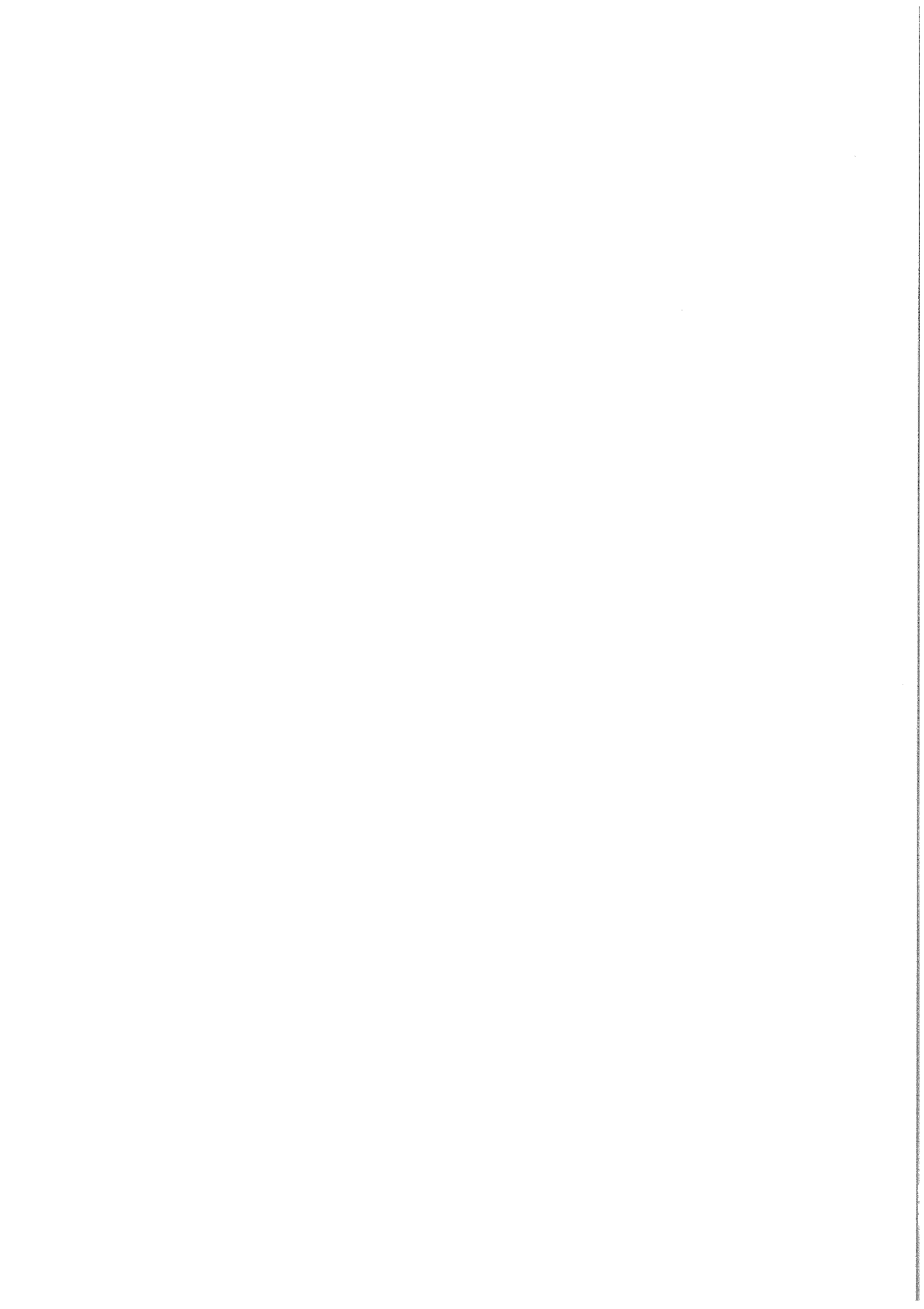
The human capital formation model presented in section 2 fails to take into account the possibility that human capital formation is subsidized by H country's government. In the model, the cost of acquiring human capital is born by the worker (it is the first period forgone earnings, lw_H). Suppose, however, that there is a public subsidy of βlw_H , where $0 \leq \beta < 1$. The reduced cost of human capital formation is then $(1-\beta)lw_H$, and first period earnings are $[1-(1-\beta)l]w_H$. While the actual level of human capital formed will now be higher, our key result remains exactly as before since the Proposition is not affected.

In an earlier paper (Stark, Helmenstein, and Prskawetz, 1997) the following argument was presented: faced with an opportunity to migrate and receive higher expected returns to investment in human capital, optimizing workers in H acquire human capital and migrate. Employers in F initially pay all migrant workers the same wage based on the average product of the group of migrants. Subsequently, after deciphering individual skills, employers tailor their wage payments to *individual* productivities. The relatively low-skill workers enjoy a pre-discovery high wage in F , but a lower wage following discovery. Such a wage adjustment can prompt return migration by these workers. We calculated the average level of human capital in H when it is a closed economy, and then following migration *and* return migration. We specified conditions under which the post-migration cum post-return average level of human capital in H is higher than the corresponding level if migration had not been permitted. While the result obtained in the present paper is akin to the result derived in our earlier paper, the modelling procedure is quite different as it completely abstracts from return migration.

Perhaps opening the gate in F to workers from H (when $w_F > w_H$), such that the probability of being allowed entry rises in the level of human capital of prospective migrants, apart from presumably benefiting the foreign country, could well generate a *positive* externality for the home country.

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