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The effect of emigration on human capital formation

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Abstract. This paper focuses on a possible effect of emigration on human capital formation. Emigration to a higher returns to skill country provides an incentive to invest in human capital. The level of human capital formation in the source country can therefore be positively correlated with the probability of emigration. Incidentally a surge in emigration can lead the source country out of an under-development trap. The implications of the model for the convergence controversy are also discussed.

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1. Introduction

It is often advocated that labour migration has a negative impact on the source country (see, for example, Haque and Kim 1995; Miyagiwa 1991). This issue has been paid much attention under the nomenclature of the "brain drain" during the 1970s. Mountford (1997), and more recently Stark et al.

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(1997) have questioned this conventional wisdom and shown the possibility of a "brain drain with a brain gain". They put the emphasis on the incentives for human capital formation in the source country. Higher returns to skill in a foreign country impinge on human capital formation at home.

This paper rests on the same economic intuition, and focuses on the dynamic consequences of labour emigration on human capital formation and economic growth. It contributes to two recent strands of literature, the international migration literature and the human capital and growth literature. Since Galor's seminal article (1986), there has been a growing interest for the overlapping generations (OLG) approach in the international labour migration literature (see, among others, Crettez et al. 1996, 1998; Galor 1992; Galor and Stark 1990, 1991, 1994; Karayalcin 1994; Kochhar 1992; Kondo 1989; Mountford 1997; Stark 1991).

The human capital and growth literature – initiated by Lucas (1988) – has investigated the role of human capital in economic growth. Lucas points out that human capital formation is both a private and a social activity. Through their investment in human capital, individuals enhance their earning ability and contribute to the aggregate level of productivity. The formation of human capital is thus driven by individuals' incentives and externalities within and across generations. One of the interesting features of the OLG approach to human capital and economic growth is the possibility of multiple steady-state equilibria and dynamical systems characterised by threshold externalities (see Azariadis and Drazen 1990; Galor and Tsiddon 1996, 1997). Galor and Tsiddon (1996) develop a model in which the evolution of income inequality and output conforms with the Kuznets hypothesis. Galor and Tsiddon (1997) analyse the pattern of human capital distribution and economic growth. Galor and Stark (1994) and Mountford (1997) apply the model developed in Galor and Tsiddon (1996, 1997) to the issue of international labour migration. Galor and Stark (1994) examine the pattern of labour immigration and human capital accumulation. Mountford (1997) analyses the interaction between income distribution, human capital accumulation, and labour emigration. This paper continues this research stream by investigating the effect of labour emigration on human capital formation and economic development when migration is uncertain.

The basic model follows rather closely the framework developed by Galor and Tsiddon, and complements Mountford's analysis in two ways. First, it abstracts from problems relating to the distribution of human capital and develops further the novel idea that emigration can in fact be constructive for growth by providing an incentive for human capital formation in the source country. Due to the simplicity of the model the dynamical system can be fully characterised; I derive the condition under which migration causes a bifurcation in the dynamics of the model. In this case, interestingly, emigration can free the sending country from a poverty trap. To do so the probability of emigration must be high enough; there is a threshold effect as in Azariadis and Drazen (1990). Second, I consider an extension in which the probability of emigration is endogenised; it is assumed to depend on the source economy's average level of human capital. In this setting, two dynamical patterns of interest emerge. First of all, the economy can be trapped at a low stage of development in the short run provided that its initial level of human capital is sufficiently low. Therefore the model is consistent with club convergence in the short run and conditional convergence in the long (see Galor 1996 for a dis-

cussion of these alternative hypotheses). The model is also consistent with club convergence in the long run for some parameter values.

The rest of the paper is organised as follws. Section 2 sets up the model. Section 3 discusses implications of labour emigration for human capital formation, economic growth, and convergence. Section 4 concludes.

2. The model

Consider a small open overlapping-generations economy that operates in a perfectly competitive world. Economic activity extends over an infinite discrete time. In every period a single homogenous good is produced using capital and labour measured in efficiency units according to a neoclassical production technology. The good can be consumed, saved or used as an input in the formation of human capital. In each period a new generation which consists of a continuum of individuals of measure N is born[1]; for the sake of simplicity there is no population growth. Agents are two period-lived and supply one unit of labour in both periods of their life. When young they choose to save and to invest in human capital formation. They face a probability p to emigrate to a high wage country at the beginning of their second period of life. The supply of capital in every period consists of domestic savings in addition to international lending or borrowing. The supply of efficiency labour in every period is equal to the supply of the young that depends on the average inherited level of human capital in the economy and the supply of the old who have not emigrated.

2.1 The production sector

Production occurs according to a constant-returns-to-scale production function which is invariant through time. The output produced at time t, Y_t, is:

$$Y_t = F(K_t, H_t) \equiv H_t f(k_t); \quad k_t = K_t/H_t$$

where K_t and H_t are the capital and efficiency labour employed at time t. The supply of efficiency labour at time t equals the supply of the young Nh_t and of the old who have not emigrated, $(1-p)\ Nh_t$; N is the size of each generation, and h_t is the level of human capital of an individual born at t that equals the average level of human capital of individuals born at $t-1$ at the beginning of their second period of life. The production function is twice continuously differentiable, strictly monotonic increasing and concave, and satisfies the Inada conditions.

The economy is perfectly competitive so that production factors are paid their marginal product:

$$R_t = f'(k_t)$$

$$w_t = f(k_t) - k_t f'(k_t)$$

where R_t is the gross rate of return on physical capital and w_t the wage rate per efficiency unit of labour.

Suppose now that the world rental rate is stationary at a level R. Since the small economy allows unrestricted lending or borrowing, its rental rate is set equal to the world rental rate. Hence the ratio of capital to efficiency units of labour is stationary over time at level k and the wage rate per efficiency unit of labour is equal to $w = f(k) - kf'(k)$.

2.2 *The individuals*

In every time period a new generation of size N is born. Within as well as across generations, individuals are identical in their production technology of human capital. A member of generation t inherits the economy average level of human capital that works as an intergenerational externality. At time t he can invest e_t units of real resources in the formation of human capital to increase his second period level of human capital. His labour supply during his second period of life is given by:

$$h_{t+1} = \mu + g(h_t)e_t^{\alpha} \tag{2.1}$$

where $\mu > 0$, $\alpha \in]0, 1[$, and $g(h_t)$ is an externality that depends on the average level of human capital in the economy ($g'(h_t) > 0$).

During their first period of life, individuals born at time t supply h_t units of labour and earn $h_t w$. They save s_t and invest e_t in human capital formation. For simplicity we will assume that agents do not consume during their first period of life:

$$h_t w = s_t + e_t$$

Individuals face a probability p of emigrating to a high wage country at the beginning of their second period of life. The high wage country is characterised by a Hicks-neutral technological superiority so that unrestricted capital mobility results in a wage rate differential (see Galor and Stark 1991); individuals born in the technologically-inferior country have an incentive to migrate to the technologically-superior one[2]. I denote with $w^* > w$ the wage rate in the destination country. In the absence of restriction on labour mobility, every individual would migrate to the high wage country. Here I assume that individuals cannot emigrate during their first period of life and that only a fraction p of old individuals is allowed to emigrate. This can reflect restrictions on labour mobility such as quotas.

With probability $(1 - p)$ individuals are not allowed to emigrate and consume:

$$c_{t+1} = Rs_t + h_{t+1}w$$

With probability p they spend their second period of life in the high wage country and consume:

$$c_{t+1}^* = Rs_t + h_{t+1}w^*$$

I assume that individuals are risk neutral so that they choose the level of in-

vestment in human capital so as to maximize their expected income[3]:

$$(1-p)[R(h_t w - e_t) + (\mu + g(h_t)e_t^{\alpha})w] + p[R(h_t w - e_t) + (\mu + g(h_t)e_t^{\alpha})w^*]$$

3. Implications of labour emigration

How does an increase in the probability of emigration affect the pattern of human capital formation in the source country? Higher returns to skill in a foreign country provide an additional incentive to investment in human capital. I first show this possible effect of emigration on human capital formation. Then I show that, in the Galor and Stark (1994) setting, labour emigration can lead the source country out of an underdevelopment trap. Finally, I consider an extension in which the probability of emigration is endogenised, and discuss the implications of the model for the convergence controversy. In particular, it is shown that the model is consistent with club convergence in the short run and conditional convergence in the long run as well as with club convergence in the long run.

3.1 Emigration fostering human capital formation

Given the assumptions concerning the production function of human capital, there exists a unique and interior solution to the individuals' maximisation problem characterised by:

$$e_t = \left[\frac{\alpha g(h_t)((1-p)w + pw^*)}{R}\right]^{1/(1-\alpha)} \tag{3.1}$$

The return on human capital is increasing with the probability of migration to the high wage country. We thus have the following proposition:

Proposition 3.1. *The higher the probability of emigration the higher the level of human capital formation. The long-run level of human capital is positively correlated with the probability of emigration.*

Proof: Differentiating (3.1) one obtains:

$$\frac{\partial e_t}{\partial p} = \frac{\alpha g(h_t)[w^* - w]e_t^{\alpha}}{(1-\alpha)R} > 0$$

The law governing human capital accumulation is given by:

$$h_{t+1} = \mu + \left[\frac{\alpha((1-p)w + pw^*)}{R}\right]^{\alpha/(1-\alpha)} [g(h_t)]^{1/(1-\alpha)}$$

Starting from any initial condition on the level of human capital, h_0, we can compare the dynamic paths for two different probabilities of emigration, say $\bar{p} > p$. Inspecting the law governing the dynamics, we obviously have: $\bar{h}_1 >$

$h_1 \Rightarrow \overline{h}_2 > h_2$ and so forth. It straightforwardly follows that the long-run level of human capital is positively correlated with the probability of emigration. ■

3.2. *Out of the underdevelopment trap*

From this section on, I assume that the externality governing human capital accumulation is of the Galor-Stark (1994) type:

$$g(h_t) = \begin{cases} h_t^{\beta} & \forall h_t < \tilde{h} \\ \tilde{h}^{\beta} & \forall h_t \geq \tilde{h} \end{cases} \quad \beta \in]0,1[\tag{3.2}$$

Following (2.1), (3.1) and (3.2), the dynamics of human capital are governed by:

$$h_{t+1} = G(h_t) = \begin{cases} \mu + \left[\dfrac{\alpha((1-p)w + pw^*)}{R}\right]^{\alpha/(1-\alpha)} h_t^{\beta/(1-\alpha)} & \text{if } h_t < \tilde{h} \\ \mu + \left[\dfrac{\alpha((1-p)w + pw^*)}{R}\right]^{\alpha/(1-\alpha)} \tilde{h}^{\beta/(1-\alpha)} \equiv \overline{H}(p) & \text{if } h_t \geq \tilde{h} \end{cases}$$

where h_0 is historically given and G is convex, that is $\beta > 1 - \alpha$. Under this assumption, $G'(0) = 0$. This dynamical system is akin to that described by Galor and Stark (1994). The difference lies in the probability of emigration, p. $\overline{H}(p)$ is always a steady state of the economy. In what follows I choose $\tilde{h}$ such that $G(\tilde{h}) > \tilde{h}$, for all $p \in [0,1]$ and $\mu > 0$; this amounts to assume: $\tilde{h} > \left(\dfrac{R}{\alpha w}\right)^{\alpha/(\beta+\alpha-1)}$. Depending on the value of parameters the system may be characterised by one, two or no other steady-state equilibria (see Fig. 1).

I am particularly interested in the sensibility of the dynamics with respect to p. I proceed further by assuming that the closed economy ($p = 0$) is characterised by three steady state equilibria (two stable, h_1 and $\overline{H}(0)$, and one unstable, h_2); the fully open economy ($p = 1$) only has the stable high level of human capital equilibrium, $\overline{H}(1)$. As shown in the appendix this amounts to restrict the admissible values of μ for the problem at hand: $\mu \in [\underline{\mu}, \bar{\mu}]$. This means that there exists a value of the probability of emigration denoted with $\tilde{p}(\mu)$ such that the economy exhibits two steady-state equilibria. Technically the dynamical system is characterised by a saddle-node bifurcation; the implicit function theorem fails to apply at the bifurcation point $\tilde{p}(\mu)$.

Proposition 3.2. *If $\mu \in [\underline{\mu}, \bar{\mu}]$, there exists a critical level of the probability of emigration $\tilde{p}(\mu) \in [0,1]$ at which the economy exhibits a bifurcation. If $p > \tilde{p}(\mu)$, the economy leaves the underdevelopment trap and converges to the high level of human capital equilibrium $\overline{H}(p)$ regardless of its initial level of human capital.*

Proof: See Appendix

The opening of the economy to labour emigration does not imply convergence to the highest possible level of human capital accumulation. The prob-

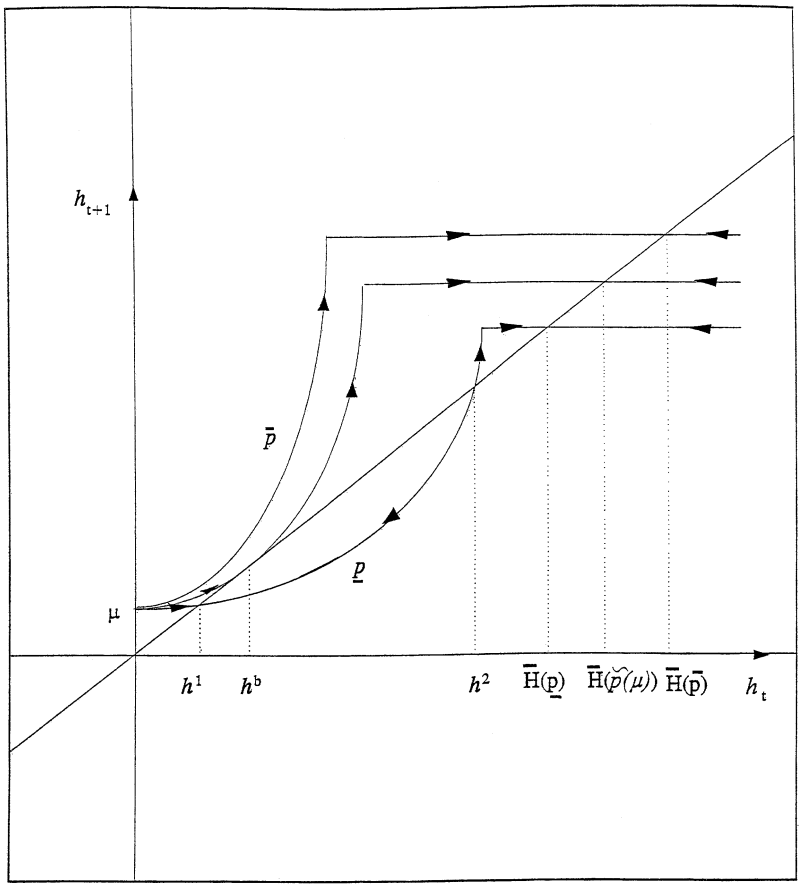

Fig. 1.

ability of emigration must be high enough to guarantee convergence to this upper level of human capital; there is a threshold effect.

3.3. Consequences for convergence[4]

As established in the previous section, the prospect of emigrating to a high wage country provides an additional incentive to invest in human capital formation in low wage countries. What are the implications of the model for the convergence controversy?

Let me first consider this question in the basic model. Again I assume that $\mu \in [\underline{\mu}, \bar{\mu}]$; emigration generates a bifurcation of equilibria. I consider two settings, one with a high probability of emigration ($\bar{p} > \tilde{p}(\mu)$) and the other with a low probability of emigration ($\underline{p} < \tilde{p}(\mu)$). The dynamical system with $\underline{p}$ has three steady state equilibria (two stable, one unstable) while there exists a unique steady-state equilibrium with $\bar{p}$. In the dynamical system associated with $\underline{p}$ the low level of human capital equilibrium, h^1, is an underdevelopment

trap (see Fig. 1). Economies starting with an initial level of human capital below h^2 are trapped in a low level of human capital steady-state equilibrium; economies starting with a sufficiently high initial level of human capital (above h^2) cluster towards the high level of human capital equilibrium. The model can generate club convergence in both the short and the long run. On the other hand, the dynamical system associated with $\bar{p}$ is characterised by a unique steady-state equilibrium (see Fig. 1); economies converge towards the high level of human capital steady state regardless of their initial level of human capital. The model generates conditional convergence provided that the probability of emigration is sufficiently high.

I now amend the basic model to endogenise the probability of emigration. I assume that the probability of emigration depends positively on the average level of human capital. This assumption corresponds to immigration quotas which are biased in favour of educated individuals. Individuals living in countries with a low average level of human capital face a lower probability of emigration than those living in relatively more developed countries. For simplicity I consider a step function as in Galor and Tsiddon (1996):

$$p(h_t) = \begin{cases} \underline{p} & \text{if } h_t < h^{\#} \\ \bar{p} > \underline{p} & \text{if } h_t \geq h^{\#} \end{cases}$$

How does the presence of a threshold externality in the probability of emigration affect the convergence patterns? The dynamical system is now characterised by a threshold externality. Would economies converge to the same steady state regardless of their initial level of human capital? Is club convergence a likely outcome? As shown by Galor (1996) the neoclassical paradigm is consistent with both the conditional convergence and the club convergence hypotheses.

If the threshold $h^{\#}$ is below the low level of human capital steady state h^1 of the previous dynamical system with $\underline{p}$, the new dynamical system is characterised by a unique stable steady-state equilibrium. Economies endowed with an initial level of human capital h^L below $h^{\#}$ will tend to converge towards h^1 as long as $h_t < h^{\#}$ (see[5] Fig. 2). Once the threshold is reached, the economy converges to the long-run steady state. Economies endowed with an initial level of human capital h^H above $h^{\#}$ will converge to the high level of human capital steady state, H. Convergence towards this long-run equilibrium will therefore be preceded by clustering. Club convergence will occur in the short run; conditional convergence results in the long run.

If $h^2 > h^{\#} > h^1$ (again h^2 and h^1 are steady states of the previous dynamical system with $\underline{p}$), the dynamical system is characterised by two stable steady state equilibria. In this case, economies starting with a level of human capital below $h^{\#}$ will converge to the low level of human capital equilibrium. Those starting with a level of human capital above $h^{\#}$ converge to the high level of human capital equilibrium. Club convergence therefore occurs both in the short and the long run.

4. Concluding remarks

This paper has further developed a novel idea that labour emigration may in fact be constructive for economic growth by providing an incentive for human

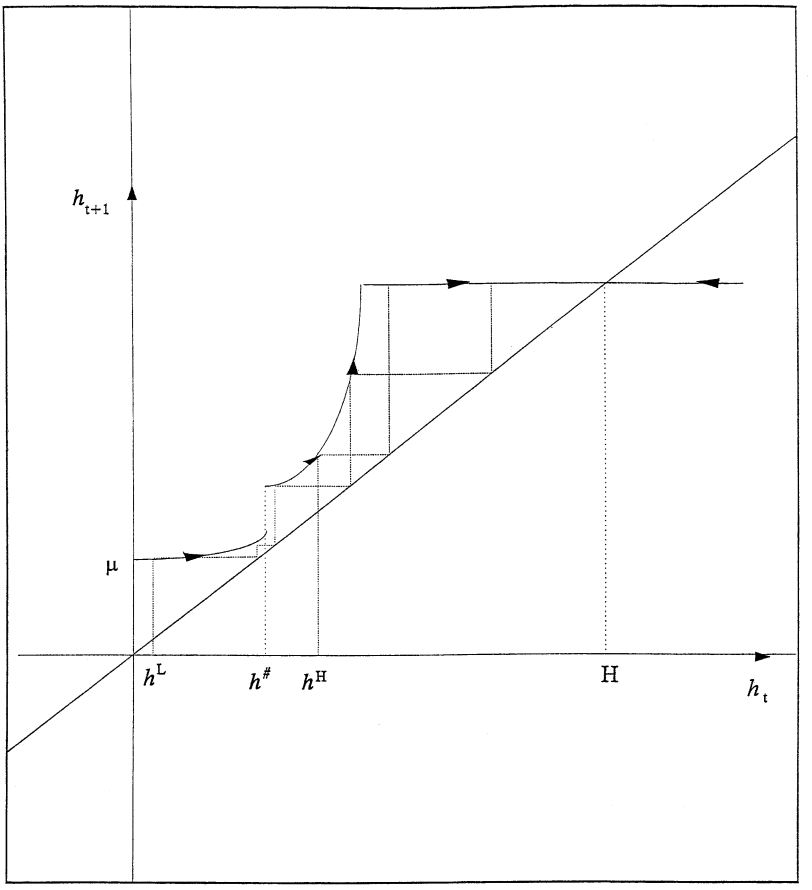

Fig. 2.

capital formation in the source country. This very simple model does not, however, capture all the effects of labour emigration and has been purposely designed to isolate the effect of a general emigration (see Mountford 1997 for an analysis with heterogenous individuals).

In turn the model – albeit very simple – can explain why the level of human capital formation differs less between low and high wage regions of a same country, in which there is no barrier to labour mobility than across countries. Barriers to labour emigration to high wage countries discourage the formation of human capital in low wage countries. On the other hand, job opportunities in a technologically-superior neighbouring country create a spillover effect on the formation of human capital in the sending country. These results are consistent with the empirical findings of Chua (1993) and Beine et al. (1998). Chua shows that convergence is more likely to occur between countries within a region than between regions within the world[6]. Beine et al. provide empirical support for a positive effect of emigration on the source country's growth rate.

Appendix

For $h_t < \tilde{h}$, the dynamics are given by:

$$h_{t+1} = \mu + \theta(p) h_t^{\beta/(1-\alpha)} \equiv G(h_t)$$

where $\theta(p) = \left[\dfrac{\alpha((1-p)w + pw^*)}{R}\right]^{\alpha/(1-\alpha)}$.

Define: $\Delta(h) = \mu + \theta(p) h^{\beta/(1-\alpha)} - h$. Assume that $G(\tilde{h}) > \tilde{h}$. Then, one has:

$$\Delta(0) = \mu > 0$$

$$\Delta(\tilde{h}) = G(\tilde{h}) - \tilde{h} > 0$$

A sufficient condition (on this, see Azariadis 1993) for the existence of two positive stationary equilibria (in addition to $\overline{H}$) is:

$$\Delta^* = \min_h \Delta(h) < 0$$

Note that $\Delta''(h) > 0$. One has:

$$\Delta'(\hat{h}) = 0 \quad \Leftrightarrow \quad \hat{h} = \left(\frac{1-\alpha}{\beta\theta(p)}\right)^{(1-\alpha)/(\beta-1+\alpha)}$$

I proceed further by studying the sign of $\Delta^* = \Delta(\hat{h})$ with respect to p. One has:

$$\Delta^* = \mu - AX$$

where

$$A = \frac{\beta - 1 + \alpha}{1-\alpha}\left(\frac{1-\alpha}{\beta}\right)^{\beta/(\beta-1+\alpha)} > 0$$

and

$$X = [\theta(p)]^{(1-\alpha)/(1-\alpha-\beta)}$$

Hence:

$$\Delta^* < 0 \quad \Leftrightarrow \quad X > \frac{\mu}{A}$$

$$\Leftrightarrow p < \frac{R}{\alpha(w^* - w)}\left[\frac{A}{\mu}\right]^{(\beta+\alpha-1)/\alpha} - \frac{w}{w^* - w} \equiv \tilde{p}(\mu)$$

Since $\tilde{p}(\mu)$ is a strictly decreasing function of range $\left]-\dfrac{w}{w^* - w}, +\infty\right[$, there

exists an interval $[\underline{\mu}, \bar{\mu}]$ such that $\tilde{p}(\mu) \in [0,1] \Leftrightarrow \mu \in [\underline{\mu}, \bar{\mu}]$ where:

$$\bar{\mu} = A\left(\frac{R}{\alpha w}\right)^{\alpha/(\beta+\alpha-1)}$$

and

$$\underline{\mu} = A\left(\frac{R}{\alpha w^*}\right)^{\alpha/(\beta+\alpha-1)}$$

I now assume that $\mu \in [\underline{\mu}, \bar{\mu}]$. At the bifurcation point $p = \tilde{p}$ the two hyperbolic equilibria (one stable and one unstable) merge. The model provides an example of saddle-node bifurcation (see Azariadis 1993).

Endnotes

[1] Since we are in a migration setting, this simplifying assumption is questionable. Alternatively, I could assume that individuals live for three periods, rear their child during their second period of life and emigrate without them.

[2] One could alternatively assume that there is a third factor of production in fixed supply such as land, whose endowments differ across countries. Unrestricted capital mobility does not result in equalization of wage rates (see Crettez et al. 1998).

[3] This assumption is made to isolate the effect I wish to highlight; introducing risk aversion or consumption when young would mitigate the result.

[4] I wish to thank an anonymous referee of this journal for urging me to write this section.

[5] Of course h^1 is not attainable, and is therefore not represented on Fig. 2.

[6] See Ades and Chua (1997) for empirical evidence concerning negative regional spillovers.

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