

Openness, Human Capital and Multiplicity of Equilibrium

Ali Benabdennour^{1,2}

¹ Laboratory of Prospective, Strategy and Sustainable Development, University of Tunis El Manar, Tunisia

² Higher Institute of Management, University of Gabès, Tunisia

Correspondence: Ali Benabdennour, Institut Supérieur de Gestion de Gabès, Rue Jilani Lahbib, 6002 Gabès, Tunisie. E-mail: ali_benabdennour@yahoo.fr

Received: July 31, 2013

Accepted: September 2, 2013

Online Published: October 26, 2013

doi:10.5539/ijef.v5n11p124

URL: <http://dx.doi.org/10.5539/ijef.v5n11p124>

Abstract

Inspired by Lucas model (1988), this paper develops a theoretical analysis of the long-term dynamic growth, with reference to threshold effects. Threshold effects are associated with openness and social endowment of human capital. The objective is to explain the divergence of long-term growth paths, observed for a long period, between countries and regions. The main results show that the long-term dynamic growth is characterized by a multiplicity of equilibrium. The latter is explained by the nonlinear effects of openness and social endowment of human capital on the long-term growth. The analysis concludes that the growth dynamic is defined by two dissimilar growth regimes. These Growth regimes are separated by a critical threshold associated with the complementarity between openness and the social endowment of human capital. The first regime (low equilibrium) corresponds to a trap and admits the usual configurations of exogenous growth models; the second regime (high equilibrium) admits the main characteristics of endogenous growth.

Keywords: openness, human capital, threshold effects, economic growth

1. Introduction

The observation of the international distribution of income shows that an increasing dispersion is the salient fact of the economic history. This dispersion is justified by the continued success of the initially rich countries in following a high-potential-growth path, against the stagnation of the majority of the initially poor countries. These latter seem trapped in underdevelopment and they find difficulties escaping it (Benabdennour, 2012; World Bank, 2006; Bourguignon & Morrison, 2002).

To explain the observed facts, numerous studies have analyzed the long-term dynamic growth with reference to threshold effects associated with the economic policies and initial conditions (Serranito, 1999; Desdoigts, 1997; Berthélemy & Varoudakis, 1995; Azariadis & Drazen, 1990; Becker, Murphy, & Tamura, 1990). These studies have shown that the long-term dynamic growth is characterized by, at least, two dissimilar growth regimes, due to the nonlinearity effects of economic policies and initial conditions. The first regime (low equilibrium) corresponds to a trap and admits the usual configurations of exogenous growth models; the second regime (high equilibrium) admits the main characteristics of endogenous growth.

Generally, studies conclude that the takeoff process is possible only if the economy succeeds in ensuring critical thresholds associated with the economic policies and initial conditions. It is a necessary condition for the economy to benefit from economic and institutional potential, allowing external effects to promote endogenous growth dynamic. Devoid of this condition, the external effects are absent and the returns are decreasing; the economy would be placed on a low-potential-growth path and converges to a poverty trap.

On the basis of this analytical framework, this paper proposes a theoretical development inspired by Lucas model (1988). The aim is to explain the long-term dynamic growth, with reference to threshold effects associated with openness and social endowment of human capital.

2. Openness, Human Capital and Growth Dynamic

The model proposes a production function with substitutable factors. The output is a function of physical capital (K) and an aggregate of effective work (u_hL). In the proposed production function, (h_a) (Note 1) denotes the social endowment of human capital; (ψ) is the elasticity of output relative to the social endowment of human capital. The integration of this variable is justified by the fact that the level of social endowment of human

capital has a positive externality that can improve the productivity of private inputs and, therefore, can stimulate the production. In the presence of this externality, the external returns of scale are increasing:

$$Y_t = A_t K_t^\alpha (u_t h_t L_t)^{1-\alpha} h_a^\psi; \quad 0 < \alpha < 1, \quad \psi > 0$$

In the expression above, (u) represents the part of the time devoted by a typical worker to production; (1-u) is the part of the time devoted to training and education. The analysis proposed by Lucas (1988) assumes that the accumulation of private human capital is determined from an optimization program: the worker arbiters between the immediate drop of income, due to the decreasing in the time devoted to production, and an increase of the future efficiency, due to the increase in the time devoted to training.

We note that, in the proposed production function specification, internal returns are constant. This assumption is adopted in order to keep a competitive structure. Therefore, the inputs are remunerated at their marginal productivities; (r) is the real interest rate and (w) is the real wage rate of a unit of effective work:

$$\frac{dY_t}{dK_t} = A_t \alpha K_t^{\alpha-1} (u_t h_t L_t)^{1-\alpha} h_a^\psi = r$$

$$\frac{dY_t}{d(u_t h_t L_t)} = A_t (1-\alpha) K_t^\alpha (u_t h_t L_t)^{-\alpha} h_a^\psi = w$$

The expressions of marginal productivities of inputs, given by the above equations, show a positive correlation between the remuneration of inputs and the social endowment of human capital. This relationship indicates that in countries where social endowment of human capital is high, the remuneration of inputs is also high. Thus, we find an explanation of the migration of production factors from South to North (Note 2).

The physical capital accumulation is expressed as follows; with (c) is the per capita consumption:

$$\dot{K}_t = Y_t - L_t c_t$$

The human capital accumulation, given by the following equation, represents the fundamental equation of our analysis:

$$\dot{h}_t = \int \eta (1-u) h_t$$

This equation indicates that the accumulation of human capital depends mainly on a productivity parameter indicating the capacity of intellectual assimilation of the individual (\int), the time devoted to the training (1-u), the level of human capital (h) and a parameter reflecting the degree of openness (η). From the equation of human capital accumulation, we aim at showing that the differences in growth rates between countries can be explained, in part, by a process of accumulation of human capital; this process is conditioned by trade policy and social endowment of human capital.

The integration of a parameter reflecting the degree of openness, in the Lucas (1988) expression of human capital accumulation, is justified by the fact that the accumulation of domestic knowledge and the human capital productivity would be stimulated by a foreign source. The latter finds its origin in the transfer of technology and interaction between individuals, which are favored by openness.

To simplify the analysis, we assume that the growth rate of the supply of physical labor is exogenous and it is equal to (n); the growth rate of technical progress is assumed to be zero. The decentralized equilibrium is established when a representative individual, with infinite horizon of life, maximizes the utility function under two constraints which represent the accumulation of physical and human capital (\dot{K}_t and \dot{h}_t). The Hamiltonian is expressed as follows:

$$H_t^c(.) = L \left[\frac{c^{1-\theta} - 1}{1-\theta} \right] + \pi_1 [A K^\alpha (u h L)^{1-\alpha} h_a^\psi - L c] + \pi_2 [\int \eta (1-u) h]$$

The first order conditions of maximization of the Hamiltonian are:

$$\frac{dH_t^c}{dc} = c^{-\theta} - \pi_1 = 0 \quad (1)$$

$$\frac{dH_t^c}{du} = \pi_1 A K^\alpha (1-\alpha) u^{-\alpha} L^{1-\alpha} h^{1-\alpha} h_a^\psi - \pi_2 \int \eta h = 0 \quad (2)$$

$$\dot{\pi}_1 = \rho\pi_1 - \frac{dH_1^c}{dK} = \rho\pi_1 - \pi_1 A \alpha K^{\alpha-1} u^{1-\alpha} L^{1-\alpha} h^{1-\alpha} h_a^\psi \tag{3}$$

$$\dot{\pi}_2 = \rho\pi_2 - \frac{dH_2^c}{dh} = \rho\pi_2 - \pi_1 A (1-\alpha) K^\alpha u^{1-\alpha} L^{1-\alpha} h^{-\alpha} h_a^\psi - \pi_2 \int \eta(1-u) \tag{4}$$

(ρ) denotes the psychological discount rate. The net discount rate ($\rho-n$), is assumed strictly positive. Under the assumption that all individuals are identical, ($h = h_a$), equations (1)-(4) are rewritten as follows, with (g_c) is the growth rate of per capita consumption:

$$\frac{\dot{\pi}_1}{\pi_1} = -\theta g_c \tag{1'}$$

$$\frac{\pi_1}{\pi_2} = \frac{\int \eta}{A (1-\alpha) K^\alpha u^{1-\alpha} L^{1-\alpha} h^{\psi-\alpha}} \tag{2'}$$

$$\frac{\dot{\pi}_1}{\pi_1} = \rho - A \alpha K^{\alpha-1} u^{1-\alpha} L^{1-\alpha} h^{1-\alpha+\psi} \tag{3'}$$

$$\frac{\dot{\pi}_2}{\pi_2} = \rho - \frac{\pi_1}{\pi_2} A (1-\alpha) K^\alpha u^{1-\alpha} L^{1-\alpha} h^{\psi-\alpha} - \int \eta(1-u) \tag{4'}$$

Substituting equation (2') in (4') we get:

$$\frac{\dot{\pi}_2}{\pi_2} = \rho - \int \eta \tag{5}$$

Equating equations (1') and (3') gives:

$$\rho + \theta g_c = A \alpha K^{\alpha-1} u^{1-\alpha} L^{1-\alpha} h^{1-\alpha+\psi} \tag{6}$$

From which we can conclude that:

$$\frac{\rho + \theta g_c}{\alpha} = \frac{Y}{K} \tag{6'}$$

The right term of equation (6) is the marginal productivity of physical capital, assuming the identity of individuals. Note that the marginal productivity of physical capital is no other than the real interest rate:

$$r = \rho + \theta g_c = \alpha \frac{Y}{K}$$

The solution of the balanced growth path is given by a constant growth rate for all variables. Throughout this path, the ratio between production and physical capital is constant. The interest rate is also constant. On the balanced growth path, we show that:

$$\frac{Lc}{K} = \frac{Y}{K} - \frac{\dot{K}}{K} = \text{constant} \tag{7}$$

Equation (7) reveals that: $g_K = n + g_c$ tag(8)

Or, $\frac{Y}{K} = \text{constant}$; from which we can conclude that: $g_Y = g_K$ and $g_y = g_k$ tag(8')

Equations (8) and (8') imply that the growth rate of physical capital is equal to the sum of the growth rate of per capita consumption and the growth rate of population. This means that the balanced growth path is characterized by equality between the growth rates of consumption, physical capital and output, evaluated per capita. From equation (6) we show that this rate is given as follows:

$$g_y = g_k = g_c = \frac{(1-\alpha + \psi)}{(1-\alpha)} g_h \tag{9}$$

The expression of saving rate, constant at steady state, is given as follows: $s = \frac{(g_c + n)\alpha}{\rho + \theta g_c}$

From equation (9) we note that the externality, generated by the social endowment of human capital, promotes the growth of production, physical capital and consumption, evaluated per capita. From equation (2') we show that:

$$\frac{\dot{\pi}_2}{\pi_2} - \frac{\dot{\pi}_1}{\pi_1} = \alpha g_c + (\psi - \alpha) g_h + n \quad (10)$$

Taking into account the equations (1'), (5), (9) and (10), the growth rates are given by:

$$g_h = \frac{(\int \eta - (\rho - n)) (1 - \alpha)}{\theta (1 - \alpha) - \psi (1 - \theta)} \quad (11)$$

$$g_y = g_k = g_c = \frac{(\int \eta - (\rho - n)) (1 - \alpha + \psi)}{\theta (1 - \alpha) - \psi (1 - \theta)} \quad (11')$$

3. Discussion: Threshold Effects and Multiplicity of Equilibrium

To simplify the analysis, we assume that the substitution elasticity in the consumption function is equal to unity; the utility function is given as follows: $u(c_t) = \text{Log}(c_t)$. Therefore, if $(\theta=1)$, the expressions of growth rates are given by:

$$g_h = \int \eta - (\rho - n) \quad (12)$$

$$g_y = g_k = g_c = \frac{(\int \eta - (\rho - n))(1 - \alpha + \psi)}{(1 - \alpha)} \quad (13)$$

Equations (12) and (13) indicate that in the absence of externality, associated with social human capital ($\psi = 0$), all variables grow at the same rate. In presence of the externality, although it is not necessary for endogenous growth in the long term, the growth rate of the output per capita is high, due to the improvement of marginal productivities of inputs.

From the expressions of the growth rate of human capital given by: $g_h = \int \eta - (\rho - n)$ and $g_h = \int \eta (1 - u^*)$, it is possible to express the optimal share (Note 3) of time devoted to the production, (u^*), as follows:

$$u^* = \frac{\rho - n}{\int \eta}.$$

This expression shows that the proportion of time devoted to production is decreasing relative to parameter reflecting the complementarity between openness and productivity of human capital ($\int \eta$); this relationship is explained by the fact that the improvement of the complementarity parameter promotes the performance of human capital. Therefore, people will be encouraged to devote more time to training. We note that the increase of this parameter induces two opposite effects on output per capita: a negative effect, resulting from the reduction of time devoted to production, and a positive effect, due to the improvement of the efficiency of human capital. The total effect on output is positive, because that human capital is both an input and an externality.

Equations (12) and (13) show that a positive growth rate is possible only for appropriate values of openness and human capital efficiency. Indeed, a high-potential-growth path is possible only for sufficiently open economies; thus, the economy is more likely to benefit from the ideas and technologies developed in the world, which will promote the efficiency and the accumulation of social human capital. However, this mechanism is operational only if the economy has a sufficient social endowment of human capital, able to assimilate and exploit ideas developed elsewhere.

This conclusion is founded by the critics addressed by Serranito (1999) to the results of the convergence retained by Sachs and Warner (1995) and Baumol (1986). Indeed, Serranito (1999) assumes that the convergence detected by the two authors in samples of open countries was not possible if these countries had not benefited from an important initial endowment of human capital; this latter has allowed the promotion of the exploitation of foreign technologies.

The necessity of sufficient social endowment of human capital for growth dynamic is also retained by Aghion and Howitt (2000). These authors consider that economies with low levels of human capital do not have the ability to produce and they risk suffering from this lack indefinitely. On the other hand, economies with higher initial endowment of human capital can easily produce and benefit from important growth rates.

In our analysis, this idea can be deduced from the expressions of growth rate of per capita variables. If the degree of assimilation of individuals is low ($\int \rightarrow 0$), due to low social endowment of human capital, openness would be

unable to make the economy converge to a high equilibrium. Therefore, the long-term growth analysis should be conducted with reference to threshold effects associated with the complementarity between openness and social endowment of human capital. This analysis suggests that there is a critical threshold associated with this complementarity above which the economy is placed on a high-potential-growth path and converges to a high equilibrium; below the critical threshold, the economy follows a low-potential-growth path and converges to a low equilibrium.

In light of these arguments, we assert that a certain level of social human capital is necessary to allow for openness to promote the productive efficiency of human capital. Thus, the productive efficiency of human capital can be expressed as follows, with (\tilde{h}) is the critical threshold associated with the social endowment of human capital:

$$\begin{cases} f = a + b\eta^\beta & \text{if } h \geq \tilde{h} \\ f = a & \text{if not} \end{cases} \tag{14}$$

The parameter (a), in equation (14), denotes the productive efficiency of human capital when the economy does not have a sufficient social endowment of human capital. In continuity with conclusions adopted by Aghion and Howitt (2000), Azariadis and Drazen (1990) and Becker et al. (1990), we assume that this parameter is null. To simplify the analysis, we assume, also, that (b=1). (β) is the elasticity of productive efficiency of human capital relative to the openness; ($0 < \beta < 1$), indicating that openness affects positively the productive efficiency of human capital at a decreasing rate. The equation of human capital accumulation is expressed as follows:

$$\begin{cases} \dot{h}_t = \eta^{1+\beta}(1-u)h_t & \text{if } h \geq \tilde{h} \\ \dot{h}_t = 0 & \text{if not} \end{cases}$$

Using equation (14), the equations (12) and (13) can be rewritten as follows:

$$\begin{cases} g_h = \eta^{1+\beta} - (\rho - n) & \text{if } h \geq \tilde{h} \\ g_h = n - \rho & \text{if not} \end{cases} \tag{12'}$$

$$\begin{cases} g_y = g_k = g_c = \frac{(\eta^{1+\beta} - (\rho - n))(1 - \alpha + \psi)}{(1 - \alpha)} & \text{if } h \geq \tilde{h} \\ g_y = g_k = g_c = \frac{(n - \rho)(1 - \alpha + \psi)}{(1 - \alpha)} & \text{if not} \end{cases} \tag{13'}$$

Equations (12') and (13') indicate that, for $h \geq \tilde{h}$, the elasticity of the growth rate of human capital relative to openness is higher than unity. This is justified by the fact that an increase in openness directly promotes the accumulation of human capital, by stimulating the transfer of foreign knowledge, and indirectly, by improving productivity. Since human capital is an input and an externality, the elasticity of the growth rate of output relative to the openness is also higher than unity.

Equations (12') and (13') allow envisaging two findings. The first is that if the social endowment of human capital is less than its critical threshold, the growth rates are independent of openness. In this case, even if the economy is open, it ends up having a negative growth rate. This analysis indicates that openness is a necessary condition, but not sufficient, for sustained growth; the economy should still have a sufficient social endowment of human capital to benefit from new opportunities for the growth induced by openness. The second finding suggests that even for a social endowment of human capital above the critical threshold, the economy ends up having a negative growth rate if it is not sufficiently open ($\eta < (\rho - n)^{1/(1+\beta)}$).

Given the equations (12') and (13'), future levels of human capital and production are expressed as follows:

$$\begin{cases} h_{t+1} = [1 + (\eta^{1+\beta} - (\rho - n))]h_t & \text{if } h \geq \tilde{h} \\ h_{t+1} = [1 - (\rho - n)]h_t & \text{if not} \end{cases} \tag{12'}$$

$$\begin{cases} y_{t+1} = [1 + \frac{(\eta^{1+\beta} - (\rho - n))(1 - \alpha + \psi)}{(1 - \alpha)}]y_t & \text{if } h \geq \tilde{h} \\ y_{t+1} = [1 - \frac{(\rho - n)(1 - \alpha + \psi)}{(1 - \alpha)}]y_t & \text{if not} \end{cases} \quad (13')$$

The dynamics of growth and accumulation of human capital, given by equations (12') and (12''), for $h \geq \tilde{h}$, are represented by Figure 1, which shows that the growth rate is positively related to openness; a positive growth is possible only if the economy is sufficiently open. We note that this growth dynamic assumes that the economy already has a sufficient social endowment of human capital. Indeed, for ($h \geq \tilde{h}$), the equation (12') indicates that there is a critical threshold associated with openness, $\tilde{\eta} = (\rho - n)^{1/1+\beta}$, from which the economy would be placed on a high-potential-growth path and converges to a high equilibrium.

The critical threshold associated with openness is represented by point B and the high equilibrium is represented by point A. If the level of openness is lower than its critical threshold, the growth rate is negative and the economy is placed on a low-potential-growth path and converges to a low equilibrium (point C). The latter corresponds to the equilibrium to which the economy converges when the social endowment of human capital is insufficient, $h < \tilde{h}$, even if the economy is sufficiently open.

Thus, for a social endowment of human capital lower than its critical threshold and/or the economy is not sufficiently open, the productivity of human capital is low and the economy is unable to benefit from the exchange of ideas and technologies developed elsewhere. In this case, individuals choose to increase the time devoted to production instead of training. The accumulation of human capital would be zero and the economy converges, in the long term, to a low equilibrium, characterized by a negative growth of all variables per capita.

This result can be explained simply by the fact that the negative impact on output per capita, due to stopping the accumulation of human capital, exceeds the positive effect of the increased time devoted to production, because the human capital is both an input and an externality.

The low equilibrium, represented by point C, is relative to the economy that is unable to accumulate more capital (human and physical). The per capita levels of output, human and physical capital and consumption are low. At low equilibrium, the interest rate and the saving rate, whose expressions are given below, are low:

$$r = \rho + g_c ; \quad s = \alpha [1 - \frac{\rho - n}{r}]$$

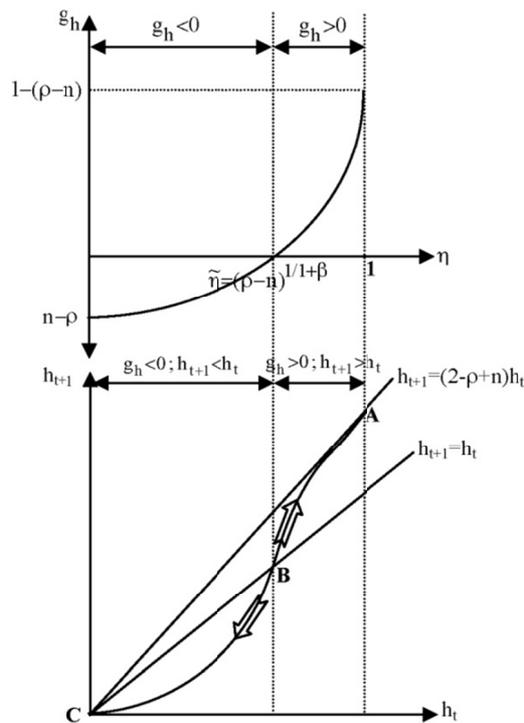


Figure 1. Growth rate and accumulation of human capital

If the social endowment of human capital is significant, ($h \geq \tilde{h}$), and the economy is sufficiently open, ($\eta > \tilde{\eta}$), the economy would be placed on a high-potential-growth path and converges to a high equilibrium (point A). This growth dynamic is justified by a high productivity of human capital, due to a sufficient social endowment of human capital and to a high degree of openness. Therefore, individuals choose to increase the time devoted to training rather than producing. In the long term, the per capita levels of human capital, output, physical capital and consumption, as well as interest rate and saving, are high.

This analysis provides an explanation for divergence of growth rates between economies. Indeed, the most open economies, which have a sufficient social endowment of human capital, have a significant potential to exploit and imitate foreign ideas and technologies. Therefore, these economies would be capable of placing themselves on a high-potential-growth and converges, in the long term, to a high equilibrium. However, the economies that are inwards orientated or having a low social endowment of human capital seem to be unable to profit from growth opportunities induced from the interaction with foreign economies; the accumulation of human capital is not advantageous, because of its low yield, and the economy would be placed on a low-potential-growth path and converges to a low equilibrium.

These two growth regimes are separated by a critical threshold, represented by point B, associated with the complementarity between social endowment of human capital and openness. Any economic policy that aims at stimulating social endowment in human capital and/or openness, without being able to put the economy above the critical threshold, has no impact on long term growth. In this case, the growth rate will increase slightly without being positive. The human capital productivity remain low and individuals are still engaged in the production rather than improving their productive capacity; therefore, the economy returns back to the low equilibrium. The latter, represented by point C, is a stable equilibrium, which corresponds to a poverty trap.

However, if the economic policy is efficient enough, insofar as it allows the economy to exceed the critical threshold, the growth rate of all variables would be positive. The accumulation of human capital would be advantageous, due to the increase of yield, and individuals decide to reduce the time devoted to production. The economy would, then, converge towards the high equilibrium (point A).

We must note that point B, reflecting the critical threshold, is an unstable steady state. It corresponds to the situation where the time devoted to training is null. Below this equilibrium, the social endowment of human capital and/or the degree of openness are not sufficient to encourage people to improve their productive performance. The growth rate is negative and the economy will converge to the low equilibrium. On the contrary, above this equilibrium, the growth rate is positive, due to a high social endowment of human capital and a high degree of openness. In this case, the economy will converge to the high equilibrium. It should be noted that at point B interest rate and saving are expressed, respectively, as follows:

$$r = \rho ; \quad s = \frac{\alpha n}{\rho}$$

4. Conclusion

This paper presents a theoretical analysis inspired by Lucas model (1988). The aim is an attempt to explain the divergence of growth paths, observed over a long period, between economies. The results show that the effect of openness and social endowment of human capital on growth is nonlinear. The results show that there is a critical threshold associated with the complementarity between openness and social endowment of human capital, which separates two dissimilar growth regimes. The first regime (low equilibrium) corresponds to a trap and represented by the usual exogenous growth models; whereas the second regime (high equilibrium) corresponds to an endogenous growth characterized by efficient external effects and increasing returns. The two regimes are separated by an unstable equilibrium defining the critical threshold associated with the complementarity between openness and social endowment of human capital.

For a poor economy, these results advocate that a process of takeoff requires the establishment of a set of sufficiently efficient economic policies. The latter should be able to push the economy above the critical threshold and place it on a high-potential-growth path.

References

- Aghion, P., & Howitt, P. (2000). *Théorie de la croissance endogène*. Dunod.
- Autume, A., & Michel, P. (1993). Hystérésis et piège du sous développement dans un modèle de croissance endogène. *Revue Economique*, 44.
- Azariadis, C. (1996). The economics of povrety traps. *Journal of Economic Growth*, 4.

- Azariadis, C., & Drazen, A. (1990). Threshold externalities in economic development. *Quarterly Journal of Economics*, 105. <http://dx.doi.org/10.2307/2937797>
- Banque, M. (2006). Rapport sur le développement dans le monde: équité et développement.
- Barro, R., & Sala-i-Martin, X. (1995). Economic growth. *McGraw-Hill*.
- Barro, R., & Sala-i-Martin, X. (1997). Technological diffusion, convergence and growth. *Journal of Economic Growth*, 2. <http://dx.doi.org/10.1023/A:1009746629269>
- Baumol, W. (1986). Productivity growth, convergence and welfare: What the long-run data show. *American Economic Review*, 76.
- Becker, G., Murphy, K., & Tamura, R. (1990). Human capital, fertility and economic growth. *Journal of Political Economy*, 98. <http://dx.doi.org/10.1086/261723>
- Benabdenour, A. (2012). Convergence ou divergence des nations. *Editions Universitaires Européennes*.
- Ben-David, D. (1997). *Convergence clubs and subsistence economies*. NBER, Working Paper, 6267.
- Ben-David, D. (1998). Free trade, growth and convergence. *Journal of Economic Growth*, 3. <http://dx.doi.org/10.1023/A:1009705702579>
- Ben-David, D., & Kimhi, A. (2000). *Trade and the rate of income convergence*. NBER, Working Paper, 7642.
- Benhabib, J., & Spiegel, M. (1994). The role of human capital in economic development: Evidence from aggregate cross-country data. *Journal of Monetary Economics*, 34. [http://dx.doi.org/10.1016/0304-3932\(94\)90047-7](http://dx.doi.org/10.1016/0304-3932(94)90047-7)
- Berthélemy, C., & Varoudakis, A. (1995). Clubs de convergence et croissance: Le rôle du développement financier et du capital humain. *Revue Economique*, 46.
- Berthélemy, C., Dessus, S., & Varoudakis A. (1997). Capital humain et croissance: Le rôle du régime commercial. *Revue Economique*, 48.
- Bourguignon, F., & Morrisson, C. (2002). Inequality among world citizens: 1820–1992. *American Economic Review*, 92. <http://dx.doi.org/10.1257/00028280260344443>
- Des-Doigts, A. (1997). Vers une convergence globale ou locale. *Economie Internationale*, 71.
- Durlauf, S. (1996). On the convergence and divergence of growth rates. *Economic Journal*, 106.
- Durlauf, S., & Johnson, P. (1995). Multiple regimes and cross-country growth behavior. *Journal of Applied Econometrics*, 10. <http://dx.doi.org/10.1002/jae.3950100404>
- Easterly, W. (2001). The lost decades: Developing countries stagnation in spite of policy reform 1980–1998. *Journal of Economic Growth*, 6. <http://dx.doi.org/10.1093/wber/15.2.177>
- Easterly, W., & Levine, R. (2001). It's not factor accumulation: Stylized facts and growth models. *World Bank Economic Review*, 15.
- Gong, G., & Keller, W. (2002). Convergence and polarization in global income levels: A review of recent results on the role of international technology diffusion. *Research Policy*, 1598.
- Hallett, A., & Piscitelli, L. (2002). Does trade integration cause convergence. *Economic Letters*, 75.
- Lucas, R. (1988). On the mechanics of economic development. *Journal of Monetary Economics*, 22. [http://dx.doi.org/10.1016/0304-3932\(88\)90168-7](http://dx.doi.org/10.1016/0304-3932(88)90168-7)
- Pritchett, L. (1997). La Distribution passée et future du revenu mondial. *Economie Internationale*, 71.
- Quah, D. (1996). Twin peaks: Growth and convergence in models of distribution dynamics. *Economic Journal*, 106. <http://dx.doi.org/10.2307/2235377>
- Quah, D. (1997). Empirics for growth and distribution: Stratification, polarization and convergence clubs. *Journal of Economic Growth*, 2. <http://dx.doi.org/10.1023/A:1009781613339>
- Sachs, D., & Warner, A. (1995). *Economic convergence and economic policies*. NBER, Working Paper, 5039.
- Sala-i-Martin, X. (2002). *The world distribution of income*. NBER, Working Paper, 8933.
- Serranito, F. (1999). *Clubs de convergence et croissance: Le rôle de l'ouverture et de l'accumulation du capital humain*. Impact sur les Pays Sud-Méditerranéens de l'Élargissement de l'Union Européenne aux PECO, Colloque International, Tunis, 28–29 janvier 1999.

Notes

Note 1. $h_a = \frac{1}{L} \sum_{i=1}^L h_i$.

Note 2. Under the assumption of the free circulation of production factors, this result also explains the difficulty of developing countries to attracting Foreign Direct Investment.

Note 3. It shows the rational behavior of the individual throughout the equilibrium growth path.

Copyrights

Copyright for this article is retained by the author(s), with first publication rights granted to the journal.

This is an open-access article distributed under the terms and conditions of the Creative Commons Attribution license (<http://creativecommons.org/licenses/by/3.0/>).