

# Poverty Reduction, Brain Drain and Development

Diana Loubaki\*

Department of Fundamental Analysis in Economics, University Marien N'Gouabi, Brazzaville, Congo

## Abstract

The aim of this article is to study development in an extended brain drain model i.e when labour is heterogenous. An endogenous growth model with probability of migration is used to highlight how incentives to increase both human capital and ability at work are able to boost development in poorest countries. On the basis of visa eligibility purposes, finally, on the one hand, the skilled labour is able to adapt new innovations in the production sector and improves goods quality over time, making the return probability no more a fundamental development tool. On the other hand, the unskilled labour ability level fluctuates around the average world threshold improving simple task performance when home and funds transfer increase when in the rich country. Indeed, development is a positive exchange trade among poor and rich countries highlighted respectively by per-capita income increase and pension funds financial support. Therefore, convergence may occur between developed and developing countries because knowledge is a jumping function.

## Keywords

Labour Heterogeneity, Labour Mobility, Human Capital, Funds Transfers, Brain Drain, Poverty Reduction

Received: June 26, 2015 / Accepted: July 25, 2015 / Published online: August 12, 2015

@ 2015 The Authors. Published by American Institute of Science. This Open Access article is under the CC BY-NC license.

<http://creativecommons.org/licenses/by-nc/4.0/>

## 1. Introduction

The aim of this article is to provide a theory of economic development which extends the standard brain drain analysis with labour heterogeneity concept i.e the introduction of the potentiality of the unskilled labour to drain development in poor countries like it is fundamentally the case for the skilled labour in the standard literature.

The theory of the brain drain focuses on the fact that, international migration leads developing countries lose skilled workers who choose to go to developed countries, because of higher relative wages (Bhagwati and Hamada, 1974). Mostly focused on the impact of the migration of the high skilled labour native of poor countries on economic development path of the source country, standard brain drain theory assumes human capital accumulation at high levels to be an engine of growth (Docquier-Rapoport, 2012)<sup>1</sup> since it

yields new innovation absorption and adaptation in good production sector to generate higher quality goods (Eicher, 1996), indeed the weakness of the return probability rate of the poor countries' high skilled labour home, cause under development (Delacroix-Docquier, 2010; Kim, 1976). Unfortunately, poverty which is a fundamental component of the development process (Sachs, 2005; Sachs and Warner, 1995), can't be well analyzed since unskilled labour is absent of the system. Moreover, in under developed regions, the unskilled agent mostly belongs to the lowest social classes explaining his motivations for community assistance for those who are left behind<sup>2</sup>. Therefore, in order to study development, this model considered funds transfers sent by the unskilled worker to his family who lives in his native country as a sustainable development tool. Consequently, the introduction of incentives to migrate to rich countries of the low skilled labour native of the poor country in the standard

<sup>1</sup> The number of highly educated immigrants living in the OECD member countries has increased by 70 percent during the 1990s (and has doubled for those

originating from developing countries) against just a 30 percent increase for low-skill immigrants.

<sup>2</sup> typical behaviour in Mali

\* Corresponding author

E-mail address: [diana.loubaki@laposte.net](mailto:diana.loubaki@laposte.net)

literature extends the brain drain analysis<sup>3</sup> which in turn, increases our understanding of the development process able to reduce poverty.

More precisely, this article examines in how far, development can be boosted since the incentives to migrate from poor to rich country increases on the one hand, average human capital level of the poor country through the time, on the other hand, funds transfers<sup>4</sup> received by poor families from the unskilled agent who live in a rich country to fight local poverty and reduce inequalities. The results found are *first*, because both human capital and ability are highly and continuously increased over time in response to the economic globalization, the agents native of the poor country try to reach the thresholds required to work there, since labour demand is published around the whole world (see tables 2 and 3). Unfortunately, all the candidates are not eligible to leave abroad, indeed both ability and human capital keeps increasing in the poor country and boost development through production output improvements in response to skills increase. Therefore, in contrast to the theory, the return probability of the high skilled labour is no more the main growth and development engine. *Second*, development may occur faster due to knowledge spread around the world making human capital able to produce higher quality goods since new innovations are introduced and adapted in the production sector continuously over time. *Third*, the young native agent of the developing country contribute to support the rich country's pension funds because population is getting old there whereas, fecundity rate keeps lowering (Bornat, and al, 1999; Bosveld, W., 1996) such that, active agents stock may be not high enough for social security system to remain in balanced. The last arguments are those which allow international labour mobility and heterogeneity and make migration being a positive exchange trade among countries. Added with the world labour market globalization, those facts justify labour mobility from the poor to the rich countries.

In this model, the visa is given only after a successful test on human capital level required by the firms which launch the jobs demand around the world and check if the candidate has the world average level required for the job they are applying for in the globalized market<sup>5</sup>. In parallel, the unskilled labour

agents when their labour demands exist, they face the same thing in ability terms. But their probability of tests success is lowered by the speed of innovations introduction any time, thus to be understood needs ability level to be quite high in conformity to the creative destruction concept of Schumpeter (1942) i.e once a new technology is adapted in the production sector by the engineers, the older one is thus discarded and its use is left to low skilled labour mainly. New technology is mostly produced in developed country, thus, the low skilled labour is not always able to understand it quite well in poor countries<sup>6</sup> because it's evolution is quite fast and needs a work environment which adapt new technology any time even through learning by doing when good production is holding (Arrow, 1962), their ability level may maintain or increase. Therefore the poor country unskilled labour entry in the rich country is less easy as we'll show it [see table 1 which show the amount of foreigners who are asking for legal status in Europe], in contrast to the skilled labour. We assume the unskilled labour motivations' to work in the rich country economic system to be relied to poverty reduction aim through funds transfers he makes to his family left behind. Thus, his action has a positive impact on the source country's development path since it yields per-capita family income increase. Finally, we show that when the foreigner human capital level or ability is high enough, it is a jumping function on the rich country's dynamical system which proves that equivalency in skills is successfully done. Consequently, this model provides theoretical foundations of development focused on poverty reduction and growth increase in poor countries.

According to the OMI<sup>7</sup>, 2003 data and the French Minister, 6900 permanent authorizations have been given to high skilled labour migrants against 0 to unskilled labour migrants. In the concern of students and according to the OECD data, in France 48% of students come from Africa against 4%, 7%, 8%, 9% and 11% respectively from Australia, United States, United Kingdom, Germany and the rest of the world. More precisely, migration purposes can be estimated to 2/3 for studies against 1/3 for work in France. Unedic reports on labour demand for French economy are based on the ANPE<sup>8</sup> data which compare the supply and the demand of labour by sector in order to provide estimations on the labour needs for 2015 through the agents who are going to leave the labour market for resting. The results of those investigations are given to the "Commissariat Général du Plan" and to the "Dares" for publication. Those results highlight the fact that there are needs for some careers. Thus,

3 According to the United Nations, the number of international migrants increased from 75 million in 1960 to 190 million in 2005, at about the same rate as the world population, meaning that the world migration rate increased only slightly, from 2.5 to 2.9 percent.<sup>1</sup> Over the same period, the world trade/GDP ratio increased threefold, from 10 to 30 percent (and from 20 to 30 percent between 1990 and 2000)

4 The first world organization to manage funds transfer from developed to developing mainly in order to help families is Western Union, which reached the whole developing countries and actually works also inside Western countries, but we couldn't get the data on that. Actually, other organizations of this type have emerged in the same mission. But the most safety and famous, still Western Union.

5 This kind of selection is in use by The Canadian Immigration Department

6 See the literature of appropriate technology

7 Office des Migrations Internationales (International Migration Office in France)

8 Agence Nationale pour l'emploi is now called pôle emploi, its mission is to ensure that people who are looking for a job will get one through assistance of the government officer in France

a list of workers with specific skills needed are published in the whole world, thereby opens doors to migration. Unfortunately, the main jobs demanded are mostly skilled [see tables 2 and 3], indeed may increase the brain drain phenomenon and close more the door to the unskilled labour whom motivation for poverty reduction is greater than the skilled agent because the one is rational and the other is more close to traditional thought which also guide his choices and actions.

Poverty<sup>9</sup> in developed and developing countries converge in thresholds of the living standards (Deaton, 2010). Thus economic take-off in living standards may rise in response to the low skilled labour incentives to migrate to rich countries in order to increase the lowest social class per-capita income. Therefore, added to human capital increase, the extended brain drain theory proposed by this article may lead to convergence both in per-capita income and human capital levels among rich and poor countries which push development path towards its long run locus. The globalization of the economy plays a great role in that strategy since the world labour market explains partly the increase of the developing country's incentives to invest more in human capital accumulation (Chen, 2008) in order to apply to those jobs supplied by rich countries such as Canada, France and United States<sup>10</sup> and the visa may be given since the required threshold in human capital is reached (Chen, 2006).

The scientific contribution of this model holds on several aspects: *first*, the model is an extension of the standard brain drain analysis with heterogenous labour mobility. *Second*, development is viewed as the conjunction of several things which are funds transfer, ability and human capital accumulation increase and behaves like a process occurring in the whole world, thus engage both the developed and the developing countries in such a way that, convergence in development levels i.e both in human capital and in per-capita income may occur faster. *Third*, whereas, the incentives to migrate abroad i.e in a rich countries mostly depend on relative wages of the two countries in the literature, in this model, they also depend on the ethnic culture of the agent based on community assistance<sup>11</sup> The data used to setup the assumptions of the model built mostly belongs to the French economic policy and their statistics of migration. The same kind of data is used for old people

increase in developed world which lead to the resting income finance difficulties. Moreover, this model is an economic development theory which study the way migration can be beneficial for the countries concerned by labour mobility and behave like a kind of exchange trade based on mutual financial support to avoid poverty.

Recently, the brain drain literature as introduced high education acquisition home (Beine-Docquier-Rapoport, 2008) and the brain waste concept because when skilled workers migrate, they face the brain waste risk, thus their project may lead to an unskilled low remunerated job (Garcia-Pires, 2015) that we use and consider the great part of the high skilled agents who acquire education, mostly stay home and work there, only a few part of them leave abroad. Western countries' economic policy on migration is more restrictive actually, according to the French Statistics of 2014, only 10% of the foreigners who ask for permanent resident status obtain it and in USA, only 20% of the students who have done their studies there obtain a permanent status, 80% of the cohort leaves the country. Consequently, the return probability rate highly considered in standard literature of the brain drain is no more essential for development to occur faster. Our results contrast with those found by Delacroix-Docquier (2010), a brain drain model focused on poverty which shows off multiple equilibria existence where convergence to the long run development path exists but the stable equilibrium is highlighted by the conjunction of high poverty and high brain drain. In contrast, our model's equilibrium conjugates low poverty and low brain drain because the brain drain force is not strong enough to retard development of the poor country. Finally, development is a coordinated investment strategy<sup>12</sup> according to this article, defined by the locus on the space where the both curves i.e per-capita income, an increasing function of funds transfers and human capital level, an increasing function of the wage rate income intercept on the plane.

International labour mobility uses the brain drain literature (Miyagiwa, 1991; Haque-Kim, 1995) which unfortunately assumes high skilled labour to be the main growth and development providers. But since development sustainability assumes also poverty reduction, the previous concept creates inequalities and maintains poverty. Thus, the standard literature becomes too restrictive to understand poverty reduction foundations which is relevant in the modern development theory, indeed both the growth and the brain drain literatures which link is the fact that human capital accumulation and R&D create growth (Lucas, 1988; Romer, 1990; Azariadis-Drazen, 1990; Aghion-Howitt, 1992, Docquier-Rapoport, 2012), are unable to explain some

9 Poverty can be measured by the dollars-a-day count according to the World Bank. Global poverty count, started with Montek Ahluwalia, Nicholas Carter and Hollis Chenery (1979) and became in the World Development Report, 1990 incorporated into international policy used in discussion like the United Nation Millennium Development Goals (MDG) i.e the expectation of cutting of poverty in half of its actual size from 2000 to 2015.

10 >"L'immigration choisie", is the name given by President Sarkozy to promote labour in the migration context

11 Typical behaviour in Mali where young agent's aim is to support old people left behind through their work in developed countries like France

12 This strategy is the one proposed by Rosenstein-Rodan (1943) as a solution of economic depressed regions

phenomenon of development relied to traditional societies' culture. The effort made in this article is to highlight some of them in order to study their impact on development.

The main models used in this model are *first*, Delacroix-Docquier (2010) brain drain model with poverty. Whereas, the authors found pessimistic results due to their estimation of the return probability of the high skilled workers i.e only 0,243%, thus development may be retarded, we show that, this component is no more a key for development. *Second*, the Ricardian comparative advantage i.e the country must focuses on its resource the most abundant, thus unskilled labour in the case of developing countries is adopted. *Third*, we also use Chen (2006; 2008) for whom, the difference between quantity and quality both in the choice of children and their education in parents' decisions is relevant for the long run growth explaining labour heterogeneity existence since human capital accumulation is costly for the families endowed with many children (Galor and Weil, 2000; Cervellati and Sunde, 2015). Finally, the incentives to increase human capital accumulation and ability of the source country may lead the poor economy growth path converge to its long run locus.

This article focuses on two main literatures which are the brain drain and development pioneer thought. *On the one hand*, four waves can be distinguished in the brain drain literature evolution. *The first* brain drain models dates back to the late 1960s and high education levels were essentially acquired in developed countries. Those models mainly focused on welfare analyzes in standard trade-theoretic frameworks (Grubel and Scott, 1966; Johnson, 1967; Berry and Soligo, 1969)] and concludes to an essentially neutral impact of the brain drain on source countries and generally emphasize the benefits of free migration to the world economy. *The second* wave comes less than a decade later under the leadership of Jagdish Bhagwati where a series of alternative models were developed throughout the 1970s to explore the welfare consequences of the brain drain in various institutional settings such as domestic labour markets rigidities, informational imperfections, as well as fiscal and other types of externalities (Bhagwati and Hamada, 1974; McCulloch and Yellen, 1977) and emphasize the negative consequences of the brain drain on the poor countries' development path. *The third* wave has emerged since the mid-1990s and stipulates that, migration prospects can foster domestic enrolment in education in developing countries, raising the possibility for a brain drain to be beneficial to the source country. *More recent contributions*, in the years 2000 and 2010 however, argue that, the brain drain story does not necessarily need to hold (Docquier and Rapoport, 2007) and claim on brain waste and brain drain (Docquier and Rapoport 2012; Schiff, 2005; Garcia Pires 2015) and adopts the fact

that education can be acquired in the source country (Beine-Docquier-Rapoport, 2008). Moreover, in a developing economy closed to international migration, the returns to schooling are very low and this discourages investment in education, the brain gain effect can arise through migration and can be strengthened or weakened with the introduction of occupational choices, network effects (Kanbur and Rapoport, 2005), fertility, education subsidies (Stark and Wang, 2002). Consequently, the brain drain view has greatly changed over time, so that when the countries are open, it still being beneficial specifically when knowledge externalities emerge from that contact i.e from the globalized economy because knowledge is a public good which can't be kept secret (Romer, 1990). Indeed, this model follows those last set of arguments developed on the brain drain, but it enlarges the previous concepts, since labour is mobile and heterogenous with the education only acquired home (McKenzie Rapoport, 2006; Docquier Marfouk, 2006).

*On the other hand*, development theory used is the one symbolized by the works of the pioneers of economic development i.e from Roseinstein-Rodan (1943) to Hirschman (1958)<sup>13</sup>, a set of ideas in the way a given poor country can achieve development. Period during which, the theory remains famous and fall in the middle of the years 70 because of the lack of models able to understand economic phenomenon (Krugman, 1994) specifically those which growth theory is unable to understand and explain [Lucas (1988)]. Then the ideas provided by standard economic development theory are modeled all the time since the 1990s (Murphy-Shleifer and Vishny, 1989 for Roseinstein-Rodan, 1943) and introduced in new development economics by Issa (2005) and Nissan Niroomand (2006) for example, on the basis of Romer (1986) and Lucas (1988)<sup>14</sup>. Demography is connected to endogenous growth models with human capital to study development (Maksymenko Rabbani, 2011; Dahan Tsiddon, 1998). Growth models with endogenous technological change and human capital accumulation on the basis of Schumpeter (1942), like Eicher (1996), are initiated by Aghion-Howitt (1992). Without the Schumpeterian creative destruction concept, the endogenous technological change growth line is initiated by Romer (1990). Endogenous

13 Those authors dispute over the nature of the policies that might be required to break a country out of a low-level trap. Rosenstein-Rodan and others appeared to imply that a coordinated, broadly based investment program -- the Big Push -- would be required. Hirschman disagreed, arguing that a policy of promoting a few key sectors with strong linkages, then moving on to other sectors to correct the disequilibrium generated by these investments, and so on, was actually the right approach. Arthur Lewis's famous "Economic development with unlimited supplies of labour" emphasized dualism among modern and traditional sectors of good production which causes under development, thus the absorption of low skilled workers from traditional sector into modern sector was the right approach leading to development. Fleming (1954), argued that owing to the role of intermediate goods in production was the way to develop faster a given country.

14 The last two endogenous growth models explain increasing returns and knowledge externalities through the neoclassical growth model of Solow (1956) extended to human capital initiated by Becker (1964) and Schultz (1961).

technological change research becomes the best answers to under-development remedies since it is caused by low skill levels or human capital absence (Maksymenko Rabbani, 2011; Issa, 2005; Mbaku Kimenyi, 1992; Eicher, 1996, Azariadis-Drazen, 1990). The literature of economic development based on growth theory also extended human capital and technological change to the case of the children who are future labor in their education for the long run growth related to their quality and quantity (Cervellati and Sunde, 2015; Galor and Weil, 2000). Recently, the World Bank has introduced poverty concept in development sustainability in order to achieve the Millennium development goals which is cutting poverty in half in 2015 so that modern economic development mainly focuses on poverty reduction<sup>15</sup>. Therefore, studying how individuals are able to escape poverty become a central issue of economic development theory in which the literature of poverty reduction contains both its advocates (Sachs, J., 2005; Sachs and Warner, 1995; Ravallion, 1997) for whom it is possible to eliminate poverty through a particular kind of economic growth policy and its non advocates (Unwin, 2007) for whom it is not possible to end poverty but urgent to encourage the world's poor and marginalized communities to enhance their lives to create and adopt alternatives for fostering economic development (Datt and Ravallion, 1999).

The article is organized such that, section 2 setup the basic model. Section 3 analyzes the Equilibrium in autarchy. Section 4 setup the model of endogenous migration. Sections 5, 6, 7, 8 study respectively *first*, funds transfers and poverty reduction, *second*, human capital convergence and development, the brain drain and development and *third*, coordinated investment policy<sup>16</sup> a policy based both on funds transfers and on human capital accumulation as growth sustainability engines able to ensure the development take off<sup>17</sup> of the poor country economy. *Finally*, development is achieved at the locus on the space in a given time where both the curves of per-capita income, an increasing function of funds transfer which yields poverty reduction, meets the curve of human capital accumulation, an increasing function of the growth rate.

Table 1. highlights the number of illegal migrants who are asking for legal status, data are from 2008 to 2014.

Table 2 highlights tensions in the labour market due to the lack of skills needed by firms, thus open the door to migration

<sup>15</sup> See the influential works of Jeffrey Sachs on Poverty

<sup>16</sup> It is the term used by Roseinstein-Rodan (1943) to present his development economic policy

<sup>17</sup> This stage is the one highlighted by Rostow (1960) for whom, development is a process composed of 5 stages and the take-off is symbolized by the third development stage

Table 3. highlights propositions for migrations if necessary in the following skills displayed which are lacking in France

**Table 1.** Records the number of migrants without legal status in Europe between 2008 and 2014.

Migrants illégaux	2008	2009	2010	2011
Allemagne	26 945	33 035	48 590	53 345
Estonie	15	40	35	65
Irlande	3865	2690	1940	1290
Grèce	19 885	15 925	19 275	9 310
Espagne	4515	3005	2745	3420
France	41 845	47 625	52 725	57 335
Croatie				
Italie	30 145	17 670	10 050	40 355
Chypre	3 920	3 200	2 875	1 770
Lettonie	55	60	65	340
Lituanie	520	450	495	525
Luxembourg	455	485	785	2 155
Hongrie	3 175	4 670	2 105	1 695
Malte	2 605	2 385	175	1 890
Pays-Bas	15 255	16 140	15 100	14 600

Source : EuroStat

**Table 1.** Continuous.

Migrants illégaux	2012	2013	2014
Allemagne	77 650	126 995	202 815
Estonie	75	95	155
Irlande	955	945	1450
Grèce	9 575	8 225	9 435
Espagne	2565	4495	5615
France	61 455	66 265	64 310
Croatie		1 080	450
Italie	17 350	26 620	64 625
Chypre	1 635	1 255	1 745
Lettonie	205	195	375
Lituanie	645	400	440
Luxembourg	2 055	1 070	1 150
Hongrie	2 155	18 900	42 775
Malte	2 080	2 245	1 350
Pays-Bas	13 100	13 095	24 535

Source : EuroStat

This table1 records the number of illegal entries in Europe through legal status claim

The following tables highlight the needs in jobs in developed countries (France)

**Table 2.** Jobs for which tension is high in the labor market (june. 2004 to july 2005).

Familles professionnelles	Indicateur de tension
Ouvriers qualifiés des travaux publics	1.85
Employés et techniciens des assurances	1.4
Employés des services divers	1.4
Ouvriers non qualifiés du bois	1.3
Cuisiniers	1.15
Ouvriers qualifiés du gros œuvre du bâtiment	1.1
Techniciens du bâtiment et des travaux publics	1.1
Employés et agents de maîtrise de l'hôtellerie	1.1
Infirmiers, sage femmes	1.1
Techniciens et agents de maîtrise de l'électronique	1.05
Ouvriers qualifiés travaillant pour formatage de métal	1.05
Techniciens et agents de maîtrise des industries	1.05

Familles professionnelles	Indicateur de tension
mécaniques	
Représentants	1.05
Ouvriers qualifiés travaillant par enlèvement de métal	0.95
Ouvriers qualifiés des industries de process	0.95
Bouchers, charcutiers, boulangers	0.9
Ouvriers qualifiés de l'électricité et de l'électronique	0.9
Conducteurs d'engins de traction et de levage	0.9
Maîtrise des magasins et intermédiaires du commerce	0.9
Ouvriers qualifiés de la mécanique	0.85
Source : DARES, calculs : DGTPE	

**Table 3.** Jobs for which migration can contribute to fill in 2 or 3 years.

Ouvriers qualifiés des travaux publics
Représentants
Employés et agents de maîtrise de l'hôtellerie
Infirmiers, sages femmes
Techniciens et agents de maîtrise de la mécanique
Cuisiniers
Boulangers, bouchers, charcutiers
Ouvriers qualifiés du gros œuvre
Techniciens du bâtiment
Ouvriers qualifiés de la mécanique
Source : Commissariat Général du Plan

## 2. The Model

The analysis is an overlapping generation model where the agents live for two periods of time. The world is composed of two open countries which differ in development level term i.e, one is a developing country denoted by  $A$  and the other is a developed country, denoted by  $B$ . The agents are young in the first period (evaluated from 0 to 40 years old) and old in the second period (after 40 years old) and when approaching a given time of the second period (evaluated at 65 years old), they are in rest in  $B$  after that time (i.e after 65 years old) and they die at the end of the second period of life. For simplicity, we levy the resting period of the agent native of  $A$  in  $B$  since their motivations have no more foundations. The agents native of  $A$  live in  $B$  only as long as they are young enough to work and bring money back home, those agents die of course at the end of the second period, but home where they go back to end their life after 65 years old i.e in a given time during their second period of life, when work force is over, thus face no resting income from  $B$ <sup>18</sup> that they leave once attained the resting age and die home. The main motivation of the agent of  $A$  is to look for a career better remunerated and prepare his resting time when in  $B$  in building his house where he is going to live once the resting age reached. Both when skilled and unskilled, the purpose of the agent in living in  $B$  is to look for business and poverty reduction and leave  $B$  once the

resting age attained. Then other young people native of  $A$  get inside  $B$  to continue the process. For that last argument, we don't take account of the children born from the foreigners who live in  $B$  i.e from the first foreigners' generation who may adopt different behaviours in regard to poverty reduction and development targets of their parents' country. Indeed are outside of the development strategy proposed here.

At each period of time in the poor country, a new generation of agents of constant size,  $N$  get inside the system. The agents born at  $t$  have the choice to get inside the education system as a student,  $S_t$  and become skilled next period or to get inside the production sector as a worker,  $U_t$  and remain unskilled endowed of a certain ability level, where for simplicity we assume  $S_t + U_t = 1$ . The both choices lead to a decision on whether to migrate to a rich country,  $B$  or not to. Those who choose to get inside the education system are at the end of the first period, endowed with a human capital level,  $h_t$  and the agent expectation is to be as closer as possible of the average world human capital threshold  $h_t^*$  for migration probability to be greater.

In contrast, the unskilled agent is endowed with a basic human capital level or ability denoted by,  $h_t^0$  but has saved more funds to support his project which consists on leaving to a rich country. Given that, total time endowed by an agent is normalized to 1, during his first period of life, the student allocates a time  $e_t$  to the education system and the remaining time i.e  $1 - e_t$  to the leisure. The young worker allocates a time  $u_t$  to the production sector and the remaining time  $1 - u_t$  to the leisure. At the end of their studies, the high skilled agents are willing to migrate to the country  $B$  in a legal way i.e through job finding with a probability  $pC(0,1)$  if his human capital level is such that  $h_t^A \geq h_t^*$  (i.e equal or higher than the threshold required). The model assumes the existence of a system which determinate the level of each candidate for abroad departure authorization. If the candidate fails to achieve the human capital level required, he stays home. It is particularly true for the skilled agent who faces less barriers to get inside the labour market even home. In contrast the unskilled labour incentives to migrate to the country  $B$  is harder but it may be possible depending on the needs of the labour market with a probability  $qC(0,1)$  since  $h_t^{0,A} \geq h_t^{0,*}$  (i.e equal or higher than the threshold required) where  $h_t^{0,*}$  is the world average ability level of the low skilled labour. Therefore, the high skilled and low skilled workers stocks who remain home are respectively expressed by  $(1-p)S_t$  and  $(1-q)U_t$  and increase the poor country potentialities in regard to development resulting from their previous investments even not high enough compare to the average world threshold required, their investments remain useful for the domestic economy and behaves like an increasing function through the time since innovations come quite fast from

<sup>18</sup> That is true in the French system, when you go back to your country, if you don't hold the citizenship, you are not eligible to receive the resting income. But staying their while not rich enough is almost impossible because it became too costly to live compare to the income hold.



developed countries and need to be adapted in the production sector and understood quite fast too.

Let  $w_t^A$  and  $w_t^B$  be the respective wage rate incomes of the high skilled labour respectively in the poor and in the rich country such that,  $w_t^A < w_t^B$  and let  $w_t^{0,A}$  and  $w_t^{0,B}$  be the low skilled labour wage rate incomes in  $A$  and in  $B$  countries respectively such that,  $w_t^{0,A} < w_t^{0,B}$ .

Indeed, following Chen (2008), the respective utility functions of the skilled and the unskilled labors in the first period are given by the following equations i.e

$$U_t^h = \ln(1 - e_t) + \beta^h \left[ (1-p) \ln(w_t^A h_{t+1}) + p \ln(w_t^B h_{t+1}) \right] \quad (1)$$

$$U_t^{\bar{h}} = \ln(1 - u_t) + \beta^{\bar{h}} \left[ (1-q) \ln(w_t^{0,A} h_{t+1}^0) + q \ln(w_t^{0,B} h_{t+1}^0) \right] \quad (2)$$

Where  $(\beta^n)$  is the discounted factor inside the range 0 and 1,  $n = h, \bar{h}$

The respective laws of motion of human capital accumulation and of routine task are given by equations (3) and (4) i.e

$$h_{t+1} = \phi e_t^\gamma h_t^\delta \quad (3)$$

$$h_{t+1}^0 = \mu u_t^{\bar{\gamma}} (h_t^0)^{\bar{\delta}} \quad (4)$$

Where  $\gamma, \delta \in (0,1)$  are the respective elasticity parameters of time spent in the education system,  $\gamma$  and human capital level,  $\delta$ . In contrast,  $\bar{\gamma}, \bar{\delta} \in (0,1)$  are the respective elasticity parameters of time spent in the production sector and of basic human capital level or ability level. Finally,  $\phi$  and  $\mu$  are the respective productivity parameters of the skilled and the unskilled labours.

The decision to invest in human capital accumulation is given by  $e_t(p)$  (introducing equation (3) inside equation (1) and setting the derivative in respect to time spent in education equal to zero, we determinate the equilibrium) defined such that

$$e_t(p)^* = \left[ 1 + (\gamma \beta^h)^{-1} \right]^{-1} = e_t \quad (5)$$

According to the equation above, time spent in the education system,  $e_t$  and the migration probability success,  $p$  are not linked, which means that, poor country agent's incentives to increase his human capital level is more relied to the mutations which occur in the world such that economic globalization and integration than what they think will happen i.e to join the Western country.

In parallel, in order to increase his funds, the unskilled labour has to take a decision whether leaving or not, thus

determinate the amount of his money through time spent in production sector which is given by the following equation i.e

$$u_t(q)^* = \left[ 1 + (\bar{\gamma} \beta^{\bar{h}})^{-1} \right]^{-1} = u_t \quad (6)$$

Like in the previous case, the migration probability success,  $q$  is not directly linked to the decision to work more or not given by,  $u_t$ , which means that, poor country agent's incentives to increase his ability level and/ or his funds is more closely relied to the mutations which occur in the world such that the desire to understand the way things work in order to do a better job as innovations are being introduced all the time and need to be adapted in production. Indeed, in order to keep doing their job quite well, they must increase their knowledge little by little while new production methods are being introduced in the production sector through the time.

*Assumption1*  $h_t^A \leq h_t^{*,A} \leq h_t^{0,B}$  and  $h_t^{0,A} \leq h_t^{*,A} \leq h_t^{0,B}$

Assumption1 means that the average developed country's human capital level,  $h_t^B$  is higher than the average developing country's human capital level,  $h_t^A$ . In parallel, the average developed country's ability level,  $h_t^{0,B}$  is higher than the developing country's average ability level,  $h_t^{0,A}$ . Moreover, there also exist a world average level or thresholds in the both cases, which are  $h_t^*$  for the high skilled agent and  $h_t^{0,*}$  for the low skilled labour. The model also assumes that, the developing country's agents are trying to get a level which reaches at least those thresholds corresponding to the average world levels.

### 3. The Equilibrium in Autarchy

*Definition1:* the long run growth path is defined by the locus on the space where:  $h_{t+1} = h_t = h$  and  $h_{t+1}^0 = h_t^0 = h^0$

Indeed, introducing equations (3) and (4) into the equations (1) and (2), we define the long run growth path, expressed such that

$$h = \phi^{1/1-\delta} \left[ 1 + (\gamma \beta^h)^{-1} \right]^{-\gamma/1-\delta} \quad (7)$$

$$h^0 = \mu^{1/1-\bar{\delta}} \left[ 1 + (\bar{\gamma} \beta^{\bar{h}})^{-1} \right]^{-\bar{\gamma}/1-\bar{\delta}} \quad (8)$$

*Proposition1:* According to definition1, the equilibrium growth rate without migration or in autarchy, is given by  $g^A = h/h^0$  i.e

$$g^A = \phi^{1/1-\delta} \left[ 1 + (\gamma \beta^h)^{-1} \right]^{-\gamma/1-\delta} / \mu^{1/1-\bar{\delta}} \left[ 1 + (\bar{\gamma} \beta^{\bar{h}})^{-1} \right]^{-\bar{\gamma}/1-\bar{\delta}} \quad (9)$$

*Proof:* setting  $g^A = \Delta(\phi, \gamma, \beta^h, \mu, \bar{\gamma}, \bar{\delta}, \bar{\beta}^h)$  i.e in function of its parameters, we can see that, the strong mechanics of economic development are:  $\phi$ ,  $\gamma$ ,  $\beta^h$  and  $\delta$ . In contrast, the weak mechanics of economic development i.e those which maintain the economy at a low level are given by:  $\mu, \bar{\gamma}, \bar{\delta}, \bar{\beta}^h$ . According to this result, the model follows the brain drain principles in the way that development is the resulting effect of human capital accumulation [Lucas (1988)] and the modern sector efficiency [Lewis (1954)] mainly. (see figure1 for proposition1 summary)

## 4. The Endogenous Model of Migration

In this part, we introduce migration prospects in order to show how the agents of  $A$  can get in  $B$  and determinate later on how coordinated funds transfers and human capital increase policy is able to lead the poor economy to the development take-off.

*Proposition2:* the migration decision in the concern of the high skilled labour is an escalator function inside the range  $[0,1]$  according to the tests rules such that:

If  $h_t^A < h_t^*$ , then the migration demand is rejected, thus  $p=0$  because  $e_t(0) < e^*$

If  $h_t^A = h_t^*$ , then the migration decision depends on the labour market demand highlighted by the value of  $p$  where  $0 < p < 1$ , it

is accepted since the demand of labour of the rich country is higher than the supply of jobs i.e when  $p$  is close to 1, the labour market faces high demand because the skills required are scarce, then we may have  $e_t(p) \rightarrow e^*$  and additional training will be given. Otherwise, if the labour market demand is quite low compare to the supply or  $p$  is close to 0 because  $e_t(p) < e^*$  i.e many people has the required skills the firms are looking for in the concern of the jobs offered or the skills available don't match then, the visa demand is rejected. Finally, if  $h_t^A > h_t^*$ , then the migration decision is accepted with  $p=1$  because  $e_t(1) \geq e^*$

*Proposition3:* the migration decision in the concern of the low skilled labour is also an escalator function defined according to the tests practice such that:

If  $h_t^{0,A} < h_t^{0,*}$ , the migration demand is rejected, thus  $q=0$  because  $u_t(0) < u^*$  which means that the skill endowed is too low compare to the one required by the labour market. If  $h_t^{0,A} = h_t^{0,*}$ , the migration demand is accepted in regard to the labour market climate highlighted by  $q$  where  $0 < q < 1$  such that if  $q$  is close to 1 meaning that, the labour demand is high and the skill required is at the right level i.e  $u_t(q) \rightarrow u^*$  it leads to an acceptance. Otherwise, if the labour market demand is too low compare to the supply of jobs, then  $q$  is close to 0 because the skill required is too low compare to the endowment of the agent i.e  $u_t(q) < u^*$ , the major part of the dossier is rejected. Finally, if  $h_t^{0,A} > h_t^{0,*}$ , the migration demand is accepted with probability,  $q=1$  because  $u_t(q) \geq u^*$

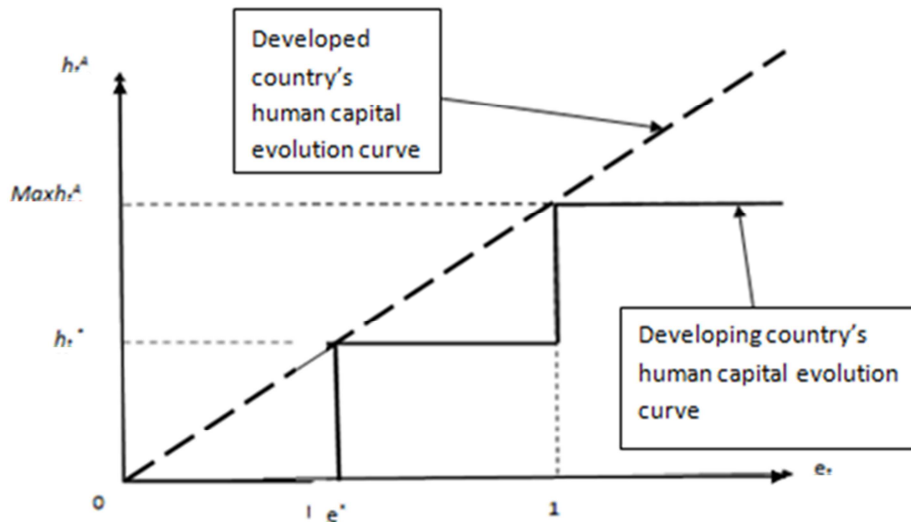


Figure 1. Displays human capital as an escalator function in function of time spent in education system.

### 4.1. Analysis of the Strategy of Entry of the Unskilled Labor Whose Demand Has Been Rejected

In this part, we analyze and justify why unskilled labour presence in rich countries is empirically observable despite of

the fact that their entry is sometimes not legal<sup>19</sup>.

If  $q=0$ , it means that the agent visa demand has been rejected

<sup>19</sup> La stratégie des migrants décrite ainsi que les modalités de reconnaissance légales invoquées s'appliquent particulièrement à la France.



and the unskilled labour opts for several other strategies allowing him to get inside the rich country through a financial sum which is his saving  $s_i^U$ . Indeed, *first* he may manage with the black market migration entry, then there exists an uncertainty  $\varpi_0$  for him to succeed, thus a fraction  $q\varpi_0$  has a probability to achieve the rich country and  $q(1-\varpi_0)$  remaining fraction has a probability of  $1-\varpi_0$  for him not achieve the rich country. *Second*, he may manage with his community who lives in the rich country for an arrangement of entry through a provision of a certificate document to present to the police control, there also exists an uncertainty  $\varpi_1$  for him to succeed, thus, a fraction  $q\varpi_1$  can get inside the rich country without being caught. In contrast, a fraction  $q(1-\varpi_1)$  cannot achieve the rich country i.e can be caught and send back home by the rich country police. Indeed,

$$q = \sum_{l=0}^{l=1} \pi_l [q(1-\varpi_l) + q\varpi_l] \text{ converges to 0 because } h_t^{0,A} < h_t^{0,*} \text{ and } u_l(q)^* < u^* \text{ where } l=0,1 \text{ and } \sum_{l=0}^{l=1} \pi_l = 1$$

*Lemma1: some of the illegal migrants reach the rich country, thus  $q \geq 0$ . In conformity to the empirical observation of illegal immigrants existence in rich countries given by the statistics on population immigration to the OEDC countries, this category of workers without status exist, called in France "Without ID"(see table 3)*

#### 4.2. Legal Status Acquisition Strategy

In this part of the analysis, we explain how in countries like France, some of the foreigners (unskilled) achieve to get a legal status (their number is presented in table 3) which allow them work and help their family through funds transfers we will study deeply later on during the analysis.

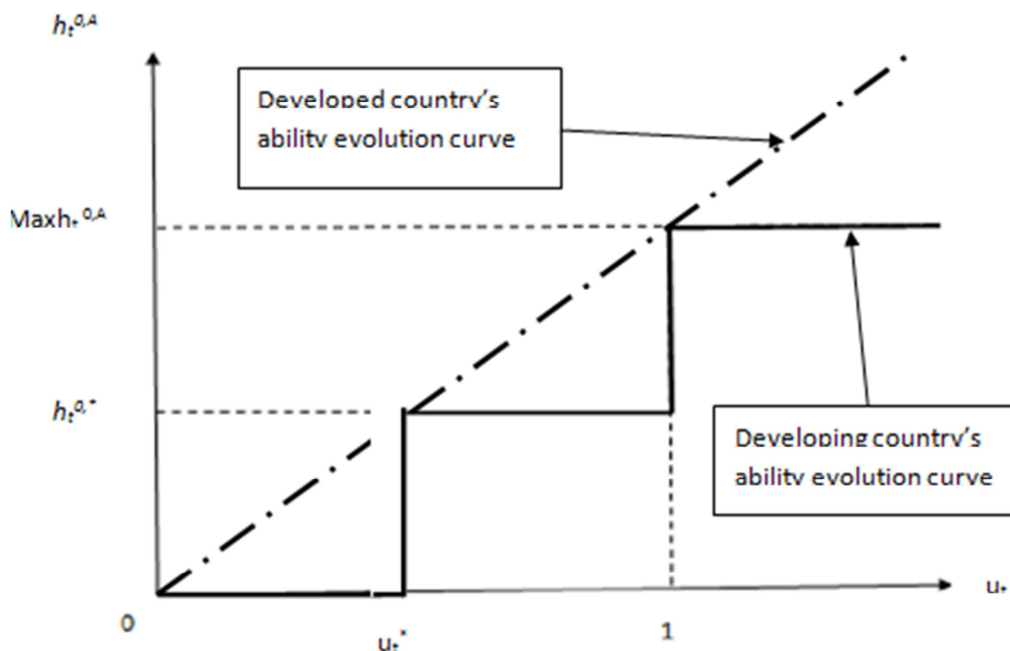


Figure 2. Displays ability as an escalator function of time spent in the production sector.

*Proposition4: there exist 3 kinds of low skilled migrants in the rich country: the workers who satisfied the tests, the workers who used the black illegal entry market and those who entered through an identity which belongs to someone else and only the first kind have the legal residence in regard to the law.*

We explain now the situation in rich countries, which make them accept some of the illegal foreigners for the social security system to maintain in balanced. In the twentieth century, people tended to retire earlier in most developed countries, despite the fact that there was a steady and significant increase in life expectancy. In the US, for example, the life expectancy at birth for men who were born

in 1900 was about 50 years. This figure increased substantially to over 70 years for those who were born in the middle of the century, and increased further to almost 80 years for those born in the 1990s. Despite increasing life expectancy, however, labour force participation rates of men aged 65 and over steadily declined from over 60% in 1900 to around 20% at the last decade of the century, while the rates of men aged 55 to 64 declined from around 90% to below 70% for the same period. Several researchers such as Bloom et al. (2010), Kalemli-Ozcan and Weil (2010) examine the relatively neglected question of how mortality decline affects retirement age. In particular, Kalemli-Ozcan and Weil (2010) show that people may retire earlier if the decrease in the variability of age at death associated with mortality decline is

very significant. In the 21th century, it is observed that the improvement in survival probabilities at various ages is more substantial for the earlier period. Moreover, unlike the later period, the mortality decline had led to pension funds financial support problem in rich countries due to the increase of the aging of the population helped by demographic transition which means that, in contrast to traditional economic system, the children choice quality is relevant than their quantity, thus to treat those questions raised by both mortality and fecundity decrease coupled with the need of financial support for aging population, migrants take opportunity of the situation in viewing their status validated in some circumstances for the social security system to maintain as for the case of France, specifically when they give birth. According to what is stipulated, the foreign agent with the need to integrate the rich country system knows thus how to achieve this goal. Fecundity rate decrease in developed country and fecundity increase in the poor country, have an impact on developed country's social policies which alleviate integration conditions to foreigners who become parents while in rich countries. According to the great social security systems such of France, once a baby is born there, specifically if one of the parent has a citizenship or has a permanent resident status, the mother or the father who was a foreigner without status, is given one in order for the baby to grow there. Therefore, sometimes, the parent endowed of a status may not be the real one but made an arrangement for the foreigner to get a legacy in the rich country. Actually, when the young child will be 18 years old, he will have the choice to be given a citizenship or not, depending on his decision. But for most of the cases, he opts for the Western country citizenship. Indeed this agent is not included inside our study. The situation of elderly increase in developed countries and the necessity for active young people to finance pension funds through their work, legitimate migration policy conducted around the world by some rich countries. Other ways to obtain a legal status exist through organizations which take care of foreigners' defense like "SOS racism". Moreover, before Nicolas Sarkozy becomes the French President, the law stipulated that since someone can prove that he has spent ten years in the territory without papers or ID, he is eligible for a permanent resident attribution, but the new President had ended that law. Then in this model, some of the candidates concerned by migration opportunity whose project failed most of the time, keep trying like a game, expecting the project to reach the goal fixed.

### 4.3. The Production Sector of the Unskilled Labour

Because the main objective of this article is to extend the standard brain analysis, a great part of the model focuses on

the unskilled labour strategy, since the skilled labour actions and results already follow those provided by the literature. This part shows the heterogeneity in per-capita income among the unskilled workers that we highlight later on with the funds transfer differences in level term. Thereby describe an escalator function in poverty reduction evolution over time.

We assume that, all the unskilled labour are employ in one single firm which produces one homogenous good using heterogenous ability stocks of labour,  $L_t = (L_t^i)_{i=0,1,*}$  along the process of production associated with both an heterogenous capital stock,  $K_t^0 = (K_t^{0,i})_{i=1,2,*}$  and the heterogenous production function of Cobb Douglas,  $Y_t^0 = (Y_t^{0,m})_{m=max,*,min}$  expressed such that

$$Y_t^{0,i} = A_t^{0,i} (K_t^{0,i})^\alpha (L_t^{0,i})^\varepsilon \quad (10)$$

Where  $\alpha + \varepsilon = 1$  and  $A_t^0 = (A_t^{0,i})_{i=1,2,*}$  is the associated heterogenous scale parameter of the production sectors.

Setting  $y_t^{0,i} = Y_t^{0,i}/L_t^{0,i}$ , the previous function can be expressed in per-capita terms such that:

$$y_t^{0,i} = A_t^{0,i} (k_t^{0,i})^\alpha \quad (11)$$

Therefore, both the wage rate income,  $w_t^{0,i}$  and the interest rate,  $R_t^{0,i} = 1 + r_t^{0,i}$  are also heterogenous and given by the following equations such that

$$w_t^{0,i} = \varepsilon A_t^{0,i} (k_t^{0,i})^\alpha \quad (12)$$

$$1 + r_t^{0,i} = \alpha A_t^{0,i} (k_t^{0,i})^{\alpha-1} \quad (13)$$

Where  $k_t^{0,i} = K_t^{0,i}/L_t^{0,i}$  is the heterogenous per-capita capital stock, it is assumed that  $1 < * < 2$  such that: the lowest ability level is  $1 = min$ , the average is  $* = average$  and the highest is  $2 = max$

### 4.4. The Utility Function of the Unskilled Agent

The heterogenous unskilled agents who live in the rich country share the same utility function expressed such that

$$U(c_t^{0,i}, \sigma_t^i) = \ln(c_t^{0,i}) + \rho_i \ln(\sigma_t^i) \quad (14)$$

Where  $\rho_i$  is the elasticity of funds transfer,  $i = *, 1, 2$

### 4.5. Funds Transfers' Process

In this part, we show how knowledge equivalency is progressively done through the use of the jumping function in order to evaluate the amount of funds transfers the agent is able to send to his family.

*Proposition5: the system admits multiple equilibria in levels of ability terms, such that:*  $\rho_t^{0,A} [\text{Min}(h_{t+1}^{0,A})] \rightarrow \rho_t^{0,1}$ ;  $\rho_t^{0,A} [\text{Ave}(h_{t+1}^{0,A})] \rightarrow \rho_t^{0,*}$ ;  $\rho_t^{0,A} [\text{Max}(h_{t+1}^{0,A})] \rightarrow \rho_t^{0,2}$  which yield  $\text{Min}(h_{t+1}^{0,A}) \rightarrow \text{Min}(h_{t+1}^{0,B})$ ; remunerated at the rate  $w_t^{0,1}$ ,  $\text{Ave}(h_{t+1}^{0,A}) \rightarrow \text{Ave}(h_{t+1}^{0,B})$  remunerated at the rate  $w_t^{0,*}$ ;  $\text{Max}(h_{t+1}^{0,A}) \rightarrow \text{Max}(h_{t+1}^{0,B})$  remunerated at the rate  $w_t^{0,2}$ . Where,  $w_t^{0,1} < w_t^{0,*} < w_t^{0,2}$  and  $\rho_t^{0,1} < \rho_t^{0,*} < \rho_t^{0,2}$  are the jumping escalator continuous functions of abilities.

*Proof:* Once in the developed country, the low skilled labours native of the poor country are heterogenous in abilities since the rejected dossier could get inside the system endowed with a low ability level. Knowledge externalities make an equivalency among the workers at each level of ability through the jumping function when production is holding. Following Chen (2008),  $(\rho_t^{0,i})_{i=1,*2}$  is a jumping function of the ability level<sup>20</sup> of the developing country's agent to the one of the developed country ability dynamical path because of knowledge externalities at work. Therefore,  $\rho_t^{0,A} [\text{Min}(h_{t+1}^{0,A})] \rightarrow \rho_t^{0,1}$ ;  $\rho_t^{0,A} [\text{Ave}(h_{t+1}^{0,A})] \rightarrow \rho_t^{0,*}$ ;  $\rho_t^{0,A} [\text{Max}(h_{t+1}^{0,A})] \rightarrow \rho_t^{0,2}$  since work is done together implying learning by doing effect [Arrow (1962)]. Indeed,  $\text{Min}(h_{t+1}^{0,A}) \rightarrow \text{Min}(h_{t+1}^{0,B})$  remunerated at the rate  $w_t^{0,1}$ ,  $\text{Ave}(h_{t+1}^{0,A}) \rightarrow \text{Ave}(h_{t+1}^{0,B})$  remunerated at the rate  $w_t^{0,*}$ ,  $\text{Max}(h_{t+1}^{0,A}) \rightarrow \text{Max}(h_{t+1}^{0,B})$  remunerated at the rate  $w_t^{0,2}$ .

For simplicity, we assume the unskilled labour immigrants stock,  $qU_t^d = U_t^d$  where  $q = \sum_{i=0}^{i=2} \pi_i [q(1-\varpi_i) + q\varpi_i]$

*Proposition6: the economy admits multiple equilibria expressed by a couple of ability levels evolutions and per-capita income associated i.e  $\{(g, \varpi), (g^{0,1}, w_t^{0,1}), (g^{0,*}, w_t^{0,*}), (g^{0,2}, w_t^{0,2})\}$  which yield multiple equilibria in poverty reduction expressed by funds transfers levels i.e  $(\sigma, \sigma_t^0, \sigma_t^1, \sigma_t^2)$  received by families in poor countries*

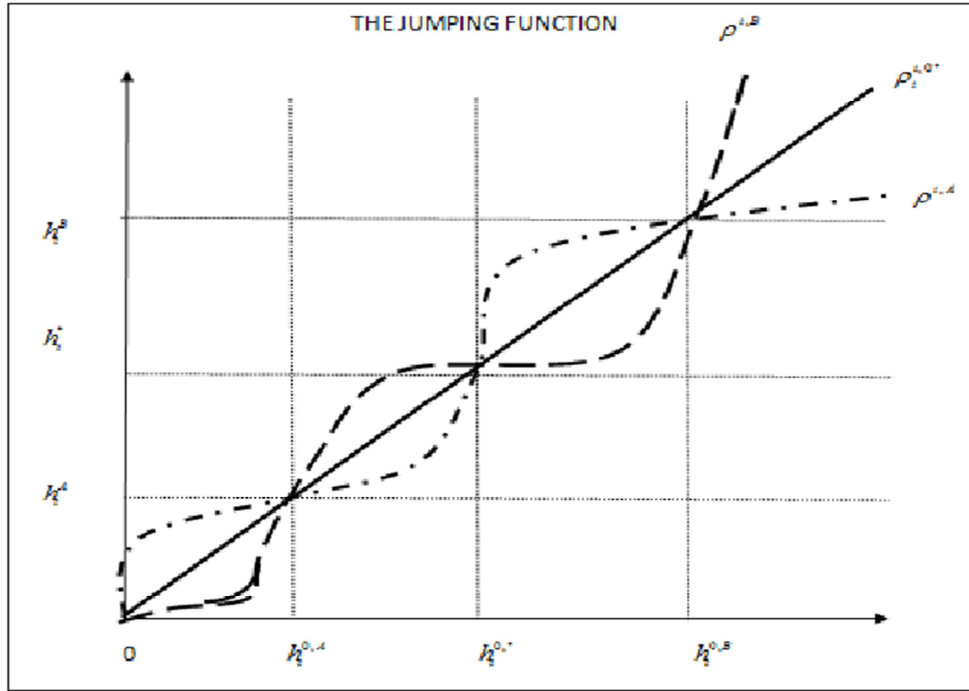
We're going to show that, there exists a vector of couples of different levels of growth rates and per-capita wage rate incomes among the low skilled foreigners. The first couple of variables corresponds more to funds reception from the poor to the rich country (student case) than the opposite.

If  $h_t^{0,A} \geq h_t^{0,*}$  then, if  $h_t^{0,A}$  is low, this agent human capital level converge to the threshold required and  $h_t^{0,A} \rightarrow h_t^{0,B}$  which stays at the middle of the dynamical system, where

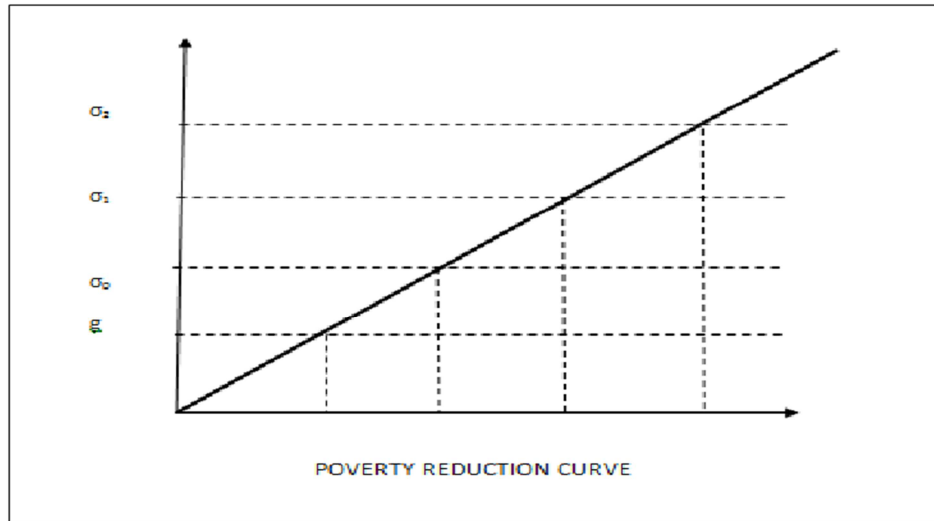
$h_t^{0,A} \approx h_{t+1}^{0,B} = h_t^{0,B} \rho_t^{0,B}$ . Thus, the agent growth rate in ability term is  $g^B = h_{t+1}^{0,B} / h_t^{0,B} = \rho_t^{0,B}$  for simplicity it can be written  $g^{0,*} = h_{t+1}^{0,*} / h_t^{0,*} = \rho_t^{0,*}$  which converges to the threshold of the living standard and yields a remuneration rate,  $w_t^{0,B} = w_t^{0,*}$  that the agent uses to finance funds transfer to his family in poor country at a fraction  $\sigma_t^*$ . Therefore, his budget constraint is such that  $w_t^{0,*} = c_t^{0,*} + \sigma_t^*$  during his second period (for simplicity, we use current time as the study is holding deeply in the second period) of life while living in the developed country where  $c_t^{0,*} \geq 0$  is per-capita consumption rate. If  $h_t^{0,A}$  is high, then the agent's productivity is increasing through learning by doing while production is holding. Indeed  $h_t^{0,A}$  jumps on the dynamical system of the rich country and settle at the highest ability level,  $h_t^{0,2}$ . Indeed, the agent ability evolution is expressed such that,  $h_{t+1}^{0,2} = h_t^{0,2} \rho_t^{0,2}$  and his earn in ability term is  $g^{0,2} = h_{t+1}^{0,2} / h_t^{0,2} = \rho_t^{0,2}$  which converges to  $w_t^{0,\max(B)} = w_t^{0,2}$  is the highest wage rate income those agents can win. That money, allows the agent proceed to funds transfers at the rate  $\sigma_t^2$  and therefore, because we are in the second period of life, the agent budget constraint can be written such that  $w_t^{0,2} / (1+r_t^{0,2}) = (c_t^{0,2} + \sigma_t^2) / (1+r_t^{0,\max})$  where  $c_t^{0,2} = c_t^{0,\max(B)} \geq 0$  is his per-capita consumption and  $1+r_t^{0,2} = R_t^{0,2}$  is the interest rate faced by the agent. If  $h_t^{0,A} < h_t^{0,*}$  (this case concern those who couldn't get inside the rich economic system legally because of their low human capital level endowment) thus, if  $h_t^{0,*}$  is low, thus this agent human capital can adapt his ability to the one required at work, his wage rate income equals the thresholds of the living standard,  $w_t^{0,\min(B)} = w_t^{0,1}$  meaning he has just enough to consume and to send money for fund transfer abroad. Indeed, his second period budget constraint is  $w_t^{0,1} / R_t^0 = (c_t^{0,1} + \sigma_t^{0,1}) / R_t^0$  where  $c_t^{0,1} \geq 0$  is his per-capita consumption and  $R_t^0$  the interest rate faces. Consequently, his  $h_t^{0,A}$  evolution remains at the bottom of the dynamical system i.e  $h_t^{0,\min(B)} = h_t^{0,1}$  and his gain in ability term is  $g^{0,1} = h_{t+1}^{0,1} / h_t^{0,1} = \rho_t^{0,1}$  and converges to  $w_t^{0,\min(B)} = w_t^{0,1}$ . If  $h_t^{0,*}$  is high, thus this agent ability remains low and his wage rate income is under the threshold of the living standard,  $\varpi$ , he doesn't have enough funds to send money for funds transfers, if he does so, then he has debt. Indeed, we have  $\varpi = c_t^{0,A} + \sigma$  where  $\sigma \leq 0$  and  $c_t^{0,A} = c$  is his per-capita consumption. Indeed, this agent is facing poverty in the rich country due to the fact that his ability is too low for him to make money and to help his family. Indeed, the agent is in the case where he may receive money from abroad to live in the rich country. Consequently, his  $h_t^{0,A}$  can't jump on the dynamical system of the rich country as long as his ability growth rate is such that,  $g = h_{t+1}^{0,A} / h_t^{0,A} = \rho_t^{0,A}$ . He may engage inside the ability increase system in order to converge toward the average ability level or he may receive funds from abroad (this case may concern the foreign student case among the developing country's agents). The budget constraint of this agent can be written such that  $\varpi = (c + \sigma)$ ,

20 rather than of human capital like stipulated the Chen (2008)

those variables are constant and low such that the interest rate function both in ability and in human capital term) doesn't exist for this case. (Figure3 displays the jumping



**Figure 3.** displays the jumping escalator continuous function of the poor country (A) to the rich country (B) both in human capital and in ability levels



**Figure 4.** displays poverty reduction as an increasing function of funds transfers sent by unskilled home.

In this part, we study development according to per-capita income increase in the source country

$$\sigma_t^{0,i} = \frac{\rho_i}{1+\rho_i} \varepsilon A_t^{0,i} (k_t^i)^\alpha \quad (16)$$

## 5. Funds Transfers and Poverty Reduction

*Proposition7: per-capita consumptions and funds transfers are given by the following equations:*

$$c_t^{0,i} = \frac{1}{1+\rho_i} \varepsilon A_t^{0,i} (k_t^i)^\alpha \quad (15)$$

Where

$c_t^{0,i} = c_t^{0,i}(k_t^{0,i})_{i=*,1,2}$  and  $\sigma_t^i = \sigma_t^i(k_t^{0,i})_{i=*,1,2}$  are both functions of per-capita physical capital.

Per-capita physical capital of the developed country is transferred into the poor country i.e investment in education, human capital or ability can be conducted by the family receiver in order to prepare young generation to enhance

development

In order to measure poverty reduction, we need to add funds transfers  $\sigma_t^i$  to per-capita income of home country  $g^A$  which we assimilate to the income received by everybody and highlight the impact of poverty reduction on development, since we know that,  $g^A = \Delta(\varphi, \gamma, \beta^h, \bar{\beta}^h, \gamma, \mu)$  which was viewed in above proposition, we obtain other development mechanisms based on per-capita physical capital.

To determinate funds transfers levels and see how they act on poverty reduction, we need to solve three programs which budget constraints are located in the second period of life in the developed country and expressed such that:

$$\begin{aligned} w_t^{0,*}/1+r_t^{0,*} &= (c_t^{0,1} + \sigma_t^1)/1+r_t^{0,*} \text{ where } w_t^{0,*} = \varepsilon A_t^{0,*} (k_t^{0,*})^\alpha \text{ and } \\ 1+r_t^{0,*} &= \alpha A_t^{0,*} (k_t^{0,*})^{\alpha-1} \\ w_t^{0,2}/1+r_t^{0,\max} &= (c_t^{0,2} + \sigma_t^2)/1+r_t^{0,\max} \text{ where } w_t^{0,2} = \varepsilon A_t^{0,2} (k_t^{0,2})^\alpha \text{ and } \\ 1+r_t^{0,2} &= \alpha A_t^{0,2} (k_t^{0,2})^{\alpha-1} \\ w_t^{0,1}/1+r_t^{0,1} &= (c_t^{0,*} + \sigma_t^1)/1+r_t^{0,1} \text{ where } w_t^{0,1} = \varepsilon A_t^{0,1} (k_t^{0,1})^\alpha \text{ and } \\ 1+r_t^{0,1} &= \alpha A_t^{0,1} (k_t^{0,1})^{\alpha-1} \end{aligned}$$

Indeed, to solve the whole program needs to write the Lagrangian such that

$$\Pi(c_t^{0,i}, \sigma_t^i) = [\ln(c_t^{0,i}) + \rho_i \ln(\sigma_t^i)] + \lambda_i [(w_t^{0,i}/(1+r_t^{0,*}) - (c_t^{0,i} + \sigma_t^i)/(1+r_t^{0,*}))]$$

Where:  $(\sigma_t^i)_{i=0,1,2}$  is per-capita fund transfer and  $(c_t^{0,i})_{i=1,2}$  is per-capita consumption,  $1+r_t^{0,i} = R_t^{0,i}$  is the interest rate and  $A_t^{*,A} < A_t^{*,I} < A_t^{*,*} < A_t^{*,2}$  are production sector's productivity differentials;  $w_t^{0,1} < w_t^{0,*} < w_t^{0,2}$  are per-capita incomes differentials and the first one of the serial is excluded from the program.

For simplicity, we set  $(c_t^{0,i})_{i=1,2}$

The first order conditions give per-capita consumption,  $(c_t^{0,i})_{i=1,2}$  and per-capita fund transfer,  $(\sigma_t^i)_{i=1,2}$  expressed by the following equations i.e

$$c_t^{0,i} = (1/(1+\rho_i)) w_t^{0,i} \text{ and } \sigma_t^i = (\rho_i / (1+\rho_i)) w_t^{0,i}$$

Which like announced by proposition7, finally the solutions are given by

$$c_t^{0,i} = (1/(1+\rho_i)) \varepsilon A_t^{0,i} (k_t^{0,i})^\alpha \text{ and } \sigma_t^i = (\rho_i / (1+\rho_i)) \varepsilon A_t^{0,i} (k_t^{0,i})^\alpha$$

*Proposition8: Development is the conjunction of poverty reduction expressed by  $\sigma_t^i$  and the economic growth rate in autarchy,  $g^A$  such that*

$$(g^A + \sigma_t^1 (k_t^{0,1}), g^A + \sigma_t^* (k_t^{0,*}), g^A + \sigma_t^2 (k_t^{0,2})) \quad (17)$$

Where  $g^A$  is the average income received by each family in the poor country (see figure3).

## 6. Human Capital Convergence and Development

For these categories of agents, illegal migration assumption is not maintained. High skilled agents are assumed to get inside the rich country in a legal way.

*Proposition9: the opening of the economy makes the poor country endowed with a higher human capital accumulation than in autarchy which yields a higher growth rate,  $g^{\bar{D}}$  than the one found in autarchy i.e  $g^A$ , where  $g^{\bar{D}}$  is a function of international human capital accumulation. The developed country's growth rate,  $g^D$  is also a function of human capital accumulation, such that*<sup>21</sup>

$$g^{\bar{D}} = a(1-p)\rho_h (h_{t+1}^B) \quad (18)$$

$$g^D = \rho_h (h_{t+1}^B) \quad (19)$$

*Proof:* since incentives of human capital investment still increasing and most of the skilled labour remain home, the growth rate in an open economy is higher than in autarchy i.e  $g^A \leq g^{\bar{D}}$ , there exist an efficient parameter of the poor country economy,  $a$  where  $0 < a < 1$  which makes the developing country less efficient than the rich country in development term. Indeed, if  $h_t^A > h^*$ , the migration probability equals  $p=1$  as already evocated. If  $h_t^A = h^*$  the migration probability is  $p \in ]0,1[$ , meaning that if  $h^*$  is high, then  $p$  is close to 1, otherwise  $p$  is close to 0. Therefore, the source country human capital dynamical system can be written such that  $h_{t+1}^A = a(1-p)h_t^A \rho_h(h_{t+1}^B)$ . Knowing that  $g^{\bar{D}} = h_{t+1}^A/h_t^A$  converges to  $h_{t+1}^*/h_t^* = a(1-p)\rho_h(h_{t+1}^B)$ . Therefore domestic human capital growth rate is defined such that:  $g^{\bar{D}} = a(1-p)\rho_h(h_{t+1}^B)$  then, the developed country's growth rate which is the reference equals,  $g^D = \rho_h(h_{t+1}^B)$ .

Indeed we can announce the following result i.e proposition 10 as the consequence of proposition9

*Proposition10: there exist a development gap function,  $G$  among rich and poor countries expressed such that,*

$$G = g^D - g^{\bar{D}} = [1 - a(1-p)]\rho_h(h_{t+1}^B) \geq 0 \quad (20)$$

*Proof:* recalling that  $g^{\bar{D}} = a(1-p)\rho_h(h_{t+1}^B)$  and  $g^D = \rho_h(h_{t+1}^B)$  therefore, there exist a difference among them in development level called the development gap,  $G$

<sup>21</sup> Those results follow the literature of endogenous growth with human capital accumulation



expressed such that,  $G = g^D - g^{\bar{D}} = [1 - a(1 - p)]\rho_h(h_{t+1}^B)$

If  $p$  which is the brain drain parameter tends to 0, then  $G$  tends to reduce and establishes at  $(1-a)\rho_h(h_{t+1}^B)$ , convergence may occur i.e. rich and poor countries may reach similar development levels. If  $a=1$ , then the poor country grows faster than the rich country and may catch him [Solow, 1956]. Otherwise if  $p$  tends to 1, then  $G$  is an increasing function of the developed country's human capital level i.e.  $G=\rho_h(h_{t+1}^B)$  and development retard keeps increasing among poor and rich countries and development path may be caught in a poverty trap. Convergence may occur among rich and poor countries since,  $p=1-1/a$  then if  $p$  is low i.e. the brain drain is low, thus  $a \geq 1$  i.e.  $a$  is high, then the poor economy is catching up the rich economy because  $g^{\bar{D}} \rightarrow g^D$ . Otherwise, if  $p$  is close to 1 or the brain drain is high, thus, the development gap parameter,  $a < 1$  i.e.  $a$  is low, then the poor country's development path still far from the rich country's development path because  $G$  is an increasing function. Moreover, the developing country's growth path is far from its frontier.

## 7. Brain Drain and Development

According to proposition 10, if  $p$  is high i.e. close to 1 and  $a \leq 0$  then, the developed countries externalities benefice are high due to high stock of skilled labour,  $G=G(h_{t+1}^B)$  is an increasing function of human capital accumulation, then the developing country's growth rate  $g^{\bar{D}} \rightarrow g^A$  at least and we may have  $g^A$  tends to zero, thus leads the economy to a stagnation. If  $p$  is low or close to 0 and  $\rho_h(h_{t+1}^B)$  closely linked to developing country, then the gap  $G=G(h_{t+1}^B)$  is a decreasing function and may define one position where the both curves meet in the space i.e.  $g^D = g^{\bar{D}}$ . Indeed, human capital convergence can be observed through time among the two countries. We also can have  $\rho_h(h_{t+1}^A)$  high and close to  $\rho_h(h_{t+1}^B)$  without  $p$  having a significant impact on  $g^{\bar{D}}$ . When employment is scarce in developed countries,  $p$  may be high without affecting  $\rho_h(h_{t+1}^B)$  and  $G$  still increasing. Therefore convergence can't occur. Otherwise, if  $\rho_h(h_{t+1}^B)$  is not too high, then if  $p$  is high enough, it may have an impact on  $G$  and convergence to a certain value can't be observed yet. Therefore, convergence occurrence will take a longer time or never appear as long as poor country's efficiency due to incentives to invest in human capital accumulation are too low i.e.  $a$  is low. If the difference between  $\rho_h(h_{t+1}^A)$  and  $\rho_h(h_{t+1}^B)$  is quite low, then if  $p$  is inside the range  $[0, 1]$  then, the speed of converge of  $G$  to 0 will be quite fast. Therefore convergence occurrence may appear.

We've seen that,  $\rho_h()$  is a jumping function of human capital accumulation (Chen, 2008) which goes from the bottom of the development path before jumping on the threshold or at the average world level of development. The function can keep jumping until it reaches the critical level when human capital increases highly (Azariadis-Drazen, 1990). Those jumps of the function  $\rho_h(h_{t+1}^A)$  on the path guided by  $\rho_h(h_{t+1}^B)$  on the dynamical system is reducing its distance from the development frontier country through convergence first and the catching up after. Indeed, the poor country is taking-off and converging towards its long run growth path. According to the model, the poor country can achieve the developed country's highest human capital level over time. The existing gap among the two countries in development terms can converge to zero under certain circumstances evoked above, remains increasing or decreasing with the increase of incentives to invest in human capital accumulation done by the developing country's agents in order to approach the threshold and since it is increasing, the developing country's growth rate increases too through the time. Therefore, the return of the fraction of the high skilled labour who have left the country through the increase of their incentives to invest in human capital accumulation had led to general human capital increase in the country. Instead, the fraction of low skilled labour stock who works in the developed country's target is poverty reduction. Consequently, we achieved the optimistic brain drain models which emerged in the mid-1990s around the idea that migration prospects can foster domestic enrolment in education in developing countries, raising the possibility for a brain drain to be beneficial to the source country. The novelty of that recent literature is to show that under certain circumstances, the brain drain may ultimately prove beneficial (but of course is not necessarily so) to the source country. (Mountford, 1995, 1997; Stark et al., 1997, 1998; Vidal, 1998; Docquier and Rapoport, 1999; Beine et al., 2001; and Stark and Wang, 2002). In order not to waste his brain, recent models have developed the preference for the skilled labour to have a better job home or to go back home if education is acquired outside [Garcia Pires (2015)]

## 8. Coordinated Human Capital Investment and Funds Transfers Policy

In this part, we show that both funds transfers and incentives to increase human capital accumulation can be coordinated as an economic policy able to enhance development in poorest countries<sup>22</sup> i.e. reduce poverty and inequality as well as understand new technology with productivity increase

<sup>22</sup> an idea of Roseinstein-Rodan, (1943) in the concern of under developed countries



allowing the production sector create higher quality goods. Indeed, we are far from the pessimistic view of the brain drain consequences on the source country like in the first papers which emphasized the negative effects of the brain drain (Miyagiwa, 1991; Haque and Kim, 1995) on poor countries development paths, in our case, labour mobility is an engine of growth and development specifically because education acquisition is done home like proposed the recent brain drain models (Beine-Docquier-Rapoport, 2008).

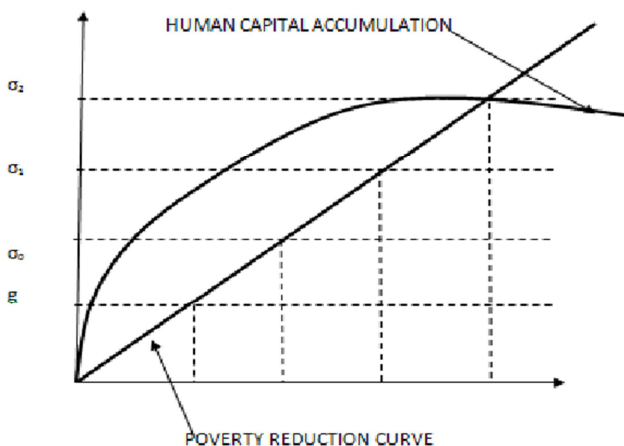
*Proposition 11: development is a coordinated investment policy like a process where on the one hand, poverty reduction, a vector of multiple components increases in per-capita physical capital, thus increases the well being through time. On the other hand, human capital accumulation growth rate increase over time, which increases also the skills required to implement high innovations in the production process. Therefore, development sustainability is expressed by the following equation:*

$$\left[ f(k_t^{\min}), f(k_{t+1}^*), f(k_t^{\max}); F(p_h(h_{t+1}^B)) \right] \quad (21)$$

Where:

$$f(k_t^{\min}) = g^A + \sigma_t^0; f(k_t^*) = g^A + \sigma_t^*; f(k_t^{\max}) = g^A + \sigma_t^2$$

The intercept of both the curve of poverty reduction and the one of human capital increase define development or coordinated investment policy (see the last figure)



**Figure 5.** Displays coordinated human capital and funds transfer policy. Highlighted by human capital accumulation and poverty reduction increase.

## 9. Conclusion

This analysis has shown *first*, the incentives to migrate which imply both labour mobility and heterogeneity can foster growth and development in poor countries. *Second*, cooperative international migration policy between rich and poor countries may partly support aging and pension funds financial needs in developed country through developing

countries' fresh labour entry. *Third*, cooperative economic policy between rich and poor country, may create convergence and allow the poor country reaches its development frontier. *Finally*, the extended brain drain model is able to fight poverty and generalize incentives to invest both in human capital and ability increase around the whole world. Consequently, the development strategy proposed by this model may be helpful both to policy makers and to the world Organizations in charge of developing countries' management. In the purpose of the reach of the UN Millennium Development Goal i.e cutting poverty in half from 2000 to 2015 instead of universal rules application in poor countries or a unique economic policy for the whole poor countries, each specificity of the poor countries' society can be classified for a better understanding of the phenomenon of development which guide agents' in traditional societies.

## Acknowledgement

The author is associate professor at Marien N'Gouabi University, Brazzaville (Congo) and wishes to thanks the editor and the Anonymous Referees for helpful comments, error or misunderstandings are solely mine.

## References

- [1] Azariadis, C. and A. Drazen, 1990, Threshold externalities in economic development, *Quarterly Journal of Economics*, 501-526.
- [2] Barro, R.J., 1990, Government Spending in a Single Model of Endogenous Growth, *Journal of Political Economy*, 98(5), 103-125.
- [3] Becker, G. (1964), Human Capital, *Columbia University Press*.
- [4] Beine, M., F. Docquier and H. Rapoport (2001): Brain drain and economic growth: theory and evidence, *Journal of Development Economics*, 64, 1: 275-89.
- [5] Berry, A.R. and R. Soligo, 1969, Some welfare aspects of international migration, *Journal of Political Economy*, 77, 5: 778-94.
- [6] Bhagwati, J. (2009): Overview of issues, Chapter 1 in J. Bhagwati and G. Hanson, eds.: Skilled immigration: problems, prospects and policies, *Oxford University Press*, pp. 3-11.
- [7] Bhagwati, J.N. and K. Hamada, 1974, The brain drain, international integration of markets for professionals and unemployment, *Journal of Development Economics*, 1, 1: 19-42.
- [8] Beine, M., F. Docquier and H. Rapoport, 2008, Brain Drain and Human Capital Formation in developing Countries, *Economic Journal*, 118, 631-652
- [9] Beine, M., F. Docquier and H. Rapoport, 2001, Brain Drain and Economic Growth: theory and evidence, *Journal of Development Economics*, 64, 1, 275-89

- [10] Bornat, J., and others (1999). Stepfamilies and older people: evaluating the implications of family change for an ageing population. *Ageing and Society*, vol. 19, pp. 239-262.
- [11] Bosveld, W. (1996). *The Ageing of Fertility in Europe. A Comparative Demographic analytic Study*. Amsterdam: Thesis Publications.
- [12] Botev, N. (1999). Older persons in countries with economies in transition. In *Population Ageing, Challenges for Policies and Programmes in Developed and Developing Countries*. New York and Brussels: United Nations Population Fund and CBGS, pp. 85-100.
- [13] Matteo Cervellati and Uwe Sunde, 2015, The Economic and Demographic Transition, Mortality, and Comparative Development, *American Economic Journal*, 7(3): 189–225
- [14] Chen, H., 2008, The endogenous probability of migration and economic growth, *Economic Modeling Journal*
- [15] Chen, H.-J., 2006, International migration and economic growth: a source country perspective, *Journal of Population Economics*, 19: 725-48.
- [16] Docquier, F., and H. Rapoport (forthcoming), Globalization, Brain-Drain and Development, in *The Journal of Economic Literature*.
- [17] Docquier, F., and D. Croix (2012), Do Brain Drain and Poverty Result from Coordination Failure?, *The Journal of Economic Growth*, 17(1), 1-26.
- [18] Delacroix, D. and Docquier, F., 2010, Do Brain-Drain and poverty result from coordination failures?, *CREAM*
- [19] Eicher, T., 1996, Interaction between endogenous human capital and technological change, *Review of Economic Studies*, 63, 127-144
- [20] Fan, Y.K., 1979, Emigration and Growth: A Model for Small Developing Countries, *The Journal of Economic Development*, 4(2), 141-154.4.
- [21] Galor, O. and Weil, D.; 2000, Population, Technology, and Growth: From Malthusian Stagnation to the Demographic Transition and Beyond." *American Economic Review* 90 (4): 806–28.
- [22] Garcia Pires, A., 2015, Brain Drain and Brain Waste, *Journal of Economic Development*, 40(1)
- [23] Glomm, G., 1992, A model of growth and Migration, *Canadian Journal of Economics*, XXV, N°4
- [24] Grubel, H. and A. Scott (1966): The international flow of human capital, *American Economic Review*, 56: 268-74.
- [25] Haque, N., U. and Kim, S., 1995, Human capital flight: impact of migration on income and growth, *IMF Staff papers*, 42, (3), 577-607
- [26] Haque, N. U and S. Kim, 1995, Human capital fight: impact of migration on income and growth, *IMF Staff Papers*, 42, 3: 577-607.
- [27] Hirschman, A., 1958, *The Strategy of Economic Development*. New Haven, Conn.: Yale University press.
- [28] Kanbur, R. and H. Rapoport, 2005, Migration selectivity and the evolution of spatial inequality, *Journal of Economic Geography*, 5, 1: 43-57.
- [29] Kremer, M., 1993, The O-ring theory of economic development, *Quarterly Journal of Economics*, 108, 3: 551-75.
- [30] Krugman, P., 1994, The Fall and Rise of Development Economics, in Lloyd Rodwin, eds., *Rethinking the Development Experience*, Brookings Institution Press.
- [31] King, R.G. and Rebelo, S., 1987, Business Cycles with Endogenous Growth, Working Paper, University of Rochester
- [32] Lewis, W.A., 1954. Economic Development with Unlimited Supplies of Labor, *The Manchester School*, May.
- [33] Loubaki, D., 2012, On the Mechanics of the Brain Drain Reduction in Poorest Developing Countries, *Journal of Economic Development*, 37, (3), September 2012, p.75-105
- [34] Loubaki, D., 2015, Unstable Political Climate, Brain Drain and Development, *Advances in Social Science Research Journal*, Vol.2 Number 6, p.124-142
- [35] Lucas, R. E., 1988, On the Mechanics of Economic Development, *Journal of Monetary Economics*, 22(1), 3-42
- [36] McCulloch, R. and J.T. Yellen, 1977, Factor mobility, regional development and the distribution of income, *Journal of Political Economy*, 85, 1: 79-96.
- [37] McKenzie, D. and H. Rapoport (2007): Network effects and the dynamics of migration and inequality: theory and evidence from Mexico, *Journal of Development Economics*, 84,1: 1-27.
- [38] Mountford, A. and H. Rapoport, 2010, The Brain Drain and the World Distribution of Income, *Journal of Development Economics*, forthcoming.
- [39] Miyagiwa, K., 1991, Scale economies in education and the brain drain problem, *International Economic Review*, 32, 3: 743-59.
- [40] Myrdal, G., 1957, *Economic Theory and Under-developed Regions*. London: Duckworth.
- [41] Preston, S., 1979, Urban growth in developing countries: a demographic re-appraisal, *Population and Development Review*, 5, 195-216
- [42] Ravallion, M., 1997 Can high-inequality developing countries escape absolute poverty?, *Economics Letters*, 56(1), pp. 51-58.
- [43] Ravallion, M., 2001, Growth, inequality and poverty: looking beyond averages. World.
- [44] Ravallion and Datt, G., M., 1999, Why has Economic Growth been more pro-poor in some states of India than others?, *Journal of Development Economics*, 68, 381-400.
- [45] Romer, P.M. , 1986, Increasing returns and long-run growth, *Journal of Political Economy*, 94, 5: 1002-37.
- [46] Rosenstein-Rodan, P.N. (1943), Problems of Industrialization of Eastern and South Eastern Europe, *Economic Journal*, 53(210-211), 202-211.
- [47] Rostow, W.W. (1960), *The Stages of Economic Growth*, Cambridge University Press.
- [48] Sachs, J. (2005) *The End of Poverty: How we Can Make it Happen in Our Lifetime*, London: Penguin Books.

- [49] Sachs, J. and Warner, A., 1995, Economic reform and the process of global integration, *Brookings Paper on Economic Activity*, 1, 1-95.
- [50] Solow, R. M., 1956, A Contribution to the Theory of Economic Growth, *Quarterly Journal of Economics*, 70(1), 65-94
- [51] Matteo Cervellati, M. and Sunde, U.; 2015, The Economic and Demographic Transition, Mortality, and Comparative Development, *American Economic Journal*, 7(3): 189–225
- [52] Todaro, M., P., 1969, A model of labor migration and urban unemployment in less developed countries, *American Economic Review*, 59, 138-48
- [53] Unwin, T., 2007, No End to Poverty, *Journal of Development Studies*, 43(5), 929-953.