# High skilled emigration and human capital: A theoretical and empirical essay for the case of Middle-Income Countries

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# HIGH SKILLED EMIGRATION AND HUMAN CAPITAL: A THEORETICAL AND EMPIRICAL ESSAY FOR THE CASE OF MIDDLE-INCOME COUNTRIES

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## Abstract

The aim of this paper is to investigate the effect of high-skilled emigration on human capital investment in some middle-income countries. Hence, we extend the Solow model by taking into account the net effect of high-skilled emigration. The theoretical result showed that if the ratio of the emigrant human capital on the resident human capital is inferior to critical level, and in the case of strong selectivity adopted, the high skilled emigration can generate an important quantitative brain gain as well as the possibility of qualitative brain gain. At the empirical level, new approximations are proposed. Then, based on these approximations a beta convergence model is re-estimated. The results showed that the emigration prospects have a positive and highly significant effect. The elasticity of the human capital investment with respect to emigration prospects varies from about 1.7% to about 2%.

**Keywords**: Brain drain, human capital, development, instrumental variables-GMM method
**JEL Classifications**: F22, J24, O15.

## 1. Introduction

The international migration of skilled workers has augmented in the latest years and it draws more attention in the economic literature. Indeed, the emergence of the new literature of brain drain has reviewed the old results, while showing that this phenomenon is more complex than a simple flight. Several works showed that the emigration prospects modify the education investment structure of the residents (Stark et al. 1997, Stark et al. 1998, Stark and Wang 2002, Beine et al. 2001 and 2008, Beine et al. 2011, Docquier and Rapoport 2004 and 2007, and Bhargava et al. 2011). Motivated by very high remunerations, the residents multiply their education efforts in order to achieve their emigration project. In presence of very selective policies all skilled workers cannot emigrate, only a minority which can emigrate. The rest remains in its source country; consequently this quantity is qualified as a brain gain (Kouni, 2012 and Eljafari et al. 2012).

However, the result of the new brain drain literature is not confirmed by some studies. Among which, the study of Schiff (2005) which found that the brain gain is small or negative. It's clear that a new debate on the brain drain consequences on source countries is taking place in the latest years.

It is in this perspective that this paper attempts to study the effect of the brain drain on the human capital investment in middle-income countries.

Further, some remarks can be addressed to the previous studies. First, the main works which study the brain drain effect have elaborated models based on the individual behavior analysis. Then, they aggregate these analyses for all society. Second, these models have considered the skilled emigration

as being the source of both negative and positive effects. Third, they have approximated the emigration prospects by the emigration probability. Nevertheless, this approximation cannot good reflect the emigration prospects because the emigration decision depends on several other factors such as the income differences, the emigration cost and the human capital level.

Starting from these remarks, this paper contributes to the existing literature from some points. First, we have tempted to elaborate a simple theoretical model that studies the net effect of high skilled emigration through the Solow model. Thus, we incorporate both negative and positive effects. The negative effect is the quantity (rate) of skilled individuals that emigrates and the positive effect is the quantity (rate) that remains in its source country in the long term. Indeed, the analysis of the high skilled emigration effect on the human capital, through an endogenous growth model, permits to determine the global (macroeconomic) effect on the economy and better show the dynamic of the model. The consideration of the brain drain effect makes the Solow model an endogenous growth model, therefore, growth rate depends on the skilled emigration effect. Second, we tempt to re-estimate a beta convergence model with skilled emigration while measuring new approximations. Indeed, we definite and measure the human capital and emigration prospects indicators.

The theoretical study shows that if the ratio of the emigrant human capital on the resident human capital is inferior to critical level ($\varepsilon < \varepsilon^* = 1+b$), emigration prospects can generate an important quantitative brain gain as well as the possibility of qualitative brain gain. The empirical part proves this result and finds that the emigration prospects have a positive and highly significant effect.

The rest of this paper is organized as follows. In section two we present a brief literature review. In section three we describe the theoretical model. In section four we study the empirical effect of brain drain on human capital investment in the middle-income countries. In section five we summarize and conclude.

## 2. Literature review

Studies conducted in the framework of the new literature of the brain drain and brain gain show that in the case of interregional divergence of incomes, emigration prospects alter residents' education investment structure. The idea is simple, it will support that, following the evolution of emigration opportunities generated by the increasing number of skilled emigrants some residents multiply their efforts to invest in education in order to achieve their emigration project. This results in an increase of the share of educated and accelerating the accumulation of human capital, which amounts to a brain gain.

The realization of such an outcome depends on several conditions, mainly:

- The nature of migration: temporary or permanent.
- The degree of uncertainty attached to emigration project.
- The liquidity constraint.
- The education policy.

- The emigration policy.

Rapoport (2002) shows that, several developing countries have actually benefited from the brain drain. Obviously, in the presence of income differentials between countries, the emigration prospects are likely to modify profoundly the human capital investment structure by the residents of origin countries. Therefore, when the educative incentive effects dominate the emigration effect, the human capital stock of the country will increase.

Docquier and Rapoport (2007) established a theoretical model dealing with the correlation between emigration prospects and human capital formation. They attempt to conclude that the optimal emigration rate of highly educated people is likely to be positive. The fact of whether an observed rate is above or below the optimal rate is an empirical question that can be posed country by country.

Beine et al. (2001) estimate the effect of the brain drain on human capital investment and the level of growth for 37 developing countries. The results show that there is a positive indirect effect of brain drain on human capital investment.

This result is confirmed by the work of Beine et al. (2008). Using a cross-sectional database (cross section model) largest than that used in 2001, the authors obtain the same result; emigration prospects generate a significant positive effect on the gross investment in human capital.

Beine et al. (2011) show, by using for the first time a panel data model, that the emigration prospects have a positive effect on the educational decision, only for some low-income countries. However, for low-income countries where emigration rates above 30%, this effect is negative. In countries with medium or high income, the brain drain does not have a significant impact.

Bhargava et al. (2011) show based on a panel of 69 developing countries on 4 periods of 3 years from 1991 to 2004, that the emigration of physicians contributes positively and significantly to the formation of a medical human capital. However, this effect remains gross, since the migration reduces the number of doctors in these countries and contributes to the increase in infant mortality.

Contrary to this new trend, Schiff (2005) reverses this result and argues that the brain gain shown by this new brain drain literature is significantly small and the net result of the brain drain is generally negative. Schiff argues this result as follows:

- Under the emigration prospects effect, individuals seek a higher education level to achieve their emigration project. This shows that education is not a choice and its yield is quite low.

- The uncertain human capital gain reduces the expected return of human capital. Among the uncertainty sources, the success degree, the future employment abroad, the immigration policies of the host countries, the education cost, etc.

- The development of the education sector increases public and private spending, which allows a lower gain and even the possibility of making a negative impact on growth.

This analysis shows that the net brain gain is equal to zero at the steady state. In the long term the skilled emigration affects negatively the stock of human capital. The author distinguishes between two types of brain gain functions. The first function characterizes the middle-income countries and the

second characterizes the poorest countries with low human capital. The net result for the first type of function starts positive, but it will become negative with high emigration probabilities. However, the second type of function gives a negative net result.

In the same sense, Lucas (2005) obtained a different result from that reported by the new brain drain literature. He shows, by estimating a model in cross-section data of a sample of 39 low-income countries and total 91 countries, that the brain drain has a negative effect on human capital.

## 3. The model : The net theoretical effect of brain drain

Without neglecting the traditional point of view (negative effect of the brain drain), we take account of the positive effect of the emigration prospects (Kouni, 2010 and 2012). Indeed, following the works of Solow (1956), Boulila (1997), Barro and Sala-i-Martin (2004), Docquier and Rapoprt (2004, 2007), Schiff (2005) and Mankiw et al. (1992), we consider a small economy (middle-income economy) which is functioning following the Solow model with emigration. The production is determined by two factors: the labour (L) and the human capital (H):

$$Y = F(H,L) = H^{\alpha}(AL)^{1-\alpha} \quad (1)$$

With $Y$ $H$ $L$ $A$ and $0 < \alpha < 1$ are respectively the output level, the human capital, the active population, the labour productivity and the elasticity of the production with respect to human capital.

The output per efficiency unit ( $y = \frac{Y}{AL}$ ) is as follows:

$$y = h^{\alpha} \quad (2)$$

With $h = \frac{H}{AL}$ is the human capital by efficiency unit. We assume, indeed, following the work of Docquier and Rapoport (2004, 2007) that $h$ is superior to one, for the simple reason that the unskilled part of population have a human capital index equal to one. The accumulation of this factor is provided in following a public and private effort denoted (s) (fraction of national income). This accumulation is decreased by ( $\delta + \varepsilon$ ) that signify respectively; the depreciation rate and the ratio of the human capital that emigrates. $\varepsilon = \frac{h_M}{h}$, where $h_M$ is the emigrant human capital by efficiency unit.

Moreover, $L$ increases at the natural rate (n) and decreases by the emigration rate (m). Also, the productivity increases with a constant rate noted (g).

The high-skilled emigration rate is defined by two factors, the differential incomes and institutional factors set (Boulila, 1997). It takes the following standard form:

$$m = a(\log y^{*} - \log y) - I \quad (3)$$

This rate is positively correlated with the differential incomes $(y^{*} - y)$ and negatively correlated with the institutional factors (I).

At the initial period, economy registers a flight of a number of high-skilled workers. Also, on the basis of the model of Schiff (2005) we consider that the economy cannot recuperate the human capital loss in short and medium terms. Schiff suggests that there is a transition period formed after emigration. Through this period, number of individuals, affected by emigration prospects, decides to invest in education. Indeed, in the medium term there's not brain gain. Economy can register a positive effect in the long term when this period is over. At this stage there are two realised effects; a positive effect engendering an investment superior to the number of emigrants, and negative effect measured by a high-skilled workers that emigrate. We assume that each skilled emigrant takes on average with him a ratio of human capital measured by $(\varepsilon H / L)$; with $\varepsilon$ is the ratio of the emigrant human capital on the resident human capital ($\varepsilon > 1$, because $h > 1$ for all skilled-emigrants) and $(H / L)$ is the part of human capital per resident work. Moreover, the economy has obtained a new number of high skills that is superior to the number that is emigrated. But the quantitative gain is inferior to brain loss from the point of view of human capital quality. We assume, therefore, this gain noted $(qh)$ is inferior to $(m\varepsilon h)$. Thus, (q) is a function positively correlated with (m) because the brain gain is the result of the evolution of emigration prospects. In fact, $(\partial q / \partial m) > 0$, $(\partial^2 q / \partial m^2) < 0$ and $0 < (\partial q / \partial m) < 1$. The last condition signifies that in the long run the quantitative loss (quality of m) is bigger than the quantitative gain (q). This means that $(qh) < (m\varepsilon h)$.

The accumulation function in this case, can be written as follows:

$$\dot{h} = sh^{\alpha} - h\left[ (g + n + \delta) - m(1 - \varepsilon) - q \right] \quad (4)$$

Therefore, the growth rate of human capital per efficiency unit equal to:

$$g_h = \dot{h} / h = sh^{\alpha - 1} - \left[ (n + g + \delta) - m(1 - \varepsilon) - q \right] \quad (5)$$

Our main objective in this paper is to reassess the gain or the loss in term of human capital in the case of equilibrium with emigration (this equilibrium is defined by the equality: $sh^{\alpha-1} = \left[ (n + g + \delta) - m(1 - \varepsilon) - q \right]$). Indeed, to attain this objective, it's important to compare between the curve of human capital depreciation in the Solow model ($C = (n + g + \delta)$) (the case of closed economy) and the one with emigration ($\left[ (n + g + \delta) - m(1 - \varepsilon) - q \right] = C_1$). If $(C) > (C_1)$, the new equilibrium is located below the (C). This means that this equilibrium associates a human capital level which is superior to the one associated in the absence of high-skilled emigration (brain gain). On the contrary, economy registers a brain loss.

### 3.1 The characteristics of ($C_1$):

To visualize the pace of this curve, we tend to determine the derivative of its equation with respect to (h) as follows:

$$\partial C_1 / \partial h = -(\partial m / \partial h)\left[ (1-\varepsilon) + (\partial q / \partial m) \right] \prec or \succ 0 \quad (6)$$

This derivative is negative when $\varepsilon > \left[ ((\partial q / \partial m) + 1) = b + 1 \right]$, because $(\partial m / \partial h) < 0$ [1] and $\varepsilon > 1$. In this case ($C_1$) is decreased with (h). If ($\varepsilon < b + 1$), this curve is increased with respect to (h).

The second derivative takes the following form:

$$\partial^2 C_1 / \partial h^2 = (\partial^2 m / \partial h^2)\left[ (\varepsilon - 1) - (\partial q / \partial m) \right] - \left[ (\partial^2 q / \partial m^2)(\partial m / \partial h)^2 \right] \quad (7)$$

It's clear that this derivative is positive when ($\varepsilon > b + 1$). Indeed, in this case ($C_1$) is convex. However, if ($\varepsilon < b + 1$) the sign of this derivative is not clear, therefore ($C_1$) can be convex or concave.

We assume, also that $0 < m < 1$, $0 < q < 1$ and $q < m$. Thus, we define the following condition [2]:

***Equilibrium condition***

*For $\varepsilon = \varepsilon^* = 1 + b$,(C) is equal to ($C_1$) and equilibrium is located on (C) (this equilibrium is equivalent at the one of Solow).*

*For $\varepsilon < \varepsilon^* = 1 + b$, (C) is superior to ($C_1$) and equilibrium is located under (C).*

*For $\varepsilon > \varepsilon^* = 1 + b$, (C) is inferior to ($C_1$) and equilibrium is located above (C).*

### 3.2 The long term dynamic transition: The case of high-skilled emigration:

In this subsection we treat the different possibilities of equilibrium. According to previous condition, we can characterize two possibilities of equilibrium with emigration:

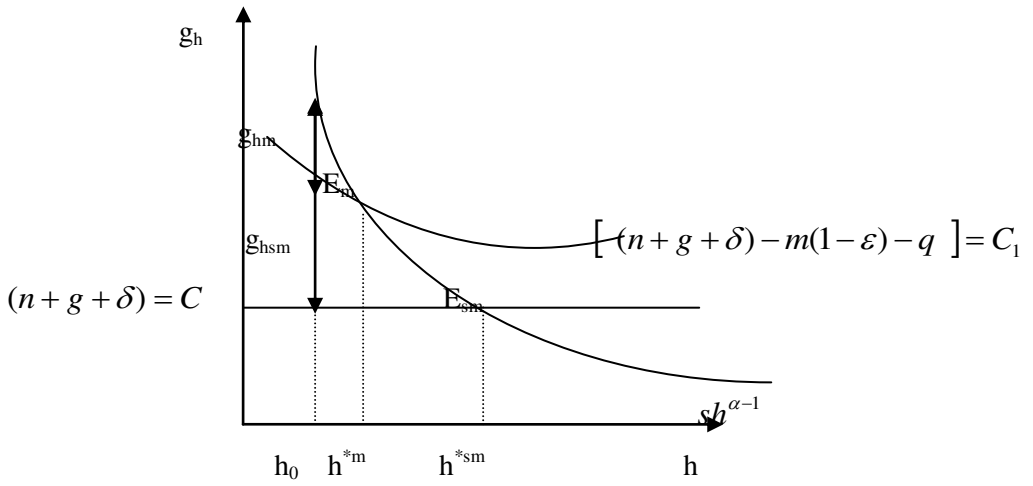
#### 3.2.1 Equilibrium in the case where $\varepsilon > \varepsilon^* = 1 + b$:

In this case, (C) is inferior to ($C_1$), so the equilibrium is located above (C). The following graphic illustrates this case:

[1] : See equations (2) and (3)

[2] : See the proof that demonstrate this condition in the appendices

**Graphic 1:** ***The long term dynamic transition: The case where*** $\varepsilon > \varepsilon^* = 1+b$

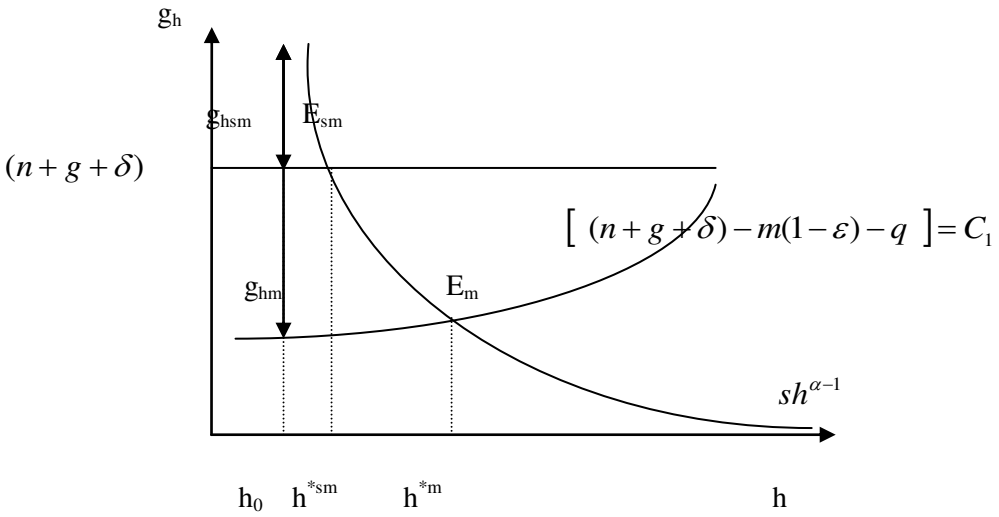



From this graphic, it's clear that the equilibrium with emigration associates a human capital level ($h^{*m}$) which is inferior to the one associated by the equilibrium without emigration ($h^{*sm}$). In the same way, the growth rate in the case of emigration ($g_{hm}$) is lower than the one of economy without emigration ($g_{hsm}$). In spite of registering a quantitative gain, the economy cannot recuperate the qualitative loss when the emigrated part of human capital is superior to critical level ($\varepsilon > \varepsilon^* = 1+b$).

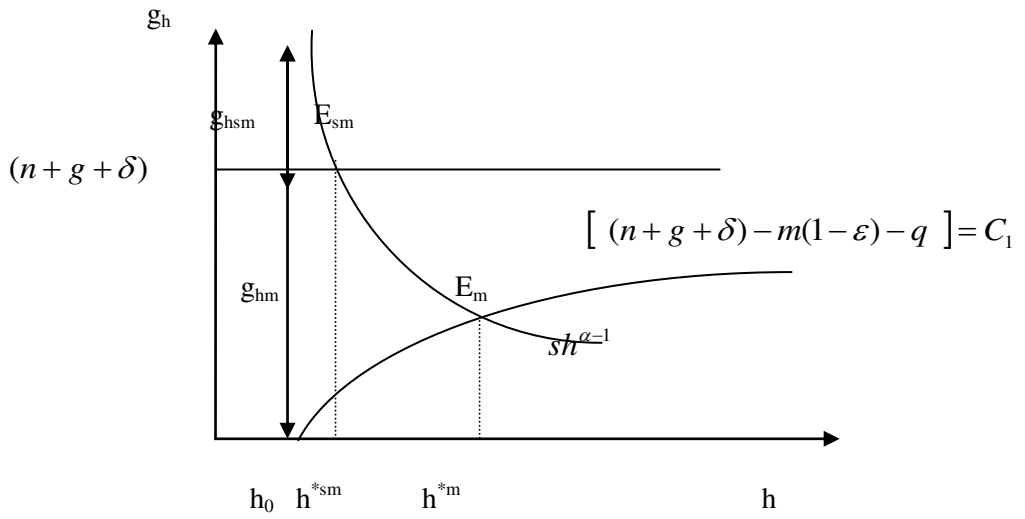
### 3.2.2 Equilibrium in the case where $\varepsilon < \varepsilon^* = 1+b$:

Now (C) is superior to ($C_1$), thus the equilibrium is located under (C). The following graphics illustrate this case:

**Graphic: 2:** ***The long term dynamic transition: The case where*** $\varepsilon < \varepsilon^* = 1+b$ ***and*** $C_1$ ***is convex***



**Graphic: 3:** ***The long term dynamic transition: The case where*** $\varepsilon < \varepsilon^* = 1 + b$ ***and*** $C_1$ ***is concave***




In spite of marking a qualitative loss, the economy succeeded in realizing a net gain in terms of human capital. This gain can be interpreted as follows: the high-skilled emigration, through the initiative mechanism, encourages the individuals to invest in education. Finally the economy obtains a human capital quantity bigger than the one that emigrated. We can, now, ask the question: how does the economy recuperate the qualitative loss (especially that the qualitative of the emigrant human capital is superior to the one of resident human capital) in order to produce a bigger quantity of human capital? Once this is attained, we assume that **the gain is the result, also, of the amelioration of the human capital quality**. This means that in presence of high-selective immigration policies, the emigration prospects create a competitive environment between the investors. But, just a part, among these competitive investors, that emigrates finally. Others remain in their source country. Consequently, the source country has a possibility to register amelioration in the quality of its human capital.

### 3.2.3 The effect of an increase in $\varepsilon$ on the stationary state variables:

In this part we study the impact of an increase of $\varepsilon$ on the level and growth rate of human capital. For obtain this result we effectuate the derivative of $h^*$ [3] and $g_h$ with respect to $\varepsilon$.

$$\partial h^* / \partial \varepsilon = \frac{1}{1-\alpha}\left[\frac{s}{((n+g+\delta)-m(1-\varepsilon)-q)}\right]^{\alpha/1-\alpha}\left[\frac{-ms}{((n+g+\delta)-m(1-\varepsilon)-q)^2}\right] < 0 \qquad (8)$$

Thus:

$$\partial g_h / \partial \varepsilon = -m < 0 \qquad (9)$$

It's clear that an increase of $\varepsilon$, decreases the equilibrium level of human capital. In spite of in the long run the economy registers a human capital level bigger than the one initially obtained, the qualitative

[3] : $h^* = \left[\frac{s}{((n+g+\delta)-m(1-\varepsilon)-q)}\right]^{1/1-\alpha}$

loss (increase of $\varepsilon$) reduces the level and the growth rate of this factor. Thus, even if economy obtain at equilibrium a net quantitative gain as well as, the possibility of gross qualitative gain, an increase of the emigrant human capital ratio, decreases the level and growth rate of human capital.

Graphically, this problem can be represented by the movement of $C_1$. Consequently, when $\varepsilon$ increases $C_1$ moves upwards because $\partial C_1 / \partial \varepsilon = m > 0$. Note, that for all $\varepsilon$, this curve moves upwards. Indeed, for three graphics (1, 2, 3) and for $\varepsilon < \varepsilon^* = 1+b$ or $\varepsilon > \varepsilon^* = 1+b$, this movement permits the movement of the equilibrium towards the left with respect to equilibrium with emigration $E_m$ ($sh^{\alpha-1}$ no affected).

### 3.2.4 The effect of an increase of $m$ on the stationary state variables:

The effect of an increase of m can be schematized as follows:

$$\partial h^* / \partial m = \frac{1}{1-\alpha}\left[\frac{s}{((n+g+\delta)-m(1-\varepsilon)-q)}\right]^{\frac{\alpha}{1-\alpha}}\left[\frac{s(1-\varepsilon+(\partial q/\partial m))}{((n+g+\delta)-m(1-\varepsilon)-q)^2}\right] \quad (10)$$

Indeed;

$$\partial g_h / \partial m = (1-\varepsilon)+\left[\partial q / \partial m\right] \quad (11)$$

The sign of the two equations is not clear. It's determined by the level of $\varepsilon$, if $\varepsilon > \varepsilon^* = 1+b$, equations (10) and (11) are positive and if $\varepsilon < \varepsilon^* = 1+b$, these equations are negative. Therefore, an increase of emigration rate (m) can improve the level and the growth rate of human capital when $\varepsilon < \varepsilon^* = 1+b$. This means that an increase of (m) create an incentive effect by the evolution of the emigration prospects. This situation leads the economy towards the new equilibrium where the human capital is superior to the one reached in the previous equilibrium. Geometrically, this problem can be appreciated by the movement of the curve of human capital depreciation ($C_1$). The derivative of the ($C_1$) with respect to (m) can be written as follows:

$$\partial C_1 / \partial m = \varepsilon - 1 - (\partial q / \partial m) \quad (12)$$

This result is positive when $\varepsilon > \varepsilon^* = 1+b$ and is negative when $\varepsilon < \varepsilon^* = 1+b$. It's clear that if $\varepsilon < \varepsilon^* = 1+b$, ($C_1$) moves downwards and if $\varepsilon > \varepsilon^* = 1+b$ this curve moves upwards. In the case where $\varepsilon < \varepsilon^* = 1+b$, the economy registers a brain gain. In the other case ($\varepsilon > \varepsilon^* = 1+b$), an increase of (m) decreases the level and the growth rate of human capital. Indeed, the equilibrium is located at the right (left) with respect to equilibrium with emigration $E_m$, when $\varepsilon < \varepsilon^* = 1+b$ (when $\varepsilon > \varepsilon^* = 1+b$), while giving a level of bigger (weaker) human capital.

To summarize this section we adopt the following proposition:

***Proposition:***

*For all* $0 < m < 1,\ 0 < q < 1,\ q < m$ *and* $\varepsilon > 1$

- *If* $\varepsilon < \varepsilon^* = 1 + b$, *the emigration prospects can generate:*
  1. *A net quantitative human capital gain.*
  2. *The possibility to obtain a qualitative human capital gain.*
  3. *An increase of the emigrant human capital ratio* $(\varepsilon)$ *reduces the level and growth rate of human capital.*
  4. *An increase of the emigration rate (m) improves the level and growth rate of human capital.*
- *If* $\varepsilon > \varepsilon^* = 1 + b$, *the emigration prospects can generate:*
  1. *A net quantitative and qualitative brain loss, and the equilibrium gives a human capital level inferior to the one given by the equilibrium without emigration.*
  2. *An increase of* $(\varepsilon)$ *and / or of (m) decreases the level and growth rate of human capital.*

**Proof**

When $\varepsilon < \varepsilon^* = 1 + b$, $C_1 < C$, consequently the equilibrium with emigration is located below C. thus, the economy registers always a human capital gain.

When $\varepsilon > \varepsilon^* = 1 + b$, $C_1 > C$, therefore, this equilibrium is located above C and the economy registers always a net qualitative and quantitative loss in term of human capital.

On the other hand, in spite of $q < m$ (the quality of the human capital gotten following the emigration is lower to the one of emigrants) the economy registers an important human capital gain (a net quantitative gain) and in presence of the high selective policies, the emigration prospects create a competitive environment between investors. Therefore, these investors tend to improve the quality of their human capital. Finally, one part emigrates and the rest of the gained human capital registers an improvement of its quality.

## 4. Empirical evidence

In our empirical part, and after have defined and measured new indicators, we use the Docquier and Marfouk database (2006) and we estimate a beta convergence model following the work of Beine et al. (2008). Indeed, specification can be written as follows:

$$\ln(h_{av,00} / h_{av,90}) = c_0 + c_1(\ln h_{av,90}) + c_2(\ln gmp_{H,90}) + c_3(\ln gdp_{90}) + c_4(\ln d\_pop_{90}) + c_5(RM_{90}) + \mu \qquad (13)$$

Where, $\ln(h_{av,00} / h_{av,90})$, $\ln h_{av,90}$, $\ln gmp_{H,90}$, $\ln gdp_{90}$, $\ln d\_pop_{90}$, $RM_{90}$ and $\mu$ are respectively the gross human capital investment, the average human capital in 1990, the emigration

prospects indicator, the per capita gross domestic product , the population density, the ratio of international remittances on GDP and the error term.

It should be noted that the negative sign of the coefficient $c_1$ translates the convergence of the model. Moreover, following our theoretical model and the new brain drain literature, $c_2$ is positive. The per capita GDP is Proxy of the individual liquidity which has a positive coefficient. However, the sign associated to the coefficient of the population density is negative. This variable is Proxy of education cost. Moreover, the remittances have a positive effect on the human capital investment (the sign of its coefficient is positive).

Furthermore, the sample of countries chosen for our empirical work comprises 65 middle-income countries (See appendix A3).

## 4.1. Data and methodology

### *4.1.1. Data*

Some serious attempts of databases on skilled migration are building in the previous recent years. Indeed, the data of skilled emigrants (all specialties) exist only for some years and until 2000.

Docquier and Marfouk (2006) attempt to substantially increase the size of the sample of the Carrington and Detragiach database (1998). They estimate emigration rates by level of education for 195 origin countries in 2000 and 175 countries in 1990 (emigration towards all OECD countries). Generalizing the Docquier and Marfouk methodology, Defoort (2008) develop a database covering five years on the period from 1975 to 2000 (1975, 1980, 1985, 1990, 1995 and 2000). The database relates only to emigrants that are welcomed by six OECD countries (USA, UK, Germany, France, Canada and Australia). Finally, Bhargava, Docquier and Moullan (2010) estimate the number of emigrant's doctors from developing countries to 18 receiving countries on the period 1991-2004.

For the reason that the data of variables concerning skilled emigration (all specialties) towards all receiving countries were considered only by the DM database (2006) we choose to found our empirical work on this database. It is true that the DM database is limited only to two years, and relatively old. Therefore, this can generate a limited choice of empirical method. But, this database provides a large number of observations and great number of receiving countries. Furthermore, we can better appreciate the human capital investment over ten years between 1990 and 2000. Other databases present some limits among which they have not considered all skills categories or all countries, and this can limit the number of observations and the data quality.

The data draws from some sources as shown by the following table:

**Table I: Data: definitions and sources**

| Variable | Definitions | Sources |
|---|---|---|
| $\ln(h_{av,00} / h_{av,90})$ | The gross human capital investment | Author calculations based on DM database (2006) |
| $\ln h_{av,i}$ $i = 1990, 2000$ | The average human capital indicator (*see paragraph n 4.2*) | Author calculations based on DM database (2006) |
| $\ln gmp_{H,90}$ | The emigration prospects indicator (*see paragraph n 4.3*) | Author calculations based on DM database (2006) for human capital indicator already calculated, World Bank indicators for per capita GDP and www.cepii.fr for average distance between 4 OCDE countries and each source country |
| $\ln gdp_{90}$ | The per capita gross domestic product | World Bank (World Development indicators) |
| $\ln d\_pop_{90}$ | The population density | World Bank (World Development indicators) |
| $RM_{90}$ | The ratio of international remittances on GDP | World Bank (World Development indicators) |

### *4.1.2. Methodology*

To estimate the equation (13), we adopt a cross section analysis. Indeed, our empirical method is the Instrumental variables-GMM method (IV-GMM). Baum et al. (2003 and 2007) showed that in presence of heteroskedasticity when some explanatory variables are endogenous, this method is preferable than the conventional Instrumental variables method (IV). The tests results showed the existence of both heteroskedasticity and endogeneity of the two variables: $\ln gmp_{H,90}$, and $\ln gdp_{90}$. Therefore, instrumental variables-GMM regression constitutes the appropriate estimation technique in our case. This method permits to generate an efficient and consistent estimator. The generalized method of moments (GMM) is based on the use of observed moments of the sample to calculate the theoretical moments of the population. Further, to deal with the problem of endogeniety of the

variables: $\ln gmp_{H,90}$ and $\ln gdp_{90}$, we might use, consistent with the economic literature such as Beine et al. (2008), total population and total migration as instruments of the emigration prospects indicator and the lagged per capita GDP value (by one period; period = 10 years) as an instrument of per capita GDP.

## 4.2 The human capital indicator

As we already mentioned, we re-estimate the equation (13) while adopting new measures of both human capital and emigration prospects indicator. Concerning the human capital indicator, Beine et al. (2008) measured the human capital as being the share of skilled population in total population. Nevertheless, this measure cannot reflect efficiently this variable for several reasons. First, this ratio reveals the share of skilled population but not the education level, because it does not reflect the number of years for each education level. Second, this share ranging between zero and one, does not make it possible to realize a good comparison between countries, as well as its average is about the same for all countries. Therefore, it does not make it possible to guarantee the disparity between countries. Third, because it is ranging between zero and one, this measure cannot satisfy our theoretical hypothesis ($h > 1$ ). Fourth, for obtaining an efficient measure of human capital it is essential to consider all population that has had effectively each concerned level of skills, even if there is a population part considered by another level. For this, the middle-and-high-skilled populations should be considered in the low human capital level and high skilled population should be considered by the middle level. In previous studies, only the population relative to each level (low, middle or high) is considered without consideration of the populations which have a higher level. This means that we can get primary skills level lower in developed countries than in developing countries (because the high skilled population is bigger than the low skilled population in the developed countries). Nevertheless, in reality the developed countries have primary human capital level greatest than the one of developing countries, if we consider all population (the middle and high levels skilled population have also the primary skills level). For all these reasons we adopt the following human capital measure. Indeed, the following system of equations expresses how we calculate each level of human capital:

$$h_{t,L}^{j} = (q_{t,L}^{j} * (4/18)) + ((q_{t,M}^{j} + q_{t,H}^{j}) * (8/18)) + 1 \quad (14)$$

$$h_{t,M}^{j} = (q_{t,M}^{j} * (10.5/18)) + (q_{t,H}^{j} * (12/18)) + 1 \quad (15)$$

$$h_{t,H}^{j} = (q_{t,H}^{j} * (15.5/18)) + 1 \quad (16)$$

Where $h_{t,L}^{j}$, $h_{t,M}^{j}$ and $h_{t,H}^{j}$ are respectively the lowest ($L$), the middle ($M$) and the highest ($H$) levels of individual human capital (j is a country index). Moreover, $q_{t,L}^{j}$, $q_{t,M}^{j}$ and $q_{t,H}^{j}$ constitute respectively the low, middle and highest shares skilled population defined by Docquier and Marfouk (2006) as follows:

$$q_{t,s}^{j} = \left( R_{t,s}^{j} + M_{t,s}^{j} \right) \Big/ \left( \sum_{s} R_{t,s}^{j} + \sum_{s} M_{t,s}^{j} \right) \qquad (17)$$

With $R_{t,s}^{j}$ and $M_{t,s}^{j}$ are respectively the resident population which has a skills level equal to s ( $s = L, M, H$ ), and the one which emigrated and it has the same skills level.

On the other hand, following works of Docquier and Marfouk (2006) and Barro and Lee (2000) we determine the various means of the schooling period for each skills level. In fact, we consider that the low skills level can be defined by 8 schooling years (we assume that the population with a low skills level is uniformly distributed, and it has in average 4 education years on 18 total years (4/18)). The middle level can be measured by the interval between 9 and 12 years (we assume that the population with a middle skills level is uniformly distributed, and it has in average 10.5 education years on 18 total years (10.5/18)). The high level can be defined by the interval from 13 to 18 years (we assume that the population with a high skills level is uniformly distributed, and it has in average 15.5 education years on 18 total years (15.5/18)). Moreover, 1 is the skills indicator of the unskilled population (Docquier and Rapoport (2004)). We assume that the unskilled individual has a minimum of skills generated from his life experience.

It is important to stress that the main previous works studied the skilled emigration effect on high human capital level. Nevertheless, this effect is very limited because skilled emigration can generate a greater impact on education, while affecting the other education levels and creating an important prospects size. In fact, it is possible to see a primary or secondary student aroused by emigration, and he (or his household) invests more in education in order to finally emigrate. The large volume of investment in the three education levels (under the effect of emigration) permits to affect the average human capital in the economy. For this, we calculate the average individual human capital for each country as follows:

$$h_{t,av}^{j} = \left( h_{t,L}^{j} + h_{t,M}^{j} + h_{t,H}^{j} \right) \Big/ 3 \qquad \text{(j is a country index)} \qquad (18)$$

Further, the gross human capital investment is defined by the log of the ratio of average human capital in 2000 to average human capital in 1990 as follows:

Gross human capital investment = $\ln(h_{av,00} / h_{av,90})$

## 4.3 The emigration prospects indicator

The previous studies have been based on the emigration rate (emigration probability) in order to measure the emigration prospects. Nevertheless, this approximation suffers from some limits as follows:

- The emigration decision does not only depend on the emigration probability. In really, it depends on some other variables such as emigration cost, wage differentials between areas and skills level of emigrant. Thus, the rational emigrant is called to make a calculation of expected benefits

before deciding to emigrate. The probability cannot reflect exactly the emigration prospects in this case.

- Then, the economic and social changes can play a big role in the change of the destination choice. Consequently the probability which is based on the emigration rate of the previous period can distort the determination of the emigration prospects effect.
- Finally, the emigration rate is a source of loss (the brain drain), whereas the authors considered it as a benefit source in the model. To calculate a net benefit, the authors used this rate as a Proxy of loss. Consequently, a sort of contradiction is appeared.

For these reasons, we propose a new approximation of this indicator. This indicator takes account of several factors as the human capital, the international relative income, the probability and the emigration cost.

Moreover, in order to calculate this indicator we start from the work of Docquier and Rapoport (2007) which propose a model analyzing the effect of emigration prospects on human capital in developing countries. Indeed, we consider that the emigration prospects can be appreciated by the net expected gain of a skilled emigrant with respect an unskilled resident. This mechanism can be schematized as follows: under emigration incentive effects households aroused by emigration invest in education in the first period (we assume that there are two lifetime periods) in order to emigrate in the beginning of the second period. Indeed, the individual incomes of the resident and the emigrant can be respectively written as follows:

$$R(US,\mathrm{Re}) = w_t + w_{t+1} \tag{19}$$

$$R(S,M) = w_t - cw_t + m_{t,H} w^*_{t+1} h_{t,H} + (1-m_{t,H}) w_{t+1} h_{t,H} - m_{t,H} k_t w^*_{t+1} \tag{20}$$

With $R(US,\mathrm{Re})$, $R(S,M)$, $w_t$, $w_{t+1}$, $w^*_{t,+1}$, $m_{t,H}$, $h_{t,H}$, $c$ and $k$ are respectively the unskilled resident' inter-temporal income, the skilled emigrant inter-temporal income, the first period salary, the second period salary, the international salary (salary in the received country), the high skilled emigration probability (rate), the high education level, the education cost and the emigration cost.

We assume also that $w_t = w_{t+1}$, $w^*_t = w^*_{t,+1}$ and $\Omega_t = \dfrac{w^*}{w}$ ($\Omega_t$ is the international relative income)

If we subtract $R(US,\mathrm{Re})$ from $R(S,M)$ we can get the net expected gain of a skilled emigrant: $gmp_{t,H} = h_{t,H} - 1 + m_{t,H} h_{t,H} \left[ \Omega_t (1 - \dfrac{k_t}{h_{t,H}}) - 1 \right]$. This gain is in really the prospects emigration size which encourages households (individuals) to invest in education in order to emigrate. But, this can be attained if the following condition is verified:

$$c < gmp_{t,H} = h_{t,H} - 1 + m_{t,H} h_{t,H} \left[ \Omega_t \left(1 - \frac{k_t}{h_{t,H}}\right) - 1 \right] \qquad (21)$$

This condition shows that the skilled emigration can generate a positive effect on the human capital in the origin economy if the education cost is inferior to the net expected income of a skilled emigrant ( $gmp_{t,H}$ ). When the net expected gain is important, the households or individuals aroused by emigration invest more and more in education in order to emigrate. Therefore, this gain is at the origin of education incentives, and it indicates so the emigration prospects' size. According to this size, residents aroused by emigration decide to invest in education or not.

Indeed, the emigration prospects can de approximated by the following equation:

$$gmp^j_{t,H} = h^j_{t,H} - 1 + m^j_{t,H} h^j_{t,H} \left[ \Omega^j_t \left(1 - \frac{k^j_t}{h^j_{t,H}}\right) - 1 \right] \quad \text{(j is a country index)} \qquad (22)$$

Further, to calculate $\Omega^j_t$ we use the ratio between the average of per capita GDP of thirty OECD countries and the per capita GDP of each source country. Moreover, to measure $k^j_t$ we follow the work of Docquier et al. (2007) in which the authors consider that the distance between countries constitute a veritable proxy of the emigration cost. In fact, we definite the emigration cost as the ratio between the average distance between each source country and 4 OECD countries (the United States, Australia, Japan and France) and the average income of last countries (average income of 4 OCDE coutries).

## 4.4 The Results:

The results are reported in the table 2:

It's clear that the model is statistically significant in all regressions (chi2 is high and significant at 1% level in all regressions). Indeed, as proved in the new brain drain literature, the results showed that the emigration prospects have a positive and highly significant effect. The elasticity of the human capital investment with respect to emigration prospects is positive and significant at 1% level in all regressions. It varies from about 1.7% to about 2%. Therefore, an increasing of the net expected emigration gain by 1% permits to raise the human capital investment by about 2%.

**Table II: The effect of the emigration prospects on human capital in the middle-income countries: Estimation Results by the instrumental variables-GMM method: Dependent variable:** $\ln(h_{av,00}/h_{av,90})$

| VARIABLES | (1) | (2) | (3) | (4) |
|---|---|---|---|---|
| **Constante** | -.2649721*** **(-7.80)** | -.2560155*** **(-7.14)** | -.2575489*** **(-6.89)** | -.2454228*** **(-6.49)** |
| **ln $h_{av,\ 90}$** | -.0354986 **(-0.31)** | -.056723 **(-0.51)** | - | - |
| **ln $gmp_{H,\ 90}$** | .020211*** **(3.99)** | .0178549*** **(4.14)** | .0194425*** **(3.60)** | .0169077*** **(3.85)** |
| **ln $gdp_{90}$** | .0426197*** **(7.35)** | .0407222*** **(6.97)** | .0408208*** **(6.84)** | .0380247*** **(7.31)** |
| **ln $d\_pop_{90}$** | -.0018432 **(-0.53)** | - | -.00186 **(-0.54)** | - |
| **$RM_{90}$** | .0036315*** **(4.78)** | .0035348*** **(4.61)** | .0035866*** **(4.60)** | .0034588*** **(4.35)** |
| **chi2** | **113.85** | **87.68** | **97.31** | **78.04** |
| **Prob > chi2** | **0.0000** | **0.0000** | **0.0000** | **0.0000** |
| **$R^2$** | **0.6058** | **0.6140** | **0.6082** | **0.6146** |

*t-statistic in parentheses. *, ** and ***: denote significance at respectively 10, 5 and 1% levels.*
*Endogenous variables: ln $gmp_{H,\ 90}$ and ln $gdp_{90}$*
*Instruments: ln $h_{av,\ 90}$, ln_pop_90, ln_m_total_90, ln_gdp_80, $RM_{90}$, ln_d_$pop_{90}$*
**Source: Author calculations**

This means that the brain drain contributes to human capital in the middle-income countries, consistent with an important part of the new migration literature (Stark and Wang 2002, Beine et al. 2001 and 2008, Beine et al. 2011, Docquier and Rapoport 2004 and 2007, and Bhargava et al. 2011).

On the same way, Beine et al. (2008) obtained a coefficient of the emigration rate equal about 5%. It appears clear, consequently, that the result obtained by the authors is likely to be over-estimated. The difference between our result and the one of Beine et al. (2008) can be explained by the use of the new emigration prospects approximation. Indeed, the real emigration prospects size can be more appreciated by the net expected emigration gain than the emigration probability. It is evident that an increase of emigration rate is not always good for origin human capital, as proven by our theoretical model. An increase of m permits to raise the human capital if $\varepsilon < \varepsilon^* = 1+b$, if not the effect of m becomes negative. Consequently, the emigration probability is not good approximation of emigration prospects and generates an overestimated effect.

Insofar as the emigration rate is not the only variable which reflects the emigration prospects, its use as Proxy of the prospects is likely to especially inflate the source of estimation bias, necessarily for the countries which have a high emigration rate and middle or relatively low income.

However, if the net expected skilled emigration gain will increase it permits to generate always an important incentive effects, and encourage households or individuals to invest in education. On the

other hand, this expected gain reflects the real size of prospects and corrects the expectations based on emigration rate. For example, several skilled emigrants change their orientation from European and North American countries to Gulf Countries on account of great difference in purchase power between the two destinations in the latest years. For this, our result is inferior to the one obtained by Beine et al. (2008).

In total, the emigration prospects exert, as proven in the new brain drain literature, a positive and significant effect on the human capital investment in the middle-income countries.

The other variables have also an important effect on the human capital. The elasticity of the human capital investment with respect to per capita GDP equal about to 4% in all regressions and it is significant at 1% level. Thus, the income level constitutes the one among the main determinants of the gross human capital investment. This correlation supports indeed, the idea for which the emigration can encourage only people having an important financial capacity. Moreover, the population density appears statistically no significant. Its negative sign comes indeed, to confirm the opposite relation between education cost and human capital investment. The same result is obtained by Beine et al. (2008).

Finally, the remittances contribute significantly to the human capital investment of the middle-income countries. In fact, the elasticity of the human capital investment with respect to remittances is around about 35% and it is significant at 1% level. Many works supported the positive effect of remittances which play an important role in education (World Bank, 2006).

It is true that the DM database (2006) is relatively old and contains only the data relative to two years (1990 and 2000). Nevertheless, it constitutes among the best databases in this field. Indeed, this database provides important qualitative and quantitative information on the brain drain for the two years with respect the other databases. Further, the main objective of this work is to verify the possibility of brain gain for the case of middle-income countries by re-estimating the beta convergence model with skilled emigration and using new measures both of human capital and emigration prospects indicator. Therefore, with these new approximations the results permit to verify the possibility of brain gain and the methodological aim is good attained.

## 5. Conclusion

This paper is interested in investigating the relationship between skilled emigration and human capital in the middle-income countries. This study contributes to the literature related to this field. To achieve this aim we elaborate an extension of the Solow model, in which we incorporate both gain and loss of skilled emigration. The loss is the quantity (rate) of skilled individuals that emigrates and the gain is the quantity (rate) that remains in its source country in long term. The main finding of this theoretical attempt shows that in the case of strong selectivity adopted and if $\varepsilon < \varepsilon^* = 1 + b$, emigration prospects can generate an important quantitative brain gain as well as the possibility of qualitative brain gain. At the empirical level, we definite and measure some new approximations. Indeed, an

indicator of human capital and another of emigration prospects have been approximated and measured. Taking account of the new approximations and following the work of Beine and al. (2008) a beta convergence model is re-estimated. The results showed that the emigration prospects have a positive and highly significant effect. The elasticity of the human capital investment with respect to emigration prospects is positive and significant at 1% level in all regressions. It varies from about 1.7% to about 2%. Therefore, an increasing of the net expected emigration gain by 1% permits to raise the human capital investment by about 2%. Indeed, the results permit to verify the possibility of brain gain using the new approximations. Moreover, remittances and per capita GDP contribute significantly to human capital investment in middle-income countries.

Further, it is important to stress that in spite of some countries such as China, India and South Korea have succeeded in their emigration policy, some other middle-income countries have not optimally benefitted from their skilled emigrants. For this, and taking into account this result, some policy implications can be proposed as follows:

- There is a need for policy-makers in these countries to adopt reinforcing network policy in order to more benefit from skills resident in the host countries. This is can be attained by several governmental measures among which the support of the travel and accommodation fees of the high skilled emigrants invited to the universities, search centers and laboratories, administration or enterprises in order to imply these skills in national decision steps. The organization of specific meetings between skilled emigrants and their homologues, and encouraging the high skilled emigrants who have permanent relations with their origin society by prizes and subsidies could generate more benefits of emigration.
- Policy-makers should ameliorate affairs' climate and institutions, enhance salary and add some favors to the high educated individuals in order to slow down emigration, necessarily for the countries where emigration rate is relatively high.
- Finally, an incentive policy is required in order to orient an important amount of remittances to human capital investment.

While this work attempts to study the impact of high skilled emigration on the human capital investment in the middle-income countries using some new approximations, future theoretical and empirical works could explore this relationship taking account some points such as institutions quality, brain drain qualitative effect, and the comparison between brain drain effect and domestic effect. Further, while the DM Database (2006) constitutes an important database related to this field and provide good information to verify our theoretical and methodological approach, it is relatively old and contains limited temporal dimension. Therefore, the use of another database can better light policymakers and open new horizons in this research field.

## Bibliography:

**Barro R. J. and Lee J. W.** 2000. International data on Educational Attainment: updates and implications. *NBER*,WP n°7911, http://www2.cid.harvard.edu/ciddata/.
**Barro R. J. and Sala-i-Martin X.** 2004. Economic Growth. 2nd ed. *The MIT Press*, USA.
**Baum C. F. Schaffer M. E. and Stillman S.** 2007. Enhanced routines for instrumental variables/GMM estimation and testing. *Stata journal*, vv, Number ii, pp. 1–38
**Baum C. F. Schaffer M. E. and Stillman S.** 2003. Instrumental variables and GMM: Estimation and testing. *Stata journal* 3-1, 1-31.
**Beine M. Defoort C. and Docquier F.** 2011. A Panel Data Analysis of the Brain Gain. *World Development*, vol 39.
**Beine M. Docquier F. and Rapoport H.** 2008. Brain drain and human capital formation in developing countries: Winners and Losers. *The Economic Journal*, vol 118.
**Beine M. Docquier F. and Rapoport H.** 2001. Brain drain and economic growth: theory and evidence. *Journal of Development Economics*, vol 64.
**Bhargava A. Docquier F. and Moullan Y.** 2011. Modelling Effects of Physician Emigration on human development. *Economics and Human Biology*, Vol 9.
**Boulila G.** 1997. Migration, capital humain et croissance économique des pays en développement. *Revue Tunisienne d'Economie*, n 8.
**Carrington W. J. and Detragiache E.** 1998. How big is the Brain drain? *IMF*, WP n° 102.
**Docquier F. Lohest O. and Marfouk A.** 2007. Brain drain in developing countries. *The World Bank Economic Review*, vol 21.
**Docquier F. and Marfouk A.** 2006. International migration by educational attainment, 1990-2000- Release 1.1. in: "Caglar Ozden et Maurice Schiff (eds) International Migration, Remittances and Development." *McMillan and Palgrave: N.Y.*
**Docquier F. and Rapoport H.** 2004. Skilled migration: The perspective of developing countries. *World Bank*, WPS n 3382.
**Docquier F. and Rapoport H.** 2007. Skilled Migration: The Perspective of Developing Countries. In "J. Baghwati and G. Hanson (eds). Skilled migration: prospects, problems and policies." *New York: Russell Sage Foundation*, 1-33.
**Eljafari M. Boughzala M. and Kouni M.** 2012. Determinants and impacts of migration and remittances: the case of Palestine and Tunisia. *FEMISE*, n° FEM33-16.
**Kouni M.** 2012. Emigration, Capital Humain et Croissance : Gain de cerveaux ou perte des cerveaux. *Omniscriptum* (ISBN 978-3-8417-9479-6).
**Kouni M.** 2010. Emigration Prospects and Human Capital in the Developing Countries: The Possibility of the Qualitative Brain Gain. *MPRA*, Working paper n 25074, http://mpra.ub.uni-muenchen.de
**Lucas R.** 2005. International migration to the high-income countries: Some consequences for economic development in the sending countries. *Annual World Bank conference on development Economics, Europe, World Bank.*
**Mankiw G. Romer D. and Weil D. N.** 1992. A contribution to the empirics of economic growth. *Quarterly journal of economics*, vol 107, n 2.
**Rapoport H.** 2002. qui a peur de la fuite des cerveaux? *Problèmes économiques*, n° 2782, 12-14.
**Sciff M.** 2005. Brain gain: claims about its size and impact on welfare and growth are greatly exaggerated. *World Bank*, W P S n° 3708.
**Solow R.** 1956. A contribution to the theory of economic growth. *Quarterly Journal of Economics*, 65-94
**Stark O. and Wang Y.** 2002. Inducing human capital formation: migration as a substitute for subsidies. *Journal of Public Economics*, vol: 86
**World Bank**. 2006. Economic Implications of Remittances and Migration. In *Global Economic prospects*

# Appendices

## A1: Proof of the equilibrium condition

- *For all m = q = 0, C = $C_1$ and the equilibrium can be located on the C curve.*
- *For all 0< m<1:* $-m(1-\varepsilon)-q=-m(1-\varepsilon)-bm=m(\varepsilon-1-b)$, *for q = bm, with 0 <b <1, the quantity* $m(\varepsilon-1-b)$, *for given b, admits a solution* $\varepsilon^*=1+b$ *that is positive when* $\varepsilon^*>1+b$ *and finally, it is negative for* $\varepsilon^*<1+b$. *Therefore C is superior to* $C_1$ *when* $\varepsilon^*<1+b$. *This means that the equilibrium is located below the C. however, C is lower to* $C_1$ *when* $\varepsilon^*>1+b$ *and therefore the equilibrium is located over to the C. finally, if* $\varepsilon^*=1+b$, *C is equal to* $C_1$ *and the equilibrium corresponds to the one without emigration. It is clear, therefore, that when 0 <m <1, the position of the equilibrium is ambiguous; it can be below, over or on the C curve. ( 0<m<1, the case of an emigrant exporting country)*
- *For all -1 <m <0, q = 0,* $\varepsilon>1$ *we have:* $-m+m\varepsilon<0$, *because,* $|m\varepsilon|>m$, *therefore C is always superior to* $C_1$, *so the equilibrium is situated below the C curve. (( -1<m<0, the case of an immigrant exporting country)*

## A2: Middle-income countries considered in the sample (the international code)

| | | | | |
|---|---|---|---|---|
| ARG | SAU | EGY | SLV | PER |
| ATG | SYC | FSM | SUR | PHL |
| BHR | TTO | GNQ | SWZ | PNG |
| BRA | TUR | GTM | SYR | PRY |
| BWA | URY | GUY | THA | ROM |
| CHL | VEN | IRN | TON | DJI |
| GAB | ALB | JAM | TUN | DMA |
| GRD | BGR | JOR | VCT | DOM |
| HUN | BLZ | KIR | VUT | DZA |
| KNA | BOL | LKA | WSM | ECU |
| LBN | COL | MAR | ZAF | MHL |
| LCA | CPV | MUS | OMN | NAM |
| MEX | CRI | MYS | PAN | POL |