The Migration and FDI Puzzle: Complements or Substitutes?*

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October 25, 2006

Abstract

This paper analyses the link between FDI inflows and migration waves from developing countries. In addition, it investigates mechanisms through which this link works. Empirical results indicate that FDI can be seen as substitutes of migration through direct and indirect labour demand. However, the paper demonstrates that a positive relationship (complementarity effect) between FDI and migration flows takes place. In longitudinal analysis results indicate that the complementarity effect prevails. In cross section analysis, estimating a two equation models, we find that a substitutability effect is at work through the impact of FDI on human capital accumulation but the direct complementarity effect also prevails.

*The authors thanks Becchetti L., Cubadda G., Ilardi G., Londono Bedoya D., Trovato G., Tuzi F., Waldmann R.J. and participants to the presentations held at Villa Mondragone Conference of Tor Vergata in June 2006 for comments and suggestions. All errors remain the authors'responsibility.

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1 Introduction

Over the last three decades of the twentieth century, the increasing expansion in global trade and capital movements across countries was accompanied by significant international workers mobility. The international migration stock in the world went from 77 million people in 1970 to 191 million in 2005. Migration pressure is particularly prevalent on the developed countries: of the 36 million who migrated between 1990 and 2005, 33 million end-up in industrialized countries. Between 1990 and 2005, 75 per cent of the increase occurred in a relatively small number of countries: one out of every four migrants lives in North America and one of every three in Europe (United Nation, 2006). Developing countries are the main origin of migration flows of both skilled and unskilled workers. At the same time, with the progressive liberalization of capital movements since the 1970s, a large amount of financial resource flows reached developing countries. Moreover, during the last three decades the external resource flows to developing countries have been changing and foreign direct investments (henceforth, FDI) have emerged in the 1990s as the predominant source of external finance for developing countries. According to the last Unctad estimates, FDI inflows to the developing world continued to rise to an estimated US$274 billion in 2005.

The aim of this paper is to understand whether there is a link between migration from developing countries and FDI inflows. This relation has not been widely analyzed in migration literature as it has predominantly focused on different push factors as main determinants of increasing world migration[1]. Among the economic causes, it is widely recognized that emigration from poor countries is related to wage differentials compared to the receiving countries[2]. Moreover, economic literature suggests that non economic factors are important in migration decisions such as network effects, colonial links, environmental disasters, wars, etc.. To our knowledge, only recently the relationship between FDI and migration has been investigated. Ivelves (2005) shows, in an Heckscher-Ohlin framework, that immigration of high-skilled individuals and FDI inflows are always complements because increase in the stock of high-skilled workers positively affects the return of foreign investments. Kugler and Rapoport (2005) find in their empirical analysis that skilled migration is associated with future increases in FDI inflows and that there is a substitutability relationship among current migration of people with secondary education and FDI. Similarly, Bugamelli and Marconi (2006) affirm the existence of positive effects of skilled migration on FDI inflows. However, all these studies analyze the impact of skilled-migration on FDI flows, while we are interested in explaining the reverse causality, that is how FDI can affect the migration flows from developing countries.

This paper intends to contribute to the literature analyzing if and through which mechanisms FDI can significantly influence the economic and non economic determinants of migration decisions. This is an important issue in designing development policies targeted to manage the migration pressure from developing countries. In particular, we attempt to understand whether FDI have a complementarity effect with migration or they may be considered as "substitutes" of migration. FDI can generate positive externalities which may reduce

[1] See for example, Hatton and Williamson (2002) and for a review of international migration literature see Zlotnik (1998) and Massey et al.(1993).

[2] See Sjaastad (1962) and Borijas (1987, 1989).

incentives to migrate by increasing the internal labour demand for skilled and unskilled workers. Conversely, by reducing liquidity constraints and positively affecting human capital formation they can induce more migration among high skilled workers which decide to migrate to benefit from the higher opportunities in the receiving countries. Moreover, FDI inflows increase the degree of openness of the developing countries and the economic and cultural links with their origin countries and consequently determine a reduction of the communication and transaction costs of migration. The latter correlation may be also enhanced by network effects. These factors facilitate the possibility to migrate so asa to take advantage from higher remuneration abroad.

FDI has also an ambiguous indirect effect on migration through their contribution to human capital formation. Higher skills acquired through a learning by doing process in multinational enterprises can be sold abroad. However, higher human capital can boost the FDI's substitution effect which takes place by improving labour market conditions contributing to reduce the income gap between developing and developed countries. Therefore, both complementarity and substitutability effects of FDI on migration also act through their impact on human capital formation. This latter link has been analyzed in several studies. Ramos (2001)[3] supports the idea that FDI lead to higher rates of human capital accumulation. FDI increase the incentives for individuals to pursue further education. The cost opportunity of spending time in education - i.e. to postpone current wages and decrease the present consumption - is lowered by FDI which both may directly finance education and help growth (see also, Bils and Klenew, 1998). FDI also introduce a factor accelerating technical change which further increases incentives for individuals to seek formal training. In this way FDI signal future growth process which may favour expected higher wages for skilled workers.

In addition, FDI contribute directly to human capital formation. It is well documented that multinational enterprises (henceforth, MNEs) often sustain formal education (in terms of curriculum, educational equipment, infrastructure, technical support, and so on) in the developing countries where they have production facilities. Miyamoto (2003) cites examples of investments in tertiary education realized by Intel Company in China and Costa Rica, and by Toyota Motor Company in Indonesia. Moreover, the author shows how MNEs and institutions (like Universities) cooperate in order to open educational branches in developing countries[4].

The paper is organized as follows. In section 2 we develop a simple theoretical model to derive testable predictions for the relationship between migration flows from developing countries and FDI inflows. In section 3 we run a longitudinal analysis of the relationship between FDI and migration flows. Our results show a positive relationship (complementarity) between FDI and migration flows. In section 4 we analyze more in depth the mechanisms that rule FDI/migration links. In particular we focus the empirical analysis on the role that human capital formation play as a channel through which FDI influence migration flows. Our results confirm both a positive relationship between FDI and migration flows and between FDI and human capital. We also find that the indirect net

[3] For more reference, see also its bibliography.

[4] The *World Class Universities Programme* represents one of the most recent effort by governments to expand educational MNEs' servicies. The programme aims to attract al least 10 world class education institutions.

effect of FDI on migration through the human capital channel is negative. This implies that substitutability effects are at work. However, our results indicate that the complementarity effect prevails. An additional result is that, despite the brain drain effect, the accumulation of human capital acts as a reducing factor of emigration flows.

2 A theoretical analysis of FDI and migration relationships

In this section we develop a model describing the decisions of individuals to migrate with the aim of exploring how the decision to migrate can be affected by FDI inflows. The model, following Beine et al.(2001), considers two-lived period individuals who decide in the first period whether to invest in human capital and in the second period whether to supply their human capital in the domestic labour market or to migrate. When young, at the time t, people may choice either to work as unskilled workers or invest e_t real resources to increase their second period level of human capital. The education investment e_t can be seen as a monetary disbursement or a loss of income due to the time dedicated to education. We assume that the wage level is a positive function of the level of human capital. If an individual decides to invest e_t^i in his education at the time t, in the second period he will be able to offer a higher human capital level $h_{t+1}^i = h_t^i[1 + a^i(e_t^i)]$ where h_t^i is the human capital of individual i and a^i is a parameter of individual ability. Then, in the second period, the skilled individual wage will be increased in proportion of the additional human capital:

$$w_{t+1} = w_t(1 + \gamma_1 h_t^i[a^i(e_t^i)]) \tag{1}$$

where $h_t^i[a^i(e_t^i)] = (h_{t+1}^i - h_t^i)$.

Then, without migration opportunity, the present value of the lifetime income of an individual is:

$$w_t - e_t^i + w_t(1 + \gamma_1 h_t^i[a^i(e_t^i)])(1 + r)^{-1} \tag{2}$$

where r is the discount rate, which is the world interest rate taken as given for a small open economy. If $e_t = 0$, that is with human capital unchanged in the second period, the discounted lifetime income will be $w_t + w_t(1 + r)^{-1}$. The individuals decide to invest in human capital if $w_{t+1} - w_t > e_t^i$, that is to say if $w_t \gamma_1 h_t^i[a^i(e_t^i)] > e_t^i$. This inequality shows that the probability and the dimension of the investment in human capital crucially depends on the parameter γ_1, which reflects the expected condition of the labour market.

If individuals have the opportunity to migrate, the expected lifetime income becomes:

$$w_t - e_t^{*i} + (1 - \pi_1)\left\{w_t(1 + \gamma_1 h_t^i[a^i(e_t^{i*})])\right\}(1 + r)^{-1} + \pi_1\left\{w_t^*(1 + \gamma_2 h_t^i[a^i(e_t^{i*})]) - k\right\}(1 + r)^{-1} \tag{3}$$

where w_t^* is the expected wage for unskilled workers abroad, $h_t^i[a^i(e_t^{i*})]$ is the additional human capital due to e_t^{i*} that denotes the level of human capital investment chosen by the individual in the first period considering the expected migration opportunity in the second period. We assume that the decisions to invest in human capital and to migrate are sequential, then even if e_t^{i*} is greater than e_t^i because the chance of future migration increase the expected return of education, the new level of expenditure enters in the individual estimation of his lifetime income even if his final decision will be to offer his human capital in domestic labour market. Both monetary and psychological fixed costs related to migration are denoted by k. The probability of migrating in the second period is denoted by π_1. Finally, γ_2 is the parameter determining the positive impact of individual human capital on his expected wage abroad. Assuming that $\gamma_2 > \gamma_1$ the migration opportunity increases the probability that individuals decide to invest in human capital.

Now, it is possible to write the wages differential condition for choosing to migrate $w_{t+1}^* - w_{t+1} > k$ as

$$(w_t^* - w_t) + (w_t^* \gamma_2 - w_t \gamma_1) h_t^i[a^i(e_t^{i*})] > k \tag{4}$$

Therefore we find that migration decision depends on both unskilled and skilled workers'wage differential between the migrants'origin and receiving countries. The parameters γ_2 and γ_1 play a significant role in determining the skilled workers' wage effect of investment in human capital. Assuming γ_2 equal or greater than γ_1, the effect of the increase of human capital on the migration choice is positive given $w_t^* > w_t$, otherwise it could also be negative. The value of γ_2 crucially depends on how the human capital acquired in the migrants' origin countries is evaluated in the foreign labour markets.

On the basis of the above analysis, we may specify the following function for individual migration decision, assuming a linear relationship among considered variables :

$$m_t^i = \alpha_1(w_t^* - w_t) + \alpha_2(\gamma_2 - \gamma_1) h_t + \alpha_3 e_t^{i*} - \alpha_4 k + \alpha_5 z \tag{5}$$

where m_t^i is the emigration flow and z is a vector of variables affecting the migration decision such as the distance between origin and receiving countries, the liquidity constraints and other political and institutional variables.

Now we have to consider the role of FDI in migration decisions. FDI can affect migration through different channels. The first one is the direct effect on the labour demand of skilled and unskilled workers in the migrants' origin countries. In an Heckscher-Ohlin framework, FDI inflows in developing countries should be concentrated in unskilled labour intensive sectors, therefore they should increase the wages of unskilled workers. At the same time, due to the complementarity between physical and human capital, foreign and domestic investments also increase the demand of skilled labour. These direct effects on domestic wages should reduce the incentive to migrate. This effect on migration through domestic wages is emphasized by the positive role played by FDI on the accumulation of human capital. As a matter of fact, the supply of skilled labour is a limiting scarce factor for domestic and foreign investments in many developing countries. Then, an increase in the endowment of human capital is a condition for higher level equilibria in the labour markets of these countries.

As for the positive influence of FDI on human capital formation, it can be explained in two ways. First, the same above mentioned complementarity between human and physical capital pushes the multinational enterprises to directly finance education where they establish their productive activities. Additionally, the positive effect of FDI on the demand of skilled labour increases the return of private investments in human capital. Finally, the skills of the workers are improved through the direct training received in multinational enterprises and the "spin-off" effect on the local firms. In conclusion, FDI can be seen as substitutes of migration through direct and indirect labour demand effect. However, the impact of FDI on migration through the human capital channel is quite ambiguous because the higher wages that skilled workers can gain abroad can increase the incentive to migrate (brain drain effect). In our model, this complementarity effect plays through the parameter γ_2: the skills acquired through the training activities of multinationals can often be more marketable abroad than formal education obtained in inadequate school systems or oriented by the needs of local labour markets. Finally, a complementarity between migration and FDI can be determined by the reduction of transaction and information costs for the potential migrants due to the fact that FDI increase bilateral information and knowledge on employment and wage condition abroad as well as on values, practices and technical and organizational procedures in foreign enterprises. This information and transaction cost effect can be seen as an inverse network effect that a recent literature highlighted to explain a possible positive effect of migration and diaspora phenomena on FDI.

On the basis of the above analysis we can include the FDI effects in our model re-writing the expected lifetime income of individuals as in (5):

$$
\begin{aligned}
&w_t(1+\beta_1(I_f)) - e_t^{i*}(1+\beta_2(I_f)+ \\
&+(1-\pi_1)\left\{w_t(1+\beta_1(I_f))(1+\gamma_1 h_t^i[a^i(e_t^{i*}(1+\beta_2(I_f))+\beta_3(I_f))])\right\}(1+r)^{-1}+ \\
&+\pi_1\left\{w_t^*(1+\gamma_2(1+\beta_4(I_f))h_t^i[a^i(e_t^{i*}(1+\beta_2(I_f))+\beta_3(I_f)-k(1+\beta_5(I_5))\right\}(1+r)^{-1}
\end{aligned}
$$

where I_f denotes the foreign direct investments. The parameters β capture the following effects:

$\beta_1$catches the positive labour demand effect of FDI on domestic wages;

β_2 captures the increase in individual human capital investment due to the FDI impact on expected returns from schooling;

β_3 indicates the increase in individual training through FDI channels.

$\beta_4$captures an efficiency increase of investments in human capital determined by FDI in terms of acquisition of specific technical skills and cultural characteristics more suitable for the foreign labour market and the organizational and technical procedures prevailing abroad.

β_5 captures the effect of FDI on the reduction of the migration costs due to the network effect and to the decrease of transaction and information costs.

We can now re-write the migration condition as

$$\left[w_t^* - w_t(1+\beta_1(I_f))\right] + \left[w_t^*\gamma_2(1+\beta_4(I_f)) + -w_t\gamma_1(1+\beta_1(I_f))\right] * \\ *h_t^i\left[a^i(e_t^{i*}(1+\beta_2(I_f)) + \beta_3(I_f))\right] > k(1-\beta_5(I_f))$$

This condition shows the various channels through which FDI can affect the individual decision to migrate. FDI can be negatively correlated with migration through β_1(domestic labour demand effect) and positively correlated through β_5 (migration cost effect) and β_4 (human capital efficiency effect). How FDI can influence migration through the human capital channel is more ambiguous because it depends on the relative effects of the increase in human capital on the expected incomes of potential migrants in domestic and foreign countries, effects that are determined by the value of $\left[w_t^*\gamma_2(1+\beta_4(I_f)) - w_t\gamma_1(1+\beta_1(I_f))\right]$.

The above condition allows us to specify the following linear functions for empirical analysis purposes:

$$m^i = \alpha_1(w^* - w) + \alpha_2 h + \alpha_3 I_f + \alpha_5 k + \alpha_6 z \tag{7}$$

$$h = \delta_1 h_{t-1} + \delta_2 e_t^{i*} + \delta_3 I_f + \delta_4 m^i \tag{8}$$

The first equation establishes that migration is a function of the expected income differential between destination and sending countries, human capital, FDI and the cost of migration. The coefficient $\alpha_1$is expected to be positive while the coefficient α_5 is expected to be negative. The others coefficients can be positive or negative. In particular the sign of α_2 depends on whether the brain drain effect of an increased human capital prevail on the general positive effect on the labour demand in domestic markets and the sign of α_3 depends on whether complementarity or substitutability effects of FDI above described prevail.

The second equation describes human capital as a function of the expenditure in formal tertiary education, FDI and migration. The sign of all the coefficients δ is expected to be positive with the exception of δ_4 because the negative effect of migration flows of skilled workers on the human capital stock can offset the incentive effect of expected migration on the investment in human capital.

3 A longitudinal test

In this section we present the results of the panel analysis on the relationship between FDI and migration flows. The main problem we faced in this analysis concerned the availability of data as there are not many data sources for long-term emigrants from developing countries. Usually data used in similar analysis (see Mayda, 2005) are provided by OECD statistics on foreign-born people in OECD countries. In our work we focus on the relationships between OECD and developing countries assessing the effect of FDI from OECD countries on the emigration flows from developing ones.

3.1 Dataset and Specification

In this section first we briefly describe variables used in the empirical specification and their sources, then we propose several estimation methods.

As we observed in theoretical model many FDI effects are related to high skilled migration through the human capital accumulation channel. Unfortunately, because of the lack of time series data on high skilled migration we chose to concentrate the panel analysis on gross migration rates. Therefore we do not explicitly consider the relation between human capital and migration that we take into account in the next section.

The model we estimate is:

$$mig_{ijt} = \beta_1 gdpratio_{ijt-1} + \beta_2 open_{ijt-1} + \beta_3 Fdi_{jt-1} + comlan_{ij} + dist_{ij} + \mu_{ijt} \quad (9)$$

Where i is the receiving country of migration, j is the sending country of migration, the time t is $1991, ..., 2001$. Table 1 shows the list of sending countries by receiving ones, while table 2 (see the appendix) lists sources and the main statistics of the variables employed.

Data for migration variable (mig) come from OECD SOPEMI statistics on inflows of foreign population by nationality or country of birth. We normalize data by population size in each sending country: mig_{ijt} is defined as immigration flow to OECD country i from developing country j divided by population size in country j in the period t.

To capture the effect of foreign direct investments as substitutes and/or complements on migration flows we use the lagged value of total FDI inflows in sending countries. Our other explanatory variables cover a number of migration push and pull factors. As a measure of the economic development we consider the log ratio of the five years moving average GDP per capita, in purchase power parity, in destination and source countries, ($gdpratio$), which are supposed to catch relative income opportunities in the two countries. Moreover, we also include its square to assess the monotonic effect of this relative inequality measure. We include a variable of trade volumes ($open$), which is defined as the total trade values (sum of imports and exports as a share of GDP) for all country pairs. We expect that the business ties represented by the volume of trade could have positive effects on international migration. Moreover, this variable is often considered as an indicator of openness degree of sending countries. We use lagged values of the variables above mentioned to account for possible reverse causality.

We also include a variable describing cultural aspects. The variable common language ($comlan$) is a dummy variable assuming value 1 if a common language is spoken by more than 9% of the population. This variable can be considered a proxy of the past colonial ties that might have some influence on cultural distance. A very common measure to control for the direct costs of migration is the distance between sending and destination country. In particular as a proxy of transportation costs, we use the distance in kilometers between the capital cities in sending and receiving countries ($dist$).

Our model has been estimated following standard procedures as pooled OLS, panel estimations methods (fixed and random effects). Since we observed macro data for a period of 11 years, we also control for residual correlation over time by applying a robust Generalized Estimating Equations (GEE) method which

controls for potential error term correlation over time. Other robustness checks are those related to Tobit, instrumental variables and dynamic models.

3.2 Panel estimation results

In table 3 we show our results with respect to different econometric estimation methods. In Column 1 we present Pooled OLS estimates in which our key explanatory variable (FDI inflows) is positive and strong significant. This supports the idea that a complementary effect prevails.[5]

When comparing the pooled OLS results with the panel models, fixed or random effects (columns 2 and 3, respectively), the general impression is that results for our explanatory variables are quite robust across different methods in terms of both sign and statistical significance. This occurs mainly when we focus on FDI inflows. Hausman's (1978) specification test results (see table 3) drive our attention towards different specifications of the fixed effects model. In all regressions shown in table 4 our key variable is confirmed significant with a positive coefficient. Column 1 indicates that migration rate increases of the 0.01 per cent when a developing country receives an additional FDI inflow of one million dollars for every one hundred thousand inhabitants.

Other explanatory variables confirm standard theoretical predictions. The gap in GDP per capita in the two locations, the degree of openness and a common language are all positively correlated with emigration rate. On the contrary, the proxy for migration costs - the distance variable - has a negative impact as expected.

In Table 5 we show some robustness checks of the panel-data results. We describe in the first column the results of Tobit estimation technique to account for truncation in the data[6] and in the second column the GEE random effect estimation that allows us to specify the within group correlation structure for the panel. Both estimations confirm the previous predictions on FDI variable.

One of the big issues in the migration and FDI literature concerns the reverse causality between these two variables[7]. To take into account the endogeneity problem we run the instrumental variable technique using as instruments the lagged values of FDI stock, migration rate and a variable for civil liberties [8]. The outcome of the analysis supports our previous results on the importance of FDI as determinants of migration flows.

Because past migration flows may influence emigration rates, reducing migration costs (network effects), we have also considered a dynamic specification of the model by introducing the lagged emigration rate as explanatory variable (table.5). To this purpose we use the econometric technique of Arellano and Bover's system-GMM estimator to deal with the problem of incidental parame-

[5] Our results don't substantially change by introducing FDI stock in lagged values.

[6] Migration rate is a variable ranges in (0,1).

[7] See for istance, Kugler and Rapoport (2006).

[8] This variable "allows for freedoms of expression and belief, associational and organizational rights, rule of law, and personal autonomy without interference from the state" (Freedom House, 2006). This variable can be considered a measure of democracy in a country which, in agreement with a strand of literature on the FDI determinants, shows positive effect (Rodrik, 1996 and Busse,2004).

ters [9] without removing time invariant regressors[10]. Lagged emigration rates clearly show a significant and positive coefficient as expected.

In conclusion the results of the panel analysis show a positive impact of FDI on migration flows that indicates a complementarity between the two variables.

4 Empirical Nexus of Migration, FDI and Human Capital Formation

In this section, we attempt to empirically assess our hypothesis about the relationship between FDI, human capital formation and migration decisions . We empirically investigate this link by running a simultaneous equations model for migration rate and human capital.

As argued in the theoretical analysis, FDI can affect directly and positively migration flows increasing the wealth in developing countries, that reduces the liquidity constraints of the potential migrants, and enhancing network effects. On the other hand, FDI can have a direct negative effect on migration (substitution effect) increasing labour demand.

FDI also act indirectly through arising human capital formation which can boost FDI's substitution effect on migration by improving internal labour market conditions. This offset the incentive effect for high skilled workers to migrate to benefit from better opportunities abroad (complement effect). Therefore the total effect of FDI on migration through the human capital channel may be ambiguous.

Due to the fact that human capital data is scarce and limited to few years for developing countries, we explore these links running a cross section analysis.

4.1 Specification Issues, Dataset and Variables

We estimate a simultaneous equations system that consists of the following two equations:

$$hum_i = \beta_0 + \beta_1 mighigh_i + \beta_2 migfdi_i + \beta_3 fdipc_i + \beta_4 exedupc_i \tag{10}$$

$$mig_i = \gamma_0 + \gamma_1 gdp9095pc_i + \gamma_2 \ln diff_i + \gamma_3 popdens_i + \gamma_4 fdipc_i + \gamma_5 hum_i \tag{11}$$

where hum_i,mighigh_i, fdipc, exedupc, mig, gdp95pc, lndiff and popdens denote respectively a measure of human capital, high skilled emigration rates, inward FDI stock per capita in sending countries, public expenditures in tertiary education, total migration rate, GDP per capita sending countries, a proxy for

[9] The problem of incidental parameters come from that in a dynamical model estimated using a panel data set (T observations for each unit a=1,..,N, where the parameters specific for each unit a are called "incidental"), the fixed effects estimator of the coefficient of the lagged dependent variable is not consistent for given T, as N , because the number of parameters to be estimated tends to infinity, while the information used to estimate each parameter does not increase

[10] This is the reason why we do not use Arellano-Bond's estimator which first-differencing the equation removes fixed effects but also the time invariant regressors

wage differentials with respect to G7 countries and population density. The variable migfdi is the product of mighigh$_i$ and a dummy variable that takes value 1 if sending country displays a value of FDI per capita higher then 0.0268029 (i.e. more than about 30 dollars per capite). This variable captures the interaction effect of FDI and migration on human capital formation.

The first equation tests the effect of FDI on human capital stock, measured as share of high educated people on total population (source Barro Lee 2001). We use as key explanatory variable the total inward FDI stock per capita, while other covariates are the rate of high skilled migrants which measures the brain drain effect[11], the public expenditures in tertiary education per capita and the interaction variable between FDI and emigration rates as above described.

The second equation assesses the complementarity or substitutability effect of FDI on migration. To test the direct effect of FDI on migration, we use the total FDI inward per capita whereas their indirect effect is tested through the human capital variable. Among the other explanatory variables of the migration decision making process, we use GDP per capita of sending countries to capture the relative position of the countries in term of living standards and to capture the absolute poverty effect on the capacity of financing migration. We have also included as a proxy of wage differentials the GDP per capita differential between sending and mean income G7 receiving countries. Controlling for the wage differential we expect a positive sign for GDP per capita. Finally, we include population density in sending countries to capture the demographic pressure on their labour markets.We use five years average data for our regressors. We run the simultaneous equations model (SUREG) for the year 2000 with a sample including 91 developing countries (see table 6 for the complete list).

Our results (table 8a) show a positive and significant correlation between migration and wage differentials, GDP per capita and the population pressure. More importantly, the human capital variable has a negative impact on the total migration rate while FDI are positively correlated. The direct positive effect of FDI on migration shows that complementarity effects prevail. The negative effect of the stock of educated people on migration (both skilled and unskilled) seems to confirm that the increase of human capital, as scarce factor, is crucial for strenghtening internal markets and labour demand. Finally, the human capital equation shows how FDI positively act on human capital formation and therefore can produce an indirect negative effect on migration rate (substitutability effect). In fact, as in table 8b, the coefficient measuring FDI indirect effect on migration through human capital formation is negative (-0.01578); however it is lower than the coefficient measuring the FDI direct effect (0.04202). Therefore the total FDI effect on migration is positive.

These results are robust to different specifications (see tables 8a-8c). Moreover when we control for the variable measuring interaction between migration and FDI we find a positive and significant effect. This implies that the brain drain effect may be mitigated by the FDI inflows as the positive sign of the

[11] For our purpose, we refer to the dataset by Docquier and Marfouk (2005) that provides new estimates of emigration rates by educational attainment for the 2000. The emigration rates measure the fraction of skilled agents born in a developing country and living in a OECD country related to the total number of people in the source country and with the same educational category. Skilled migrants are those with at least tertiary educational attainment (we remaind to the paper to a detailed discussion of the estimates and methodological issues, pag 7).

interaction term shows. In fact, as in table 8c, the coefficient measuring the brain drain effect on human capital formation is negative (-21.6086); while that measuring the interaction effect is positive (16.1769). This latter result appears to tell us that the negative impact of brain drain on the stock of educated people of developing countries is, at least partially, offset by the joint positive incentive effect determined by FDI and expected migration opportunity.

Results shown in table 8d confirm our previous outcomes even if we focus our attention on high skilled migration. In addition, we find that human capital accumulation negatively affects the high skilled migration. This result contradics with the findings of the migration literature on brain drain.

5 Conclusions

The aim of this paper is to find empirical evidence for the link between FDI inflows and emigration flows from developing countries and to investigate through which channels this relationship works. The first channel is the direct effect on the labour demand of skilled and unskilled workers in the migrants' origin countries and on the domestic wages. This effect, that should reduce the incentive to migrate, is emphasized by the positive role played by FDI on human capital accumulation which is a condition for higher level equilibria in the labour markets of most developing countries.

We found empirical evidence of this positive influence of FDI on human capital formation which can be explained in two ways. First, the complementarity between human and physical capital pushes the multinational enterprises to finance education where they establish their productive activities. Additionally, the positive effect of FDI on the demand of skilled labour increases the return of private investments in human capital. In conclusion, FDI can be seen as substitutes of migration through direct and indirect labour demand effect. The substitutability effect of FDI through the human capital channel depends on the fact that, according to our results which contradict the brain drain literature, a higher endowment of human capital reduces emigration flows.

However, a strong complementarity effect between migration and FDI should be taken into account. This complementarity can be determined by the reduction of transaction and information costs for the potential migrants. This may due to the fact that FDI increase bilateral information and knowledge on employment and wage condition abroad as well as on values, practices and technical and organizational procedures in foreign enterprises. This information and transaction cost effect can be seen as the inverse of the network effect that recent literature highlighted to explain a possible positive effect of migration and diaspora phenomena on FDI. This effect can be enhanced by an increase of human capital suitable for developed countries as a results of the learning by doing externalities produced by FDI.

The empirical evidence shows that the complementarity effect is strong. In longitudinal analysis we find that the complementarity effect prevails. In cross section analysis we show both complementarity and substitutability effects are at work, even if the complementarity effect prevail. However, evidence that human capital is a channel for the substitutability effect support the idea that FDI policies should be addressed so as to spread within the developing countries benefits they create in term of human capital formation.

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6 Appendix

Table1. Sending country list by destination country

Receiving Countries	Sending Countries
Australia:	China, South Africa, India, Philipine, Sri Lanka Vietnam, Fiji Lebanon and Hong Kong.
Belgium:	Morocco, Dem. Rep.of Congo, China.
Canada:	China,India, Pakistan, Philippines, Sri Lanka, Hong Kong, Vietnam, Iran.
Denmark:	Afghanistan, Somalia, Thailand, Iran Pakistan.
Finland:	China, Thailand, Somalia, Iran, Vietnam.
France:	Morocco, Algeria, Tunisia, China, Haiti, Sri Lanka, Dem. Rep. of Congo, Brazil.
Germany:	China, India, Iran, Morocco, Thailand, Vietnam.
Japan:	China, Philippines, Brazil, Indonesia Thailand and Vietnam.
Netherlands:	Morocco, China, Suriname.
Norway:	Somalia, Iran, Pakistan, Thailand, Philippines.
Portugal:	Angola, Capoverde, Brazil, Guinea Bisseau, SaoTome& Principe, Venezuela.
Sweden:	Iran, Somalia, India, Chile.
UK	China, India, South Africa, Philippines, Malaysia, Pakistan, Bangladesh.
USA	Dominican Republic, China, Philippines,Vietnam, Pakistan, Colombia, Mexico, El Salvador, Cuba, Haiti.

Table2. Panel variables descriptive statistics

Variables	Source	Mean	St.dev.	Max	Min
Mig	OECD - SOPEMI	.0005302	.0014045	.0193099	1.13e-07
gdp sending	World Bank	4376.931	3851.318	25797.84	646.079
gdp receiving	World Bank	25084.52	4106.726	34827.87	14455.06
open	OECD	.0183905	.0365896	.2988749	0
comlan	CEPII	.372093	.4836443	1	0
dist	CEPII	7144.587	3563.042	17693.2	1340.39
FDI	UNCTAD	5374.049	11900.83	61924.1	-4550

Table3. Panel estimation results

Dep var: mig	POOLED	RANDOM	FIXED
gdp ratio	0.00008	0.00020***	0.00021***
	(0.00005)	(0.00005)	(0.00005)
dist	-0.00036***	-0.00048***	-0.00051***
	(0.00005)	(0.00006)	(0.00006)
comlan	0.00048***	0.00024***	0.00020**
	(0.00007)	(0.00008)	(0.00008)
fdi	0.00007***	0.00005***	0.00005***
	(0.00002)	(0.00002)	(0.00002)
Constant	0.00331***	0.00466***	0.00503***
	(0.00046)	(0.00050)	(0.00051)
Observations	657	657	657
N. receiving countries		14	14
sigma_u		0.000297	0.000361
sigma_e		0.000735	0.000735
Test			
R^2	0.18	.	0.20
Hausmann	chi2(4)= 9.90 ; Prob>chi2 = 0.0422		

Note: Standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1

Sample: Unbalanced panel in Oecd countries by origin country; Years 1991-2001.

See table 1 for country list and table 2 for data sources.

Variable definitions:

mig is the immigration flow to country i from country j divided by population size in country j in the period t.

gdp_ratio is lagged log ratio of the five years moving average GDP per capita (in purchase power parity) in destination and source countries

dist measures the distance in kilometers between the capital areas in the sending and receiving countries

comlan is a dummy variable assuming value 1 if a common language is spoken by a more then 9% population

fdi is the lagged value of FDI inflows in sending country.

Table 4.Different fixed effects specifications

	(1)	(2)	(3)
Dep var: mig			
gdpratio	0.00021***	0.00093***	0.00017***
	(0.00005)	(0.00018)	(0.00005)
dist	-0.00051***	-0.00055***	-0.00039***
	(0.00006)	(0.00006)	(0.00006)
comlan	0.00020**	0.00017**	0.00014*
	(0.00008)	(0.00008)	(0.00008)
fdi	0.00005***	0.00005***	0.00004**
	(0.00002)	(0.00002)	(0.00002)
gdpratiosquared		0.00020***	
		(0.00005)	
open			0.00009***
			(0.00002)
Constant	0.00503***	0.00600***	0.00454***
	(0.00051)	(0.00056)	(0.00053)
Observations	657	657	649
N. of receiving	14	14	14
R^2	0.20	0.22	0.22

Standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1

Sample: Unbalanced panel in Oecd countries by origin country; Years 1991-2001.

See table 1 for country list.

Variable definitions:

mig is the immigration flow to country i from country j divided by population size in country j in the period t.

gdpratio is lagged log ratio of the five years moving average GDP per capita (in purchase power parity) in destination and source countries.

dist measures the distance in kilometers between the capital areas in the sending and receiving countries

comlan is a dummy variable assuming value 1 if a common language is spoken by a more then 9% population

fdi is the lagged value of FDI inflows per capitain sending country.

gdpratiosquared is the squared value of the gdpratio

open is sum of imports and exports as a share of GDP for all country pairs.

See table 2 for data sources.

Table5. Robustness check

COEFFICIENT	TOBIT	GEE	IVREG	DYNAMIC
gdp_ratio	-0.00011	0.00021	-0.00003	-0.00011
	(0.00011)	(0.00014)	(0.00002)	(0.00009)
dist	-0.00079***	-0.00050*	-0.00007***	-0.00010***
	(0.00010)	(0.00028)	(0.00002)	(0.00002)
comlan	0.00025*	0.00022***	0.00002	0.00010***
	(0.00013)	(0.00008)	(0.00003)	(0.00003)
fdi	0.00007**	0.00005**	0.00003***	0.00003**
	(0.00003)	(0.00002)	(0.00001)	(0.00001)
mig(t-1)			0.88187***	0.77996***
			(0.01804)	(0.03290)
Constant	0.00678***	0.00482**	0.00054**	0.00063**
	(0.00080)	(0.00245)	(0.00021)	(0.00025)
Observations	680	657	549	645
Number of idr	14	14	14	14

Note: Standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1

Sample: Unbalanced panel in Oecd countries by origin country; Years 1991-2001.

See table 1 for country list. and See table 2 for data sources.

Variable definitions:

mig is the immigration flow to country i from country j divided by population size in country j in the period t.

gdp_ratio is lagged log ratio of the five years moving average GDP per capita (in purchase power parity) in destination and source countries

dist measures the distance in kilometers between the capital areas in the sending and receiving countries

comlan is a dummy variable assuming value 1 if a common language is spoken by a more then 9% population

fdi is the lagged value of FDI inflows per capita in sending country.

mig (t-1) is lagged value of immigration flow to country i from country j divided by population size in country j in the period t-1.

Instruments for FDI: Inward Stock t-2; mig t-2; civil liberties (cl).

Table6. List of developing countries in corss section analysis

Countries:
Angola,Argentina, Burundi, Benin Burkina Faso, Bangladesh Bolivia Brazil
Barbados, Botswana, Central African Republic, Chile, China, Cote d'Ivoire,
Cameroon, Rep. of COngo, Dem. Rep. of Congo, Colombia, Comoros, Cape Verde,
Costa Rica, Dominica, ominican Republic, Algeria, Equador, Egypt, Ethiopia, Fiji, Ghana
Guinea, Gambia, Guinea Bissau, Grenada, Guatemala, Guyana, Honduras, Haiti, Indonesia
India, Iran, Jamaica, Jordan, Kenya, Saint. Lucia, Sri Lanka, Lesotho, Morocco,
Madagascar, Mexico, Mali, Monzambique, Mauritania, Mauritius, Malawi, Malaysia,
Niger, Nigeria, Nicaragua, Nepal, Oman, pakistan, Panana, Peru, Philippines,
Papua New Guinea,Syria, Chad, Togo, Thailand, Paraguay, Rwanda,
Sudan,Senegal, Solomon Islands, El Salvador,Swaziland, Seychelles,
Tonga,Trinidad and Tobago, Tunisia, Turkey, Tanzania, Uganda, Uruguay, Saint Vincent
and the Grenadines,Venezuela, Vanuatu, Samoa, South Africa, Zambia, Zimbabwe

Table7. Cross section descriptive statistics

	Source	Obs	Mean	St.Dev	Max	Min
mighigh	Docquier Morfouk (2005)	100	.2365979	.2462157	.8895777	0047969
gdppc	World Bank (average 1990-95)	95	3788.159	3131.154	14336.85	504.5671
diff	World Bank (average 1995-2000)	95	9.9658	.1899017	10.13629	9.204492
popdens	World Bank (average 1995- 2000)	100	112.1958	168.3223	1006.76	2.579934
fdi	Unctad (average 1995- 2000)	93	.5789252	1.009237	5.615716	.0035688
expeduc	World Bank (average 1995- 2000)	94	5.529259	14.84319	81.3785	.001644
hum	Barro Lee (2001)	73	4.849863	2.031878	8.83	.84
cl	Freedom House	100	3.92	1.541873	1	7

Table 8. Cross Section Estimation Results,(8a-8d).

Table 8a

	hum	mig
fdipc	0.67079**	0.05226***
	(0.29710)	(0.01317)
mighigh	-5.42412***	
	(1.18682)	
gdp95pc		0.00007***
		(0.00002)
lndiff		1.00395***
		(0.34430)
popdens		0.00018**
		(0.00007)
hum		-0.01682***
		(0.00431)
Constant	3.09640***	-10.19485***
	(0.37592)	(3.50925)
Observations	91	91
R^2	0.08	0.33

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Variable definitions:

mig¿is the total emigration rates.

mighigh¿is the emigration rates of high skilled workers (with tertiary education)

gdp95pc is the average GDP per capita in sending country in 1990-1995

lndiff is the ln of GDP differentials between sending countries and G7 countries (average 1995-2000).

popdens is the population density

fdipc is the inward stock FDI per capita in sending countries (average 1995-2000).

hum is the %of people with higher education in total population.

exedupc is the public expenditures in education per capita (average 1995-2000).

migfdi is obtained multiplying mighigh to a dummy variable that takes value 1 if sending country displays a value of FDI per capita higher then 0.0268029.

See table 7 for data sources.

Table 8. Cross Section Estimation Results,(8a-8d).

Table 8b

	hum	mig
fdipc	1.24666***	0.04202***
	(0.36522)	(0.01522)
expedupc	0.12900***	
	(0.04153)	
mighigh	-5.50742***	
	(1.49685)	
gdp95pc		0.00007**
		(0.00003)
lndiff		1.24042**
		(0.51598)
popdens		0.00006
		(0.00008)
hum		-0.01266**
		(0.00501)
Constant	0.49548	-12.58096**
	(0.93787)	(5.25319)
Observations	57	57
R^2	0.24	0.19

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Variable definitions:

mig¿is the total emigration rates.

mighigh¿is the emigration rates of high skilled workers (with tertiary education)

gdp95pc is the average GDP per capita in sending country in 1990-1995

lndiff is the ln of GDP differentials between sending countries and G7 countries (average 1995-2000).

popdens is the population density

fdipc is the inward stock FDI per capita in sending countries (average 1995-2000).

hum is the %of people with higher education in total population.

exedupc is the public expenditures in education per capita (average 1995-2000).

migfdi is obtained multiplying mighigh to a dummy variable that takes value 1 if sending country displays a value of FDI per capita higher then 0.0268029.

See table 7 for data sources.

Table 8. Cross Section Estimation Results,(8a-8d).

Table 8c

	hum	mig
fdipc	1.10644***	0.04104***
	(0.35473)	(0.01524)
mighigh	-21.60863***	
	(7.95140)	
expedupc	0.13105***	
	(0.03984)	
migfdi	16.17691**	
	(7.77269)	
gdp95pc		0.00008***
		(0.00003)
lndiff		1.28874**
		(0.51769)
popdens		0.00005
		(0.00008)
hum		-0.01243**
		(0.00503)
Constant	0.72217	-13.07467**
	(0.90791)	(5.27067)
Observations	57	57
R^2	0.31	0.19

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Variable definitions:

mig_i is the total emigration rates.

$mighigh_i$ is the emigration rates of high skilled workers (with tertiary education)

gdp95pc is the average GDP per capita in sending country in 1990-1995

lndiff is the ln of GDP differentials between sending countries and G7 countries (average 1995-2000).

popdens is the population density

fdipc is the inward stock FDI per capita in sending countries (average 1995-2000).

hum is the % of people with higher education in total population.

exedupc is the public expenditures in higher education per capita (average 1995-2000).

migfdi is obtained multiplying mighigh to a dummy variable that takes value 1 if sending country displays a value of FDI per capita higher then 0.0268029.

See table 7 for data sources

Table 8. Cross Section Estimation Results,(8a-8d).

Table 8d

	hum	mighigh
fdipc	0.74768**	0.12655***
	(0.35140)	(0.03104)
expedupc	0.16527***	
	(0.04239)	
gdp95pc		0.00013**
		(0.00006)
lndiff		2.49629**
		(1.08320)
popdens		0.00013
		(0.00016)
hum		-0.02490**
		(0.01048)
Constant	-0.92739	-25.21435**
	(0.88596)	(11.02831)
Observations	57	57
R^2	0.23	0.33

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Variable definitions:

mighigh$_i$ is the emigration rates of high skilled workers (with tertiary education)

gdp95pc is the average GDP per capita in sending country in 1990-1995

lndiff is the ln of GDP differentials between sending countries and G7 countries (average 1995-2000).

popdens is the population density

fdipc is the inward stock FDI per capita in sending countries (average 1995-2000).

hum is the %of people with higher education in total population.

exedupc is the public expenditures in higher education per capita (average 1995-2000).

See table 7 for data sources.