Skilled migration and sending economies. Testing brain drain and brain gain theories*

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Abstract

Traditional models of brain drain stress its negative impact on the welfare and growth of sending economies, while new models introduce the possibility of brain gain through several channels (human capital, remittances, return migration or FDI and trade linkages). We test all these theories by estimating cross-country individual regressions for each channel, and a system of equations to assess the overall effect of brain drain on economic growth. Results suggest a negative effect on human capital stock, negligible on remittances (controlling for total migration) and a positive effect on trade and FDI. The net impact of skilled migration on economic growth remains ambiguous.

Keywords: *brain drain, human capital formation, ethnic networks, remittances, source country effects.*

JEL codes: *C30, F22, J24, O15*

1 Introduction

Talent is becoming one of the most prized resources in modern economies. Companies and governments in industrialized countries recruit and retain skilled individuals from all over the world to face up to the shortage of specialized workers. This transfer of skilled labor has consequences on the welfare and growth of sending economies that should be investigated.

Recent migration data collected by Docquier and Marfouk (2006) reveals that, during the 1990s, the number of higher educated migrants living in OECD countries increased by 8 million (40 per cent of total migrants arrived in that period). The magnitude of brain drain flow seems to be extraordinarily large in recent years; for example, in 2000 more than 50 percent of the skilled migrant stock from Africa arrived during the previous decade, (as did 41 percent of Asians and 34 percent of Latin Americans)[1]. Furthermore, brain drain rates [2], are higher in developing than in developed countries (Figure 1).

[Figure 1 here]

In the late sixties a large number of scientists and engineers moved from developing to developed countries; it was the first time that concerns about skilled migration arose. Such reallocation of skilled labor was seen as detrimental to sending economies; on the one hand, it reduced the productivity of workers left behind, and on the other, it entailed negative fiscal consequences (Grubel and Scott, 1966; Johnson, 1967; Bhagwati and Hamada, 1974).

In more recent years, new provocative arguments have emerged suggesting that skilled migration can generate net gains for individuals left behind thanks to positive externalities. For example, the possibility of migrating to an economy with higher wages raises the expected returns to education; this increase creates incentives for individuals to invest in human capital that, with uncertain migration prospects, might leave the country with a higher level of human capital. Relevant literature here includes Mountford (1997), Stark et al. (1997, 1998), Vidal (1998), Stark and Wang (2002), Beine et al. (2001), Stark (2004) and Beine et al. (2001, 2007).

Furthermore, the literature indicates other channels through which brain drain generates gains for sending economies. One of them is through worker remittances[3]. Another important welfare enhancing channel is represented by migrant returnees, who have accumulated knowledge and experience in professional and entrepreneurial activities abroad. Finally, recent studies in the area of international economics suggest that migration is complementary to trade and FDI (foreign direct investment) rather than a substitute, and it encourages gains from trade and the dissemination of technology for the source country.

This paper investigates the relationship between the migration of individuals with a higher education and the outcomes for sending economies by examining cross-country evidence. In particular, we focus on human capital, openness to trade, FDI inflows, worker remittances and GDP per capita growth. We contribute to the existing literature by estimating the effect of skilled migration probability on human capital post migration. We also contribute to the business network literature, by isolating the effect of skilled migration on trade from the overall migration effect, a channel relatively unexplored in the literature. Similar disaggregation was considered when measuring FDI and remittance channels. Finally, we investigate the overall effect of brain drain on GDP per capita growth.

Results suggest that brain drain harms human capital in the home economy. More precisely, our estimates suggest that the incentive to education is too low to overcome the human capital loss from skilled migration, not only when migration probability is very high, but also at lower levels. Meanwhile, brain drain seems to stimulate business networks in both channels, trade and FDI, while the effect of unskilled migration on both variables is negative. With respect to remittances, skilled migration does not produce different effects than unskilled migration. The overall effect on growth is ambiguous.

The paper is organized as follows. Section 2 reviews theory and evidence from brain drain and brain gain literature. In section 3, we introduce the empirical model, describing each particular channel and the data used. Section 4, presents the results of the individual and joint estimates. Finally, Section 5 presents the conclusion.

2 Theory and evidence

The conventional literature views brain drain as being detrimental to sending economies (Grubel and Scott, 1966; Johnson, 1967). If migrants present a greater amount of human capital per worker than the population left behind, then the stock of human capital per worker decreases. Both in the case of short-run adjustment costs and externalities, this fall generates a welfare loss. Bhagwati and Hamada (1974) exploit both features, introducing wage rigidities and education subsidies[4]. With respect to externalities, if the contribution of highly educated workers to social welfare goes beyond their private gains, as is often argued, skilled migration may involve a welfare loss (as actually happens in Lucas-type endogenous growth models such as those used in Miyagiwa (1991) and Wong and Yip (1999)).

A new wave of dynamic models raises the possibility of benefits from skilled migration for developing countries[5]. The most common argument is that migration does not leave the process of human capital formation unaltered. If the return to education is relatively low in the sending country, opening to migration will not only reduce human capital stock but also will increase the profitability of education acquisition for those left behind, encouraging the process of skill creation (incentive effect)[6]; as a result, a net brain gain may occur. Mountford (1997), for example, in an overlapping generations model, shows that opening a country to skilled migration produces an incentive to invest in education that, if large enough, may result in a rise in the human capital *ex-post* in the presence of uncertain emigration prospects (the main point is that some of those who invest in education to obtain the opportunity to migrate, remain in their country)[7]. Other examples of this kind of approach are found in Stark et al. (1998), Vidal (1998), Beine et al. (2001) and Stark and Wang (2002).

The incentive effect (brain gain) is a necessary condition for net brain gain, although it has to be large enough to compensate for the migration of more skilled workers (brain drain). The relevant question is, therefore, whether this incentive effect is strong enough. Figure 2 illustrates this[8]. The brain gain function is expected to have an inverted U (or hump shaped) profile with respect to skilled worker migration probability (see Schiff (2006) for a detailed explanation). A curve like BG_1 leads to the possibility of net brain gain (if migration rate is below p^*), while in a case like BG_2 net brain gain is impossible. According to Schiff (2006), this second case is more plausible. In this paper, we are interested in demonstrating whether or not the empirical evidence is in line with this statement.

[Figure 2 here]

Some of the assumptions present in this area of the literature seem to be critical. Firstly, it being the source country that decides the emigration prospects, is in sharp contrast with the evidence, which suggests that migration controls are in the hands of destination countries. Moreover, in these models, opening a country only implies increased emigration prospects for skilled workers, while the emigration prospects for individuals with secondary and primary education (and even non-educated) remains constant; cross-country data, however, suggests a strong correlation between them (for example, the correlation between the emigration rates of secondary and higher educated individuals in the Docquier and Marfouk (2006) dataset is roughly 0.75). Finally, it is assumed that migration prospects are exogenous, i.e. unaffected by size of skilled population residing in the country; nevertheless, Schiff (2006) proves that once migration probability is determined endogenously, the brain gain associated with a higher human capital stock will never compensate for the brain drain at the steady state[9].

Despite the fact that most of this literature is theoretical, there is an increasing number of empirical studies aimed at testing the incentive effect. Beine et al.

(2007) regress changes in human capital *ex-ante* against initial human capital, initial skilled emigration rate and other control variables in a cross section of countries and find evidence of the incentive effect. Checchi et al. (2007), however, find that skilled migration does not increase enrolment into secondary or higher education. However, as far as we know, there is no empirical work attempting to test the presence or absence of net brain gain, since, as we pointed out above, investigation has focused on the incentive effect[10].

Skilled worker migration also affects sending economies through other channels. One of which is worker remittances. It is not clear whether skilled migrants send more remittances to their home country than non-skilled migrants. Cinar and Docquier (2004), emphasize the positive effect of remittances in the case of liquidity constraints for education; in this case, a brain drain can enhance human capital in the country, if it reduces these limitations. However, other studies (e.g. Faini, 2003) show that when there is a high proportion of skilled individuals among emigrants, there is a low volume of remittances to the home country, hence, remittances cannot compensate for the negative effects of brain drain.

The formation of migrant networks creates FDI and trade linkages which help strengthen the gains from trade and the dissemination of knowledge, which ultimately spur growth in the sending economy. Networks or diaspora externalities emerge as a consequence of a reduction in transaction and other information costs associated with the commitment problem that is inherent in agency relationships. For example, in business-related services operating at distant locations, diaspora creates or replaces a weak international environment based on trust and punishment mechanisms that prevent opportunism and contract violation among individuals belonging to the same community. Moreover, information on market-related issues is easier to obtain in the presence of ethnic networks. For example, emigrants have more information on consumer preferences, product providers, regulatory regimes, and business ethics in both receiving and home countries, which in fact reduces transaction costs, facilitates exchange in goods and services and creates business opportunities.

Relevant references with respect to trade networks are Gould (1994), Rauch and Trindade (2002) and Rauch and Casella (2002), none of whom consider educated migrants separately from total migrants. Furthermore, there is an increasing number of studies evaluating the FDI network channel. For example, Tong (2005) uses a gravity model to explain bilateral investment as a result of the number of ethnic Chinese in 1990, Javorcik et al. (2006) find that the US FDI abroad between 1990 and 2000 is positively associated with the presence of skilled migrants from the receiving country and Kugler and Rapoport (2007) suggest that skilled migration is negatively correlated with US FDI inflows contemporaneously and positively correlated with future increases in FDI inflows. Surprisingly there is only one unpublished study reporting cross-country evidence that suggests a positive relationship between skilled migration and FDI (Docquier and Lodigiani, 2007).

In conclusion, the literature suggests several potential channels through which skilled migration can affect welfare and growth in sending countries; the most controversial of which is the effect on human capital, which is also likely to be the most important, but there are also other elements to take into consideration when evaluating the impact on welfare of human capital flight. Therefore, it is an empirical task to detect the sign and magnitude of each channel and the joint influence on growth.

3 Model and data

3.1 Model

In the previous section, we reviewed the main literature on the consequences of human capital flight for sending economies. As the reader will have noted, some of these are the channels through which the migration of skilled workers can affect the welfare of those left behind in their country of origin. In this paper we present evidence of most of these effects. The effect of brain drain on human capital has been addressed by the majority of the literature (it is probably the most relevant consequence of skilled migration), and we also give it special coverage; but we also attend to the other channels as far as data allows us to do so. In particular, we are in a position to fully analyze trade and FDI channels, and remittances to a lesser extent (due to lack of data). In this section we present the different models that we considered, focussing on their implications for, and relationship with, the previously described theoretical models.

Human capital

As we discussed above, the flight of skilled workers entails a brain drain (since those who emigrate do not remain in the country of origin) but they may also generate an incentive to those individuals left behind to invest in education (the so-called brain gain or incentive effect). The existing empirical literature has focused on testing the existence of these incentives, concentrating on the effect of brain drain on human capital *ex-ante* . However, as we highlighted in Figure 2, Schiff (2006) notes that it is important to focus on the sufficient condition for a positive effect, which is that the incentive effect has to be large enough to compensate for the drain. Therefore, welfare analysis should not examine the consequences of skilled worker migration on human capital *ex-ante*, but on human capital *ex-post*.

The parameter of interest in the present analysis is net brain gain. This net gain is the increase or fall in human capital *ex-post* that follows a marginal increase in the emigration probability of skilled workers. Therefore, it can be obtained as the derivative of the stock of human capital with respect to the probability to migrate (it could also be seen as an elasticity). However, it is important to mention a very sensitive issue: the incentive effect does not take place instantaneously, instead, it takes from three to five years to undertake higher education, whereas the drain effect is instantaneous. For that reason, we measure the brain drain/gain as the marginal effect of the emigration prospects on the rate of human capital five years after.

Our model, therefore, is the following:

$$\ln h_{i,1995} = \alpha_0 + \alpha_1 \ln bd_{i,1990} + \alpha_2 \left(\ln bd_{i,1990}\right)^2 + X'_{i,1995}\boldsymbol{\alpha} + \varepsilon_{i,1995} \tag{1}$$

where $h_{i,1995}$ is the share of skilled workers in the population in 1995, $bd_{i,1990}$ is the brain drain rate in 1990, $X_{i,1995}$ is a vector of exogenous determinants of human capital, and $\varepsilon_{i,1995}$ is the regression error with the classical assumptions. The following is our justification for choosing that particular model.

A dynamic specification is likely to have problems when estimating with a cross-section. If the error term followed equation (2),

$$\varepsilon_{i,1995} = \rho \ln h_{i,1990} + \eta_i + v_{i,1995}, \tag{2}$$

with $E\left[\eta_i \ln bd_{i,1990}\right] = 0$, then we might consider the following alternative convergence-like specification:

$$\ln h_{i,1995} - \ln h_{i,1990} = \alpha_0 + \alpha_1 \ln bd_{i,1990} + \alpha_2 \left(\ln bd_{i,1990}\right)^2 + X'_{i,1995}\boldsymbol{\alpha} + (\rho - 1)\ln h_{i,1990} + \eta_i + v_{i,1995} \tag{3}$$

with $\eta_i + v_{i,1995}$ being unobservable. The endogeneity of $h_{i,1990}$ due to fixed effects would contaminate the estimation of the vector $\tilde{\boldsymbol{\alpha}} = (\alpha_0, \alpha_1, \alpha_2, \boldsymbol{\alpha})$ of parameters, since fixed effects can obviously not be accounted for with a cross-section.

The most important issue, however, does not regard endogeneity but concerns the interpretation of $\tilde{\boldsymbol{\alpha}}$. A model like (3) would be appropriate for testing the incentive effect, but it is no longer valid for verifying the presence of net brain gain: the brain drain effect is mostly given by the effect of $bd_{i,1990}$ on $h_{i,1995}$ through $h_{i,1990}$ which is not accounted for in (3) since $\ln h_{i,1990}$ appears as a control variable; moreover, the dependent variable, $\ln h_{i,1995} - \ln h_{i,1990}$, is the variation of human capital *after* the drain, not including it.

Of course, $bd_{i,1990}$ could be partially induced by the underlying (especially fixed) determinants of human capital; therefore, we include control variables in (1) to capture this. In particular, in our preferred specification, we include the compulsory hours of school per year and the share of Muslims in the population. The former captures the opportunity cost of investing in education, which is very important especially in developing countries. The latter is included to capture the extent to which religious beliefs and moral issues influence family decisions regarding education. These variables are assumed to capture the fixed effect and brain drain is therefore assumed to be predetermined.

The purpose of (1) is to verify whether there may exist a net brain gain for some migration levels (i.e., whether we are in a BG_1 or BG_2 situation in Figure 2). Figure 3 illustrates the expected human capital versus brain drain schedule in each of the two cases[11].

[Figure 3 here]

Trade networks

The so-called trade network or diaspora effect reflects a reduction in transaction costs associated (mainly) with skilled migration, which ultimately increases the flow of goods and services with migrants' countries of origin. The specification of the trade channel is the following:

(4)

$$\ln \frac{X_{i,1995-2005} + M_{i,1995-2005}}{Y_{i,1995-2005}} = \beta_0 + \beta_1 \ln bd_{i,1990} + \beta_2 \ln m_{i,1990} + Z'_{i,1995-2005}\boldsymbol{\beta} + \nu_{i,1995-2005}$$

where $\frac{X_i+M_i}{Y_i}$ is the average ratio of exports plus imports over GDP for the 1995-2005 period, bd_i is the brain drain rate in 1990, $m_{i,1990}$ is the total emigration rate in the same year, $Z_{i,1995-2005}$ is a vector of exogenous international trade determinants, and $\nu_{i,1995-2005}$ is the regression error with classical assumptions. Brain drain is again assumed to be predetermined. The total emigration rate is included in some specifications to identify which part of the effect is due to overall ethnic links and to what extent do skilled migrants have a specific influence over this channel.

FDI networks

As in the case of trade, foreign direct investment inflows in the sending economy can be stimulated by the presence of outbound skilled migrants. Our specification is very similar to the former:

$$(5) \qquad \ln \frac{FDI\ stock_{i,1995}}{Y_{i,1995}} = \gamma_0 + \gamma_1 \ln bd_{i,1990} + \gamma_2 \ln m_{i,1990} + W'_{i,1995}\boldsymbol{\gamma} + \zeta_{i,1995}$$

where $\frac{FDI\ stock_{i,1995}}{Y_{i,1995}}$ is the foreign direct investment stock as a share of GDP and the remaining variables are analogous to those in (4). As in the previous case, brain drain is assumed to be predetermined and total emigration rate is included in some specifications for similar reasons.

Remittances

Remittances received from migrants have an impact on the incomes of their families and, indirectly, on the incomes of those who do not have emigrants in their families, due to the so-called multiplier effect. These private transfers increase welfare in sending economies, but may also have a more sustained effect if receiving families invest part of this income in physical or human capital. However, the behavior pattern of the sending unit is conditioned by its attributes (education, income, etc.) and to the strength of the ties with the country of origin. *A priori*, one suspects that more educated migrants earn and send more resources to the home economy; however this effect can be offset if skilled workers migrate for longer periods than unskilled workers and, as a result, break ties more easily with the home economy (taking families with them, for example). To estimate migrant contribution to the sending economy through this channel we propose the following specification:

$$(6) \quad rem_{i,1995-2005} = \delta_0 + \delta_1 \ln bd_{i,1990} + \delta_2 \ln m_{i,1990} + V'_{i,1995-2005}\boldsymbol{\delta} + \epsilon_{i,1995-2005}$$

where remittances, $rem_{i,1995-2005}$, are included as the average portion of GDP of migrant remittances for the period 1995-2004. The only one difference with previous models is that we have fewer observations with which to estimate this model.

Growth impact

In recent decades, an abundance of studies have tried to estimate the effect of human capital, trade openness and FDI on growth, and there is an increasing interest in estimating the impact of worker remittances on this variable. However, while growth theories reveal clear implications for each of these variables, empirical evidence at a macro level is less conclusive.

Our purpose is not to bring more evidence to this vast and controversial debate. However, this paper would not be complete if we omitted the last step in our research: the joint effect of all channels. The purpose of this analysis, therefore, is neither to find expected sign-significant parameters of each of the previous variables, nor to lose degrees of freedom by introducing multiple control variables in a growth regression, but to see whether the results in (1), (4) and (5) still hold when we estimate them jointly (with correlated shocks) and to see whether or not it is possible to estimate an overall effect. This joint estimate is important in order to account for correlated shocks to variables that may drive the results.

The model, therefore, consists of a system of equations that include the previously described channels and a growth equation, in which coefficients may be interpreted as if they were weights. For that reason, and because of the small number of observations available, we do not introduce many control variables into said equation; in contrast, we introduce either institutions (as is usually done in trade-growth regressions) or no controls. In summary, the last equation of the system is the following:

$$(7)\quad \Delta \ln y_i = \varphi_0 + \varphi_1 \ln h_i + \varphi_2 \ln trade_i + \varphi_3 \ln FDI_i + \varphi_4 \ln bd_i + \varphi_5 \ln m_i + S_i' \boldsymbol{\varphi} + \xi_i$$

where the dependent variable, $\Delta \ln y_{i,2005}$, is the annual growth rate of GDP per capita between 1995 and 2004; $trade_{i,1995-2005} \equiv \frac{X_{i,1995-2005}+M_{i,1995-2005}}{Y_{i,1995-2005}}$; $FDI_{i,1995} \equiv \frac{FDI\ stock_{i,1995}}{Y_{i,1995}}$; h, bd and m are interpreted as before; and $S_{i,1995-2005}$ is either an empty vector or a vector of control variables that include institutional quality or regional dummies (we have omitted temporal sub-indexes in the equation for reasons of space). Brain drain and total emigration rate are included to capture effects through channels not included in the system: remittances on the one hand and temporary migration and return migration on the other.

3.2 Data issues

In order to estimate the equations described in the previous subsection, we use a cross section of 94 countries[12]. The proxy of the probability of emigration for skilled workers is considered as the brain drain rate in 1990, i.e. the share of the population of the country aged above 25 years old and with more than 13 years of education living in the OECD in that year (see section 3.1 for more details on the choice of the different periods). This variable comes from Docquier and Marfouk (2006).

[Table 1 here]

The aforementioned economic variables affected by the brain drain phenomenon are human capital, trade, FDI, remittances and growth in GDP per capita. The first variable is measured as the share of the over-25 population with more than 13 years of education in 1995 and is taken from Barro and Lee (2000). The trade measure is average exports plus imports over GDP (in constant dollars) for the period 1995-2005 from Heston et al. (2006) (Penn World Table 6.2). FDI is introduced as the inward foreign direct investment stock in 1995 from UNCTAD (2007). Remittances are measured as the average worker remittances for the 90s, as a share of GDP in constant US$ (data from World Bank (2006) (World Development Indicators 2005).). Finally, growth in GDP per capita is the annual growth rate in output per capita for the 1995-2005 period from Heston et al. (2006).[13]

Before discussing the results, Table 1 presents the summary statistics for the variables. In order to facilitate the reader's interpretation, all variables have been included in a raw state i.e. without taking logarithms or any other transformation. It is worth mentioning that growth in GDP per capita has been included as a percentage whereas other variables are considered as rates; the reason for this apparent incoherence is to eliminate zeros from Table 6, and its impact is only on the scale of coefficients, but not in their relative magnitude, since we obviously do not take logarithms to GDP per capita growth rates. The main conclusion of Table 1 is that it appears there is enough variance among all the variables to identify the coefficients of the different equations from the previous subsection.

4 Results

Our estimation strategy follows two steps. On the one hand, we test the effect of skilled migration on each of the variables described above and on the other, we simultaneously estimated individual channels together with a growth equation, taking into account that skilled migration might impact on growth either directly through unobserved channels or indirectly through the measured channels.

4.1 Individual channels

The most important effect of skilled migration on the sending economy is on human capital. We estimate equation (1) by OLS for different specifications and samples. Table 2 presents the results. The specification in column 1 is the basic; column 2 includes a quadratic brain drain term; the specification in column 3 adds education expenditure (in logs), but the number of observations falls to 81; column 4 is the basic specification with a dummy for Sub-Saharan countries, and finally columns 5 and 6 report estimates for the basic and quadratic specifications for the developing country sample.

[Table 2 here]

Initial brain drain rates are negatively associated with human capital *ex-post* in all the specifications and samples, with elasticities ranging from -0.358 to -

0.256. This strong and very significant brain drain effect is better fitted with a quadratic term, suggesting that the linear effect is even stronger, (-0.875) but its marginal contribution decreases with the brain drain rate (-0.101). Results are stable when expenditure is included and fall with the inclusion of the Sub-Saharan Africa dummy. Both control variables, the portion of Muslims in the population and the compulsory hours of schooling are negatively correlated with human capital, as expected.

This result is not at odds with the results of Beine et al. (2007). Their findings suggest that there is an incentive effect since brain drain appears to increase subsequent *ex-ante* human capital. Our results suggest that this potential increase is not large enough to compensate for the drain, and that the net effect is negative[14]. Therefore, coming back to Figures 2 and 3, we are in a situation similar to h_2. Figure 4 plots, on the left chart, the estimated brain drain-human capital schedule, and confirms that statement[15].

[Figure 4 here]

The right-hand chart presents the estimated elasticities for the sample countries and corresponding brain drain distribution. As can be seen, elasticities are always negative for the whole distribution (notice that the decreasing slope of that curve is due to the choice of a hump-shaped instead of an inverted-U form).

To obtain a functional form more similar to the suggested in Figures 2 and 3, we also assessed the effect of brain drain on human capital *ex-post* allowing for a quadratic form (including brain drain rates without logs) shown in Figure 5[16]. The pattern, however, seems to be linear (presenting a very small non-significant concavity). Nevertheless, its shape decreases over the whole rank, meaning that the drain is dominating the incentive effect for all levels of brain drain, as in the h_2 curve in Figure 3. With respect to elasticities, results should not be taken into account for rates above 80%, since human capital appears to be negative (though not significantly different from zero)[17].

[Figure 5 here]

Table 3 represents the results of OLS regression equation (4) which analyzes the trade channel. The basic specification is in column 1, column 2 includes total migration, GDP per capita is added in column 3, and a regional dummy in column 4. Columns 5 and 6 are the first two specifications for the developing country sample. Results suggest that brain drain significantly favors openness in sending economies, and this effect is even greater when total migration is included in the specification. Estimated elasticities range from 0.097 to 0.263. Moreover, total emigration rate tends to be negatively correlated with openness, but it is only significant in one specification (column 3). When adding income as a control variable (column 3), the brain drain effect on trade doubles. Finally, when we restrict the sample to developing economies, the elasticity of the trade to skilled emigration rate results insignificant, however, it continues to be positive.

[Table 3 here]

Table 4 presents OLS estimation results for the FDI channel (equation (5)). The first specification (column 1) is the basic, and from column 2 to 4, total emigration rate is included as an additional regressor. Moreover, the specification in column 3 includes a variable of natural resource abundance and in column 4 we omit the lagged dependent variable to test the robustness of results. The two final columns are estimates of the first two specifications restricted for the developing country sample. The major findings can be summarized as follows: the migration of skilled workers has a positive and significant effect on FDI inflows to the sending economies in all specifications and samples. Elasticities are in a range from 0.126 to 0.439, becoming higher when we omit lagged FDI stock. The effect of total migration on FDI is negative and significant in two out of six columns, and when we include it as a regressor, the elasticity of the brain drain rate is higher.

[Table 4 here]

Finally, Table 5 gives the OLS results of the remittances channel represented in equation (6). In this case, we just present two specifications for the two samples considered, as the sample size considerably reduces the degrees of freedom. In columns 1 and 3 we simply include the basic specification and in columns 2 and 4 we separate the effect of skilled migration from the total migration effect. Our findings reveal that brain drain fosters remittance flow to sending economies, but when we include total migration, this variable absorbs all of the above effect making the effect of the brain drain virtually zero.

[Table 5 here]

To summarize, the brain drain appears to have a negative impact on human capital levels in the countries of origin of emigrants, meaning that incentives to acquire higher education among non-migrant individuals that remain in their country do not compensate for the loss of skilled migration after five years. On the other hand, trade and FDI linkages seem to be stimulated by skilled migrants in a similar way. However, total migration operates in the opposite direction, reducing both trade and FDI inflows (in the case of trade, it could be interpreted as evidence of a substitution between trade and unskilled migration, as suggested by traditional trade models, and of complementarity with skilled migration). Finally, skilled migrants do not make a different contribution to remittances than their unskilled counterparts.

4.2 Joint estimation

A further step in our estimation strategy is to check whether parameters estimated in the individual equations are robust enough to withstand the simultaneous shocks in the different variables through which migration affects growth. Moreover, we try to obtain an estimate of the overall effect of brain drain. We obtain these results with the regression of the system of equations formed by (1), (4), (5) and (7) by 3SLS [18].

[Table 6 here]

Table 6 presents the results for three different specifications for each of the two samples to observe parameters' stability when we modify basic specifications. In particular, maintaining the quadratic specification for the human capital channel (Table 2, column 2), the basic trade specification with and without total migration (Table 3 , columns 1 and 2) and the basic FDI specification with and without total migration (Table 4, columns 1 and 2), but excluding an irrelevant variable (exchange rate volatility). For the growth equation, we do not present a very exhaustive specification since it is not the aim of this paper. Instead, we simply present a growth equation that captures the channels studied, brain drain rate, total emigration rate and a measure of institutional quality which is widely used in cross-country growth regressions.

The first and fourth columns display the system estimate excluding total migration from all the equations in both samples. Results are in a similar range to the individual estimation coefficients. Moreover, direct and indirect effects on growth, though positive, are not significant. It is worthy of note, however, that point estimates of the direct effect are positive in the wider sample and negative when high income OECD countries are excluded.

In the second and fifth columns, we added total migration in the network channels and in the growth equation. Now, the brain drain coefficient is negative and the total emigration rate presents a positive effect, but of a lesser magnitude. In the third and sixth specifications we added the institutional quality variable. In line with the literature, the effect of institutions is positive and significant, the brain drain effect being positive (and insignificant) in both samples. Once again, the parameters of the different channel specifications remain quite stable when institutions are controlled for.

[Figure 6 here]

Unfortunately the joint estimate does not shed any light on the net aggregate affect of brain drain: positive effects are offset by negative effects to an inaccurate level. The problem, however, is that the coefficients of human capital, trade and FDI are not precisely estimated, as usually happens in the literature; the impact of each of these variables is itself controversial, but this is an area of study that we do not wish to approach in this paper. Of course, all these variables are important in explaining economic growth, as theoretical models suggest, but the empirical evidence is not conclusive.

Figure 6 documents the difficulty of providing a sign for the global effect. Therefore, we should retain the idea that brain drain damages economies through a reduction of human capital *ex-post*, and benefits them through the creation of business linkages, whatever the effect of those variables on GDP per capita growth is.

[Table 7 here]

Given the broad sample heterogeneity and the cross-sectional nature of the data, we explore the system estimation from a regional perspective, interacting brain drain with regional dummies (Table 7). Each column represents the benchmark model specification including dummies and interactions for each of the six regional areas. Brain drain coefficients appear to be very stable across specifications, especially in the human capital equation, in which none of the interacted terms differs significantly from zero. Except for the case of trade in Sub-Saharan Africa, all linear coefficients are within one standard deviation of the respective coefficient in Table 6, column 1. Brain drain seems to have a more positive effect on trade in East Asia and the Pacific and is virtually zero in Sub-Saharan Africa; on the other hand, the effect on FDI is negative in Europe and Central Asia, and very positive in the Middle East and North Africa.

5 Conclusion

This paper takes some steps towards understanding the consequences of cross-country variations in brain drain rates on migrants' home economies. It provides empirical evidence on the consequences of brain drain on sending economies; in particular, it analyzes the effect of skilled worker migration on human capital, trade, FDI, remittances and growth.

Human capital stock (*ex-post*) appears to be reduced as a consequence of increased skilled emigration rates; brain drain predominates over brain gain, at least during the period studied. This result is compatible with Beine et al. (2007) findings which suggest that skilled migration generates significant incentives to acquire higher education, and it reconciles that evidence with Schiff (2006), who argues that net brain gain has been greatly exaggerated.

Furthermore, estimates show that increasing the fraction of skilled individuals living in the OECD area increases the volume of goods and services that sending countries trade with the rest of the world. However, countries reduce trade volumes when total emigration rates increase. The combination of both results suggests that the migration of skilled workers is complementary to trade (as has recently been suggested) while unskilled migration is a substitute (as predicted by traditional trade models).

Similarly to the effect on trade, FDI inflows to home economies increase as a result of a rise in skilled migration, while again, total migration seems to moderate these. The results are closely related to those already existing in the literature.

Regression analysis indicates that a significant share of skilled workers in migrant stock has an imperceptible impact on the amount of received remittances compared to unskilled migrants. This result seems to support the view that the family ties of migrants tend to be reduced equally, whether they migrate permanently or whether they are able to reunite the family in the receiving country; this reduction should imply a cut in remittance flow irrespective of the educational level of migrants.

Finally, estimates of the growth effect of skilled migration show that individual channels remain robust in the face of joint estimation, and that there are positive and negative implications. However, estimations of the growth equation are not very precise and do not allow rejection of the hypothesis that the overall effect is null. This low level of precision is likely the result of existing controversies concerning the scale of the effect of human capital, trade and FDI on GDP per capita growth.

To sum up, this paper emphasizes the importance of analyzing all channels through which brain drain acts before policies are implemented. We find both positive and negative effects, and the overall result is, *a priori*, undetermined. Moreover, further research should be done on human capital, trade and FDI literatures to extract direct policy implications. Finally, it is important to mention that, despite the great improvement in data quality, thanks to the Docquier and Marfouk (2006) dataset, there are still important measurement issues that could introduce bias into estimation. For example, the recorded level of education is the current level of education instead of the level at the time of entry. Moreover, this data only includes OECD immigrants.

Notes

[1]Developed regions display lower rates (Europe: 26 per cent; North America: 20 per cent and Oceania: 24.5 per cent).

[2]Brain drain rates at country level represent the number of skilled migrants aged over 25 who are residing in the OECD area, as a share of the total amount of skilled individuals from that country, including those who migrated (see Docquier and Marfouk (2006) for a detailed description).

[3]World Bank (2006) reports that official remittances amounted $232 billion in 2005 and that 72 per cent of these private transfers were wired to developing countries.

[4]If education is publicly funded, maintaining a human capital stock level after the migration of skilled workers requires extra public expenditure and extra taxes for those individuals that remain in the country. For that reason, Bhagwati and Wilson (1989) suggest taxing migrant income abroad to repay society for what they have been given.

[5]Docquier and Rapoport (2004) summarize the traditional and new models in a unified analytical framework. Commander et al. (2004) and Schiff (2006) are alternative surveys.

[6]This increase is due to a change in the skill premia in the country since higher emigration prospects increase the expected gain from the education-to-emigrate option.

[7]Similar results can be obtained using other arguments. See for example, Stark et al. (1997), who argue that brain gain may also occur in the case of temporary migration with imperfect

information.

[8]Taken from Schiff (2006), Figure 1.

[9]This result holds irrespective of whether the net brain gain is positive or negative in the transition.

[10]In fact, Beine et al. (2007) do some counterfactual simulations for country-specific net brain gain based on their estimation of the incentive effect.

[11]Note that the presence of logs changes the inverted U shape into a hump-shaped profile; we also come back to this point in the next section.

[12]The countries are: Algeria; Argentina; Australia*; Austria*; Bangladesh; Barbados; Belgium*; Benin; Bolivia; Botswana; Brazil; Cameroon; Canada*; Central African Republic; Chile; China; Colombia; Congo, Dem. Rep.; Congo, Rep.; Costa Rica; Cyprus; Denmark*; Dominican Republic; Ecuador; Egypt, Arab Rep.; El Salvador; Fiji; Finland*; France*; Gambia, The; Germany*; Ghana; Greece*; Guatemala; Honduras; Hungary; Iceland*; India; Indonesia; Iran, Islamic Rep.; Ireland*; Israel; Italy*; Jamaica; Japan*; Jordan; Kenya; Korea, Rep.*; Kuwait; Lesotho; Liberia; Malawi; Malaysia; Mali; Mauritius; Mexico; Mozambique; Nepal; Netherlands*; New Zealand*; Nicaragua; Niger; Norway*; Pakistan; Panama; Papua New Guinea; Paraguay; Peru; Philippines; Poland; Portugal*; Rwanda; Senegal; Singapore; South Africa; Spain*; Sri Lanka; Swaziland; Sweden*; Switzerland*; Syrian Arab Republic; Taiwan; Thailand; Togo; Trinidad and Tobago; Tunisia; Turkey; Uganda; United Kingdom*; United States*; Uruguay; Venezuela, RB.; Zambia; Zimbabwe. Countries with a * are excluded from developing country sample.

[13]The sources of the control variables are: Share of Muslims: own design using data from Alesina et al. (2003) ; Compulsory hours of schooling per year: Barro and Lee (2001); Total emigration rate: Docquier and Marfouk (2006); Frankel and Romer instrument: own design following the procedure of Frankel and Romer (1999); GDP per capita in 1995: Heston et al. (2006); Coefficient of variation of the exchange rate: own design with World Bank (2006); Education expenditure, Area and Natural resources exports: World Bank (2006); Religious and linguistic fractionalization: Alesina et al. (2003); Institutions: Kaufmann et al. (2006)

[14]In fact, the obtained pattern, shown in Figure 4 only contradicts the counterfactual simulations of Beine et al. (2007) which suggest a positive net brain gain for low rates of skilled migration.

[15]Note that the hypothesis that human capital stock is zero when brain drain equals 100% can not be rejected at 10%.

[16]Regression results are available upon request from the authors.

[17]Nevertheless, as in the previous case, it can not be rejected that the curve crosses the horizontal axis at $bd = 1$. Moreover, it should be noted that there are few observations in that range.

[18]We do not include remittances due to the loss of observations.

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Appendix: Tables and Figures

Table 1: Summary statistics

Variable	Mean	Std. Dev.	Min.	Max.	N
bd_{90}	0.167	0.182	0.002	0.851	94
h_{95}	0.102	0.093	0.001	0.487	94
$\frac{1}{10}\sum_{t=95}^{04}\frac{X_t+M_t}{Y_t}$	0.783	0.495	0.122	3.811	94
$\frac{1}{10}\sum_{t=95}^{04}\frac{FDI\ stock_t}{Y_t}$	0.384	2.052	0	20.011	94
$\frac{1}{10}\sum_{t=95}^{04}\frac{rem_t}{Y_t}$	0.854	1.354	0.009	7.600	61
$\Delta \ln y$	1.92	2.09	-5.22	8.71	94
$Share\ of\ muslims$	0.139	0.237	0	0.693	94
$Comp.\ sch.\ h./year$	989	130	666	1,600	94
$Edu.\ expend._{90s}$	0.041	0.017	0.01	0.081	81
m_{90}	0.044	0.063	0	0.322	94
$F\&R\ instr.$	0.058	0.034	0.012	0.163	94
$GDPpc_{95}$	9,334	8,587	171	30,559	94
$\frac{\sigma(e_{85/94})}{\mu(e_{85/94})}$	0.889	0.948	0	5.175	94
$Area$ (1000s)	931	2,044	0.43	9,971	94
$\frac{1}{10}\sum_{t=85}^{94}\frac{FDI\ stock_t}{Y_t}$	0.224	0.756	0.002	7.229	94
$Natural\ resources\ exports$	0.131	0.12	0.006	0.728	86
$Institutions$	0.094	0.707	-1.6	1.36	94
$Rel.\ fractionalization$	0.431	0.243	0.005	0.86	94
$Ling.\ fractionalization$	0.367	0.305	0	0.923	94
$Latitude$	25.31	17.06	0	64	94
$Eastern\ Asia\ \&\ Pacific$	0.138	0.347	0	1	94
$Europe\ and\ Central\ Asia$	0.223	0.419	0	1	94
$Latin\ Amer.\ and\ Caribbean$	0.223	0.419	0	1	94
$Mid.\ East\ \&\ Northern\ Africa$	0.085	0.281	0	1	94
$SubSaharan\ Africa$	0.255	0.438	0	1	94
$OECD$	0.245	0.432	0	1	94

Table 2: Brain drain and human capital. Dependent variable: $\ln h_{i,1995}$

	(1)	(2)	(3)	(4)	(5)	(6)
$\ln bd_{90}$	-0.350***	-0.875***	-0.358***	-0.256***	-0.260**	-0.721**
	(0.114)	(0.308)	(0.132)	(0.073)	(0.117)	(0.348)
$\ln^2 bd_{90}$		-0.101*				-0.091
		(0.053)				(0.054)
Share of muslims	-1.817***	-1.878***	-1.599***	-1.416***	-1.177*	-1.264**
	(0.555)	(0.533)	(0.528)	(0.344)	(0.595)	(0.580)
Comp. sch. h./year	-0.002***	-0.002**	-0.002 **	-0.001	-0.003***	-0.002***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
$\ln Edu.\ expend._{90s}$			0.756***			
			(0.240)			
SubSaharian Afr.				-1.941***		
				(0.205)		
Constant	-1.049	-2.002*	1.427	-1.804**	-0.923	-1.685
	(0.839)	(1.023)	(1.294)	(0.767)	(0.847)	(1.085)
Obs.	94	94	81	94	71	71
$\bar{R}^2$	0.23	0.24	0.24	0.65	0.15	0.16

Robust standard errors in parentheses. Significance levels: * 10%** 5% *** 1%. Columns (1) to (4) use all available observations and columns (5) and (6) exclude high income OECD countries. All equations are estimated by OLS.

Table 3: Brain drain and trade. Dependent variable: $\ln(\frac{1}{10}\sum_{t=95}^{04}\frac{(X_t+M_t)}{Y_t})$

	(1)	(2)	(3)	(4)	(5)	(6)
$\ln bd_{90}$	0.126**	0.129**	0.263***	0.129**	0.099	0.097
	(0.060)	(0.064)	(0.082)	(0.064)	(0.068)	(0.082)
$\ln m_{90}$		-0.003	-0.115*	-0.002		0.002
		(0.044)	(0.065)	(0.042)		(0.051)
$\ln F\&R\ instr.$	0.397***	0.398***	0.356***	0.415***	0.443***	0.443***
	(0.087)	(0.092)	(0.083)	(0.087)	(0.115)	(0.117)
$\ln GDPpc_{95}$			0.156**			
			(0.062)			
East. Asia & Pacif.				0.390**		
				(0.153)		
Constant	1.104***	1.102***	-0.510	1.103***	1.207***	1.208***
	(0.239)	(0.240)	(0.622)	(0.221)	(0.327)	(0.331)
Obs.	94	94	94	94	71	71
$\bar{R}^2$	0.32	0.31	0.35	0.37	0.29	0.28

Robust standard errors in parentheses. Significance levels: * 10%** 5% *** 1%. Columns (1) to (4) use all available observations and columns (5) and (6) exclude high income OECD countries. All equations are estimated by OLS.

Table 4: Brain drain and FDI. Dependent variable: $\ln(\frac{1}{10}\sum_{t=95}^{04}\frac{FDI\ stock_t}{Y_t})$

	(1)	(2)	(3)	(4)	(5)	(6)
$\ln bd_{90}$	0.126*	0.192**	0.285**	0.439*	0.168*	0.256**
	(0.071)	(0.075)	(0.121)	(0.242)	(0.092)	(0.099)
$\ln m_{90}$		-0.084*	-0.090	-0.033		-0.103*
		(0.048)	(0.066)	(0.100)		(0.058)
$\ln(\frac{1}{10}\sum_{t=85}^{94}\frac{FDI\ stock_t}{Y_t})$	0.886***	0.891***	0.913***		0.893***	0.894***
	(0.088)	(0.084)	(0.084)		(0.106)	(0.102)
$\frac{\sigma(e_{85/94})}{\mu(e_{85/94})}$	-0.044	-0.057	-0.097	-0.231**	-0.051	-0.037
	(0.065)	(0.068)	(0.069)	(0.115)	(0.079)	(0.085)
$\ln Area$	0.072*	0.068*	0.095**	0.084	0.086*	0.072
	(0.041)	(0.039)	(0.043)	(0.127)	(0.050)	(0.048)
Nat. res. exports			-0.861			
			(0.985)			
Constant	-0.552	-0.660**	-0.637*	-2.081**	-0.589	-0.679*
	(0.335)	(0.326)	(0.335)	(1.045)	(0.394)	(0.383)
Obs.	94	94	86	94	71	71
$\bar{R}^2$	0.80	0.80	0.81	0.07	0.78	0.79

Robust standard errors in parentheses. Significance levels: * 10%** 5% *** 1%. Columns (1) to (4) use all available observations and columns (5) and (6) exclude high income OECD countries. All equations are estimated by OLS.

Table 5: Brain drain and remittances. Dependent variable: $\frac{1}{10}\sum_{t=95}^{04}\frac{rem_t}{Y_t}$

	(1)	(2)	(3)	(4)
$\ln bd_{90}$	0.476**	-0.076	0.405*	-0.044
	(0.202)	(0.310)	(0.220)	(0.328)
$\ln m_{90}$		0.506**		0.452**
		(0.208)		(0.212)
$\ln Black\ mkt.\ pr._{95/04}$	-0.231***	-0.067	-0.177***	-0.054
	(0.066)	(0.083)	(0.046)	(0.075)
$\ln PPP_{95/04}$	-0.066	-0.820**	0.434	-0.447
	(0.186)	(0.385)	(0.430)	(0.500)
Constant	2.000***	2.083***	2.387***	2.338***
	(0.647)	(0.644)	(0.856)	(0.858)
Obs.	57	57	45	45
$\bar{R}^2$	0.07	0.14	0.04	0.09

Robust standard errors in parentheses. Significance levels: * 10%** 5% *** 1%. Columns (1) and (2) use all available observations and columns (3) and (4) exclude high income OECD countries. All equations are estimated by OLS.

Table 6: Estimation of the system of equations

	(1)	(2)	(3)	(4)	(5)	(6)
			Human capital			
$\ln bd_{90}$	-0.902***	-0.941***	-0.966***	-0.764**	-0.782**	-0.849**
	(0.309)	(0.315)	(0.305)	(0.338)	(0.344)	(0.336)
$\ln^2 bd_{90}$	-0.106*	-0.113**	-0.112**	-0.099	-0.103	-0.109*
	(0.056)	(0.057)	(0.055)	(0.062)	(0.063)	(0.062)
$Share\ of\ muslims$	-2.033***	-1.919***	-1.944***	-1.411***	-1.286**	-1.474***
	(0.462)	(0.472)	(0.456)	(0.501)	(0.512)	(0.498)
$Comp.\ sch.\ h./year$	-0.002**	-0.002**	-0.002**	-0.002**	-0.002**	-0.002**
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
$Constant$	-1.964*	-2.020*	-2.198**	-1.612	-1.708	-1.939*
	(1.027)	(1.048)	(1.011)	(1.120)	(1.143)	(1.113)
			Trade			
$\ln bd_{90}$	0.129***	0.155***	0.108***	0.102**	0.128*	0.072
	(0.043)	(0.053)	(0.039)	(0.052)	(0.070)	(0.047)
$\ln m_{90}$		-0.033			-0.029	
		(0.041)			(0.052)	
$\ln F\&R\ instr.$	0.378***	0.396***	0.318***	0.417***	0.433***	0.317***
	(0.073)	(0.076)	(0.067)	(0.092)	(0.095)	(0.083)
$Constant$	1.052***	1.034***	0.821***	1.132***	1.115***	0.753***
	(0.227)	(0.228)	(0.208)	(0.293)	(0.297)	(0.265)
			FDI			
$\ln bd_{90}$	0.104*	0.145**	0.107*	0.146**	0.228**	0.147**
	(0.060)	(0.070)	(0.060)	(0.072)	(0.090)	(0.072)
$\ln m_{90}$		-0.048			-0.084	
		(0.048)			(0.063)	
$\ln(\frac{1}{10}\sum_{t=85}^{94}\frac{FDI\ stock_t}{Y_t})$	0.893***	0.897***	0.893***	0.898***	0.900***	0.897***
	(0.047)	(0.047)	(0.046)	(0.057)	(0.057)	(0.057)
$\ln Area$	0.053	0.055*	0.056*	0.059	0.061	0.053
	(0.032)	(0.033)	(0.032)	(0.038)	(0.038)	(0.038)
$Constant$	-0.388	-0.498	-0.421	-0.345	-0.550	-0.279
	(0.364)	(0.368)	(0.364)	(0.428)	(0.431)	(0.428)
			GDP per capita growth			
$\ln h_{95}$	0.057	-0.811	-0.289	-0.227	-0.909	-0.586
	(0.323)	(0.792)	(0.383)	(0.400)	(0.731)	(0.364)
$\ln(\frac{1}{10}\sum_{t=95}^{04}\frac{(X_t+M_t)}{Y_t})$	0.535	0.281	-0.477	0.885	0.686	-1.167
	(0.664)	(0.661)	(0.704)	(0.763)	(0.756)	(0.999)
$\ln(\frac{1}{10}\sum_{t=95}^{04}\frac{FDI\ stock_t}{Y_t})$	0.304	0.364*	0.322	0.251	0.320	0.398
	(0.215)	(0.214)	(0.205)	(0.249)	(0.253)	(0.249)
$\ln bd_{90}$	0.070	-0.757	0.204	-0.026	-0.733	0.003
	(0.263)	(0.914)	(0.225)	(0.296)	(0.923)	(0.261)
$\ln m_{90}$		0.641			0.547	
		(0.725)			(0.711)	
$Institutions$			1.483**			2.922**
			(0.617)			(1.149)
$Constant$	3.107**	1.341	1.935	1.870	0.551	0.863
	(1.298)	(1.577)	(1.442)	(1.637)	(1.537)	(1.410)
$Obs.$	94	94	94	71	71	71

Standard errors in parentheses. Significance levels: * 10%** 5% *** 1%. Columns (1) to (3) use all available observations and columns (4) to (6) exclude high income OECD countries. All equations are estimated by 3SLS. In equations (3) and (6), *Institutions* variable has been instrumented with religious and linguistic fractionalization, and latitude.

Table 7: Regional effects

	Eastern Asia & the Pacific	Europe & Central Asia	Latin America & the Caribbean	Middle East & Northern Africa	Sub-Saharan Africa	High income OECD
Human capital						
$\ln bd_{90}$	-0.887***	-0.826***	-1.160***	-0.776***	-0.665**	-0.849***
	(0.314)	(0.309)	(0.354)	(0.288)	(0.300)	(0.300)
$\ln^2 bd_{90}$	-0.095*	-0.085	-0.135**	-0.088*	-0.096	-0.115**
	(0.056)	(0.055)	(0.061)	(0.052)	(0.059)	(0.055)
$\ln bd_{90} * R$	-0.114	1.081	0.251	-2.54	-0.021	0.977
	(1.191)	(1.980)	(0.808)	(3.393)	(0.444)	(1.001)
$\ln^2 bd_{90} * R$	-0.085	0.168	-0.049	-0.494	0.043	0.182
	(0.236)	(0.424)	(0.186)	(0.689)	(0.077)	(0.163)
Trade						
$\ln bd_{90}$	0.084*	0.125***	0.124***	0.130***	0.225***	0.107**
	(0.043)	(0.045)	(0.048)	(0.044)	(0.051)	(0.048)
$\ln bd_{90} * R$	0.277***	0.007	0.051	-0.149	-0.284***	0.09
	(0.105)	(0.148)	(0.106)	(0.254)	(0.087)	(0.108)
FDI						
$\ln bd_{90}$	0.132**	0.154**	0.100	0.090	0.072	0.140**
	(0.065)	(0.062)	(0.067)	(0.061)	(0.083)	(0.066)
$\ln bd_{90} * R$	-0.160	-0.459***	0.123	0.626**	0.084	-0.204
	(0.141)	(0.177)	(0.137)	(0.309)	(0.122)	(0.131)
Obs.	94	94	94	94	94	94

Standard errors in parentheses. Significance levels: * 10%** 5% *** 1%. All equations are estimated by 3SLS. The variable R represents a dummy for the correspondent region. The dummy has also been included directly in the equations. Control variables of Column 1, Table 6 included in estimation. Growth equation omitted due to space reasons

Figure 1: Brain drain rates by regions (2000)

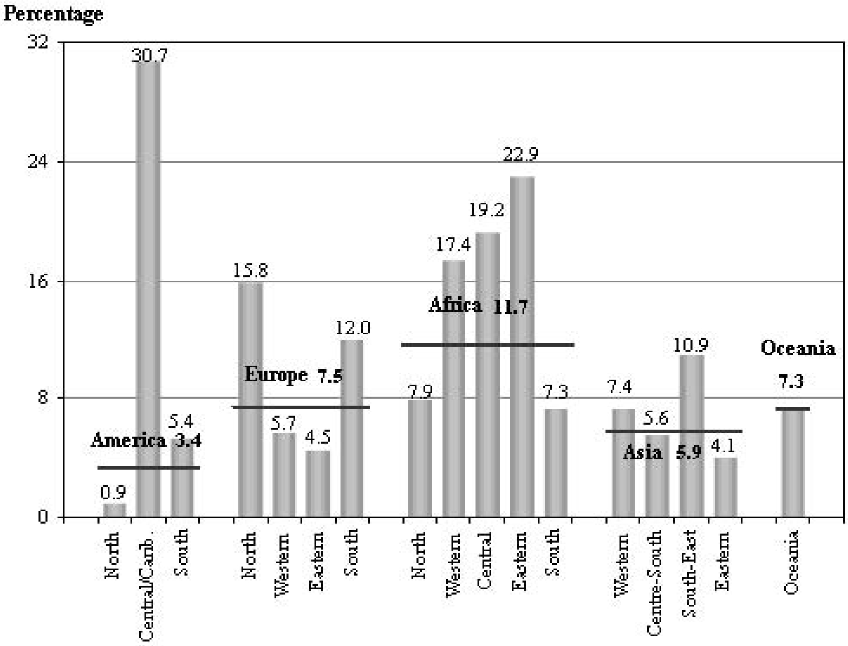

Figure 2: Brain Grain (BG), Brain Drain (BD) and Net Brain Gain (NBG = BG-BD).

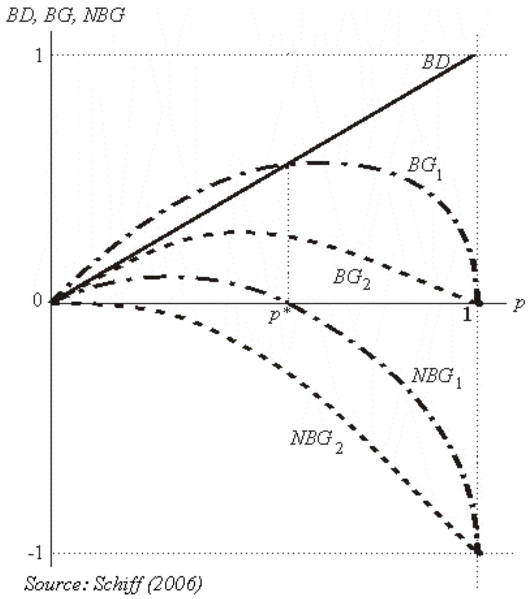

Figure 3: Human capital profile in each case of Figure 2

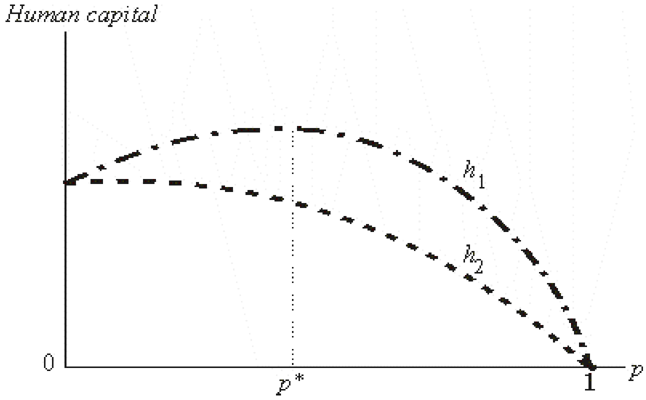

Figure 4: The effect of brain drain on human capital I (quadratic polynomial of logs)

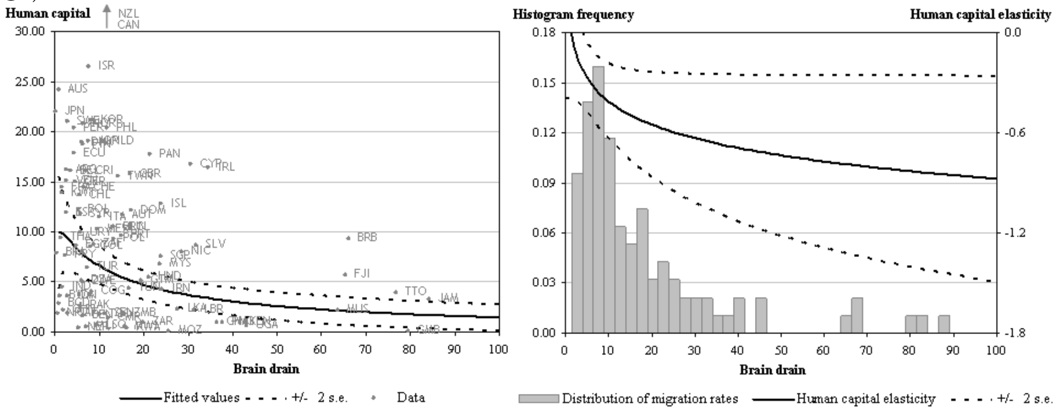

Figure 5: The effect of brain drain on human capital II (quadratic polynomial without logs)

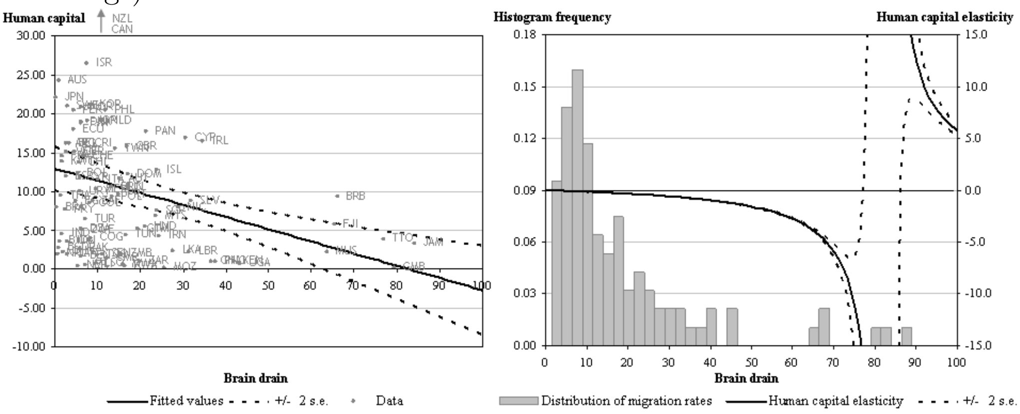

Figure 6: Overall effect for each level of brain drain