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ABSTRACT

Brain Drain and Inequality Across Nations*

Is the brain drain a curse or a boon for developing countries? This paper reviews what is known to date about the magnitude of the brain drain from developing to developed countries, its determinants and the way it affects the well-being of those left behind. First, I present alternative measures of the brain drain and characterize its evolution over the last 25 years. Then, I review the theoretical and empirical literature. Although the brain drain is a major source of concern for origin countries, it also induces positive effects through various channels such as remittances, return migration, diaspora externalities, quality of governance and increasing return to education. Whilst many scientists and international institutions praise the unambiguous benefits of unskilled migration for developing countries, my analysis suggests that a limited but positive skilled emigration rate (say between 5 and 10 percent) can also be good for development. Nevertheless, the current spatial distribution of the brain drain is such that many poor countries are well above this level, such as sub-Saharan African and Central American countries.

JEL Classification: F22, J61

Keywords: brain drain, international migration, human capital, economic development

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1. Introduction

International migration is a diverse phenomenon and its impact on countries of origin and destination has attracted the increased attention of policymakers, scientists and international agencies. The migration pressure has increased over the last years and is expected to intensify in the coming decades given the rising gap in wages and the differing demographic futures in developed and developing countries. Understanding and measuring the consequences for migrants, host countries' residents and those left behind is a major and complex task.

This piece of analysis tackles the migration issue from two particular angles. First, it focuses on the implications for sending countries (typically developing countries). A large strand of literature analyzes the effects of migration on welfare in host countries and on the attitude towards migrants. On the contrary, my main objective is to design policy recommendations that increase the well-being of the world's poorest, although the current state of knowledge inclines me to be as cautious as possible.

Second, it focuses on the very controversial issue of skilled migration. Many recent studies present unskilled migration as generating huge gains for migrants, their families and the sending countries. Indeed, by relaxing labor market constraints at origin and inducing large amounts of remittances, there is little doubt that unskilled migration should be seen as an explicit component of the development policy of the rich world[2]. On the contrary, the emigration of skilled workers is usually blamed for depriving developing countries of one of their scarcest resources, human capital. Although many studies emphasized positive feedback effects of the brain drain (in the form of remittances, return migration, diaspora externalities, quality of governance and increasing return to education), international agencies and many scientists often turned a deaf ear to these effects and considered them as negligible.

Until recently and despite many anecdotal evidence, nobody was able to estimate the cost of the brain drain and the size of its feedback effects for sending countries. The reason is that there was no reliable data set documenting the brain drain for a large set of countries and for different years. The debate remained essentially theoretical. Fortunately, it is today possible to have a more accurate vision of the size and intensity of the brain drain thanks to new harmonized and original data sets on migration stocks and rates by educational attainment.

[2] The Commitment to Development Index (CDI) computed by the Center for Global Development, an independent American think tank that works to reduce global poverty and inequality, rewards immigration of unskilled people. See http://www.cgdev.org. See also the 2006 version of the World Bank's global Economic Prospects devoted to international migration.

The purpose of my paper is to offer a comprehensive and accurate picture of the brain drain and to provide an updated survey of existing empirical and theoretical studies. My analysis offers mitigated view of the consequences of skilled emigration on sending countries, with conclusions and policy recommendations sometimes in opposition to general preconceived ideas. Let me give three examples:

i. Many argued that the rise in the international mobility of labor has been small compared to the extraordinary increase in trade, foreign investment and communication. Pritchett (2006) recently talked about the "globalization of everything but labor". Data show that the evolution of the proportion of international immigrants residing in the more developed countries is very similar to the change in trade. An increasing proportion of these migrants originates from developing countries. Hence, south-north migration is an essential component of globalization.

ii. The educational structure of international migration is more and more skill-biased. Many believe that this structural change contributed to increasing the brain drain from developing countries, what they consider as a by-product of increasingly selective immigration policies conducted in the major immigration countries. My analysis reveals that the increasing number of skilled migrants is also strongly related to increasing demographic sizes and drastic rises in educational attainment in developing countries. In relative terms, the average brain drain remained very stable over the last three decades.

iii. By depriving the sending country of one of its scarcest resources (i.e. human capital), skilled migration is seen as impoverishing sending countries whereas receiving countries make handsome profits. Many think that eliminating the brain drain would reduce inequality across nations. My analysis reveals that a limited, but positive rate of skilled migration (say between 5 and 10 percent of the native skilled labor force) is very likely to be beneficial for both sending and receiving countries. Unfortunately, many poor regions such as sub-Saharan Africa and Central America, are well above that "optimal" threshold.

The rest of the paper is organized as follows. Section 2 provides many alternative measures of the brain drain and discusses its determinants. Section 3 analyzes its long-run trends in an increasingly opened world. The traditional arguments against the brain drain are depicted in Section 3. Section 4 reviews the range of feedback effects through which the brain drain positively impacts on sending countries. Finally, Section 4 concludes.

2. Contemporaneous snapshot

This section provides a large set of complementary data on the intensity and distribution of the brain drain. I first describe the general methodology used to compute these new and original data . Then I discuss the results.

– Data sources and methodological issues. National statistics in countries of origin do not offer an accurate picture of emigration. There is a large consensus that emigration data, when available, are incomplete and not precise. Hence, the only way to capture the structure of emigration is to collect immigration data in the most important host countries. This is a complex task given the lack of harmonized and consistent data on international immigration stock in receiving countries.

The United Nations population division (UNPD) evaluates on a regularly basis the number of international immigrants by region and country of destination. However, the UNPD gives no detail on the structure by country of origin and education level. For industrialized countries, the OECD statistics provide data on the immigration structure by country of origin (country of birth or citizenship) but only report the number of immigrants for the major emigration countries and give no detail about their education level. Hence, capturing the brain drain requires building new and original data sets.

The first serious effort to put together an harmonized international data set on migration rates by education level is due to Carrington and Detragiache (1998, 1999) from the International Monetary Fund. They used US 1990 Census data and other OECD statistics on international migration to construct estimates of emigration rates at three education levels for about 60 developing countries. The emigration "rate" of skill $s = l, h$ from country i at time t is defined as the ratio of emigrants ($EM_{i,t}^{s}$) to natives, i.e. residents ($N_{i,t}^{s}$) and emigrants ($EM_{i,t}^{s}$):

$$m_{i,t}^{s} = \frac{EM_{i,t}^{s}}{N_{i,t}^{s} + EM_{i,t}^{s}}$$

Although Carrington and Detragiache's study initiated new debates on skilled migration, their estimates suffer from a number of limitations. The two most important ones were: i) they transposed the education structure of the US immigration to the immigration to the other OECD countries (transposition problem); ii) immigration to EU countries was estimated based on OECD statistics reporting the number of immigrants for the major emigration countries only, which led to underestimate immigration from small countries (under reporting problem).

In Docquier and Marfouk (2006), we generalize this work and provide a comprehensive data set on international skilled emigration to the OECD. The construction of the database relies on three steps: i) collection of Census and register information on the structure of immigration in all OECD countries (this solves the transposition and under reporting problems noted for Carrington Detragiache); (ii) summing up over source countries allows for evaluating the stock of immigrants from any given sending country to the OECD area by education level, and iii) comparing the educational structure of emigration to that of the population remaining at home, which allows for computing emigration rates by educational attainment in 1990 and 2000[3]. This data set (labeled as DM06) is the cornerstone of this section.

– The world distribution of the brain drain. The DM06 data set provides many insights on the distribution of the brain drain. To understand the sources of the brain drain, it is useful to use a simple multiplicative decomposition of the skilled emigration rate (see Docquier, Lohest and Marfouk, 2006): "Skilled emigration rate" = "Average emigration rate" x "Schooling gap".

The first multiplicative component is the ratio of emigrants to natives, i.e. the average or total emigration rate. It reflects the degree of openness of the sending country. The second multiplicative component is the division of the proportion of skilled among emigrants by the same proportion calculated among native-born individuals. This ratio reflects the schooling gap between emigrants and natives.

What do the data reveal? Table 1 summarizes the data for different country groups in 2000. Countries are grouped according to demographic size, average income (using the World Bank classification), and region.

[INSERT TABLE 1]

Although large countries send more migrants abroad than small countries[4], we observe a decreasing relationship between emigration rates and country size: an increase in population at origin generates a less-than-proportional increase in emigration. Hence, the average emigration rates about 7 times higher for small countries (with population lower than 2.5 million) than for large countries (with population higher than 25 million). From the last two columns, we can see that these differences cannot be attributed to higher '*schooling gaps*' in small countries.

[3] A similar work can be found in Dumont and Lemaître (2005) who provide emigration rates for about 100 countries in 2000. The correlation between Docquier-Marfouk's and Dumont-Lemaître's estimates varies between 91 percent and 88 percent depending on the human capital indicators used for residents.

[4] In absolute numbers, the main emigration countries are the largest ones (such as Mexico, Turkey, India, China, Philippines) whilst the smallest diasporas originated from small countries (such as Palau, Vanuatu, Tuvalu, Nauru, Maldives).

Small countries simply tend to be more opened to migration. In the whole sample, the correlation between average emigration rates and the log of native population sizes (including emigrants to avoid endogeneity problems) amounts to -56 percent.

Regarding income groups, the highest emigration rates are observed in middle income countries where people have incentives to emigrate and can afford paying moving costs. High-income countries (low incentives) and low-income countries (where liquidity constraints are likely to be more binding) exhibit the lowest rates. The apparent pattern is therefore that of an inverted U-shaped relationship between income levels and (skilled) migration. Such an assertion should be econometrically tested, as it is strongly dependent on the average country size in each group[5]. However, there is a strong relationship between the level of development and the schooling gap. It is natural that the proportion of educated among emigrants increases with the general level of education of the native population. However, an increase in education level of native populations generates a less-than-proportional increase in the education level of emigrants. Hence, the schooling gap decreases with human capital at origin. The correlation rate between the schooling gap and the proportion of educated natives amounts to -90 percent.

Regarding the regional distribution of the brain drain, the most affected regions are the Caribbean and the Pacific, which consist of relatively small islands, and Sub Saharan and Central American countries. The difference between skilled and total emigration rates is especially strong in Africa.

– ***Endogenizing skilled migration rates.*** Docquier, Lohest and Marfouk (2006) use SURE regression models to examine the joint determinants of average emigration rates and schooling gaps, hence explaining the source of regional disparities in the brain drain. They include five sets of potential explanatory variables: the first set concerns country size at origin[6], a second set of variables accounts for the level of development[7], the third set captures the socio-political environment at origin[8], the fourth set of variables accounts for geographical and cultural proximity between developing and OECD countries[9], and the fifth set concerns the main

[5] The largest countries of the world belong the low-income group whilst the smallest countries are in the upper-middle-income group.
[6] It includes the log of the native population and a dummy equal to one for small developing island.
[7] It includes the log of the percentage of tertiary educated among natives, Gross National Income per capita, a dummy equal to one for the least developed countries and a dummy for oil exporting countries
[8] It includes a variable of political stability and absence of violence, government effectiveness, property rights and religious fractionalization.
[9] It includes geographic distance with OECD countries, linguistic proximity from selective countries, and colonial links with a OECD country.

destination of emigrants[10].

Many determinants are highly significant and the R-squared obtained in the parsimonious model are of 69 and 85 percent. The empirical analysis confirms that country size is a key determinant of openness, but has no effect on the schooling gap. The level of development has a very strong effect on openness and schooling gaps. Natives' human capital has a positive impact on emigration and a decreasing impact on the schooling gap. This explains why poor regions such as sub-Saharan Africa and South Asia suffer from a huge brain drain. In addition, average emigration rates are higher in politically unstable, religiously divided regions where property rights are jeopardized, such as sub-Saharan Africa, East Asian and Pacific.

Proximity significantly affects openness and schooling gaps. Distance between origin countries and the major host regions reduces the emigration rate and augments the self-selection among emigrants (higher schooling gap). The lack of territorial access to the sea, remoteness and isolation from world markets reduce the degree of openness of landlocked developing countries. Being a former colony has a positive effect on openness but no significant impact on schooling gaps. Sharing the same language with selective countries (which is the main destination for many developing countries) has a positive effect on the schooling gap. These proximity variables strongly contribute to the brain drain in the Middle East and North Africa, Latin America and the Caribbean.

– *The European Union is an important actor.* Using DM06 data, Docquier, Lohest and Marfouk (2005) analyzed the role of the EU15 (European Union with 15 members) on the international mobility of skilled workers. Compared to other OECD countries, the average skill level of EU15 immigrants is low. However, by attracting an important proportion of African migrants, the EU15 plays an important role in the brain drain debate. The EU15 is an important source of brain drain for countries that are strongly concerned by human capital shortages. It is worth noticing that the EU15 experiences a large deficit in its exchanges of skilled workers with the other traditional immigration countries (about 2.4 million European skilled workers are living in the US, Canada and Australia). This deficit is compensated by importing human capital from developing countries. Figure 1 illustrates this impact of the EU immigration on the losses of human capital in developing countries. It compares country-specific skilled emigration rates (X-axis) and the European contribution to these losses, measured as the share of the EU15 in the brain drain (Y-axis). We consider that the EU15 contribution is high

[10] In includes a dummy equal to one if the main destination is a selective country and a dummy equal to one if the main destination is one of the EU15 member states

(respectively very high) when the share of skilled emigrants living in the EU15 exceeds the share of the EU15 (respectively twice the share of the EU15) in the total OECD population. Similarly, we consider that countries suffering from the brain drain are those experiencing a loss higher than 20 percent.

[INSERT FIGURE 1]

We observe that the EU15 contribution is high in 75 cases, and very high in 20 cases. Some of these countries are strongly affected by the brain drain (The Gambia, Cyprus, Cape Verde, Sierra Leone, Mauritius, Seychelles, Malta, Ghana, Somalia, Uganda, Kenya). The EU15 is the main source of human capital flight from Suriname, Mozambique, Angola, Sao Tome and Principe, Republic of Congo, Guinea-Bissau, Togo or Comoros.

– Brain drain and children migration. Counting all foreign born individuals as immigrants independently of their age at arrival, both Carrington-Detragiache and Docquier-Marfouk data sets do not account for whether education has been acquired in the home or in the host country[11]. This leads to a potential over-estimation of the intensity of the brain drain as well as to possible spurious cross-country variations in skilled emigration rates (Rosenzweig, 2005).

The data set of Docquier and Marfouk (2006) can be seen as providing an upper bound to brain drain estimates. In contrast, Rosenzweig (2005) suggests that only people with home-country higher education should be considered as skilled immigrants. This must be considered as a lower-bound measure of the brain drain. Indeed, except for those arrived at very young age, most of the immigrants who then acquired host country tertiary education arrived with some level of home country pre-tertiary schooling. In addition, some of them would still have engaged in higher education in the home country in the absence of emigration prospects.

Beine, Docquier and Rapoport (2006) use immigrants' age of entry as a proxy for where education has been acquired. Data on age of entry are available from a subset of receiving countries, which together represent more than 75 percent of total skilled immigration to the OECD. Using these data and a simple gravity model, they estimate the age-of-entry structure of skilled immigration to the other OECD countries. This allows them to propose alternative measures of the brain drain by defining skilled immigrants as those who left their home country after age 12, 18 or 22, and to do so for both 1990 and 2000. These corrected skilled emigration rates, which can be seen as intermediate bounds to the brain drain estimates, are by

[11] Mexican-born individuals who arrived in the US at age 5 or 10 and then graduated from US high-education institutions later on are counted as high-skill Mexican immigrants.

construction lower than those computed without age-of-entry restrictions by Docquier and Marfouk (2006).

For the year 2000, 68 percent of the global brain drain is accounted for by emigration of people aged 22 or more upon arrival (the figures are 78 percent and 87 percent for the 18 and 12-year-old thresholds, respectively). For some countries there is indeed a substantial difference between the corrected and uncorrected rates. However, cross-country differences are globally maintained in the corrected data sets, resulting in extremely high correlation levels between the corrected and uncorrected rates.

Table 2 gives the stock and rates of skilled migration in the 30 most affected countries (in relative terms, or brain drain intensity[12]). The left panel reports the results for countries with population above 0.25 million while the right panel reports results for countries with population above 4 million. The brain drain appears to be very strong in small countries, with emigration rates as high as 80 percent in some Pacific or Caribbean islands. Controlling for age of entry does not significantly affect the rankings, although reducing the intensity.

Focusing on countries where the population exceeds 4 million, the top of the list mainly includes middle-sized countries from all regions: Africa (Sierra Leone, Ghana, Mozambique, Kenya), Central America (Haiti, El Salvador, Nicaragua, Cuba), South and South Eastern Asia (Laos, Sri Lanka, Hong Kong, Vietnam), and also Europe (Portugal, Slovakia).

[INSERT TABLE 2]

– Brain drain and occupational shortages. General emigration rates may hide important occupational shortages (e.g. among engineers, teachers, physicians, nurses, IT specialists, etc). In many poor countries, shortages are particularly severe in the medical sector where the number of physicians per 1,000 inhabitants is far below the acceptable threshold of 2 defined by the World Health Organization. The brain drain of physicians and nurses to countries such as the US, Australia, Canada and the UK is one of the multiple causes of shortage. To illustrate this phenomenon, Docquier and Bhargava (2006) have collected data on doctors with *foreign qualification* working in the 16 main OECD countries[13] from 1991 to 2004 on an annual basis.

[12] In absolute terms, the main international suppliers of skilled migrants are large countries such as the UK (1.441 million), the Philippines (1.126 million), India (1.037 million), Mexico (0.923 million), Germany (0.848 million) and China (0.816 million). In proportion of their skilled labor force, these countries are moderately affected by the brain drain.

[13] In a very recent study, Clemens and Pettersson (2006) have compiled a dataset of the cumulative bilateral net flows of African-born physicians and nurses to the nine most important destination countries. The concept of African-born, rather than African-qualified in Docquier and Bhargava, leads to more pessimistic measures (see http://www.cgdev.org/content/publications/detail/9267/).

Aggregating these data and comparing them to the total number of doctors who qualified in their country, they have computed medical emigration rates for all the world countries.

The correlation between the medical brain drain and the corrected general brain drain of the 22+ (those who were likely to qualify before emigration) is about 41 percent (and the elasticity of medical brain drain to general brain drain amounts to 46 percent). However, many observations are far from the general trend. Despite moderate general rates of skilled migration, some countries suffer from a strong medical brain drain. Figure 2 gives the medical brain drain observed in the most affected countries. Small countries are strongly affected, including some industrialized countries with efficient education systems (Ireland, Luxemburg). Among the affected countries, we have 13 African countries (Cape Verde, Sao Tome and Principe, Liberia, Ethiopia, Somalia, Ghana, Uganda, Malawi, Zimbabwe, Gambia, Zambia, Togo, South Africa) where the health care shortages are particularly severe. Obviously, the medical brain drain can be blamed for depriving sub-Saharan countries of many of their health professionals.

[INSERT FIGURE 2]

Estimating random effects models on sub-Saharan African countries, Bhargava and Docquier (2006) show that lower wages and higher HIV prevalence rates are key determinants of the medical brain drain. Countries with higher wages of physicians experience lower emigration rates. This finding supports the responses of physicians from sub-Saharan African countries (Awases et al., 2003) where percentages of health professionals reporting that higher salaries are a motivation for emigration from Cameroon, Ghana, South Africa, Uganda and Zimbabwe were, 68, 85, 78, 84, and 77, respectively. The second result shows that working conditions also play an important role. The elasticity of the medical emigration rate to HIV prevalence rate (0.07) is robust across specifications. Thus, a doubling of HIV prevalence rate implies an increase of around 15% in the medical brain drain. While this might seem to be a relatively small magnitude, it can make a strong difference in countries where the average number of physicians per 1,000 of population is only 0.15.

2. Long-run trends

Analyzing the evolution of the international (skilled) migration is an even more complex task since it is extremely difficult to expand the time series dimension of the previous data sets. This section takes advantage of some recent longitudinal studies and summarizes their main

results, sometimes contradicting some preconceived ideas.

– South-North migration is an important component of globalization. The United Nations population division evaluates on a regularly basis the number of international immigrants by region and country. This number increased from 75 million in 1960 to 190 million in 2005 (i.e. by 2.1 percent per year). In percentage of the world population, the rate of migration only rose from 2.5 to 2.9 percent and has been extremely stable between 1990 and 2000 (see figure 3.1). As the trade/GDP world ratio increased from 10 to 30 percent on the same period (from 20 to 30 percent between 1990 and 2000), many argued that the international mobility of workers was rather unaffected by globalization. They explain this paradox by anti-immigration sentiments and policies in the rich world, nourished by hugely contentious labor and immigration studies.

However, this common belief is invalidated by more detailed data. The UN regional immigration data reveal that the proportion of immigrants residing in the most developed countries has tripled since 1960 and has doubled since 1985, following the same growth pattern as the trade/GDP ratio. The average annual growth rate of immigrants in developed countries amounts to 3 percent between 1960 and 2005 (4 percent between 1985 and 2000), much more than the native population growth rate (0.5 percent). Hence, restricting the destination region to developed countries, figure 3.2 shows that the mobility of labor responded to globalization with the same intensity as the mobility of goods and services. Many of these new migrants originated from developing countries.

[INSERT FIGURE 3]

– The number of skilled migrants has increased. Case studies and anecdotal evidence suggest that the number of skilled migrants is much more extensive than it was two or three decades ago[14]. The annual average growth rate of the skilled immigration stocks in the six major receiving countries between 1975 and 2000 can be estimated to 6 percent, twice as large as the growth rate of the total immigration. This trend is usually explained by increasingly "quality-selective" immigration policies introduced in the late eighties and early nineties in many important immigration countries such as Australia, New Zealand, Canada and the US[15].

[14] For example, Haque and Jahangir (1999) indicate that the number of highly skilled emigrants from Africa increased from 1,800 a year on average during the 1960-75 period to 4,400 during 1975-84 and 23,000 during 1984-87.

[15] In European Union (EU) countries, immigration policies are less clear and still oriented toward traditional targets such as asylum seekers and applicants requesting family reunion. However, there is some evidence suggesting that European countries are also leaning toward becoming quality-selective.

It is confirmed by the data set of Docquier and Marfouk. The number of working-aged foreign-born living in an OECD country increased from 42 million in 1990 to 59 million in 2000. Skilled workers are much more concerned by international migration. Between 1990 and 2000, the number of skilled immigrants increased from 12.4 to 20.4 million. Over the same period, the number of unskilled migrants only increased from 18.8 to 21.5 million.

– In relative terms, the brain drain remained stable. Although globalization and selective immigration policies are undoubtedly important, the increasing number of skilled migrants must also be related to two important changes at origin: (i) the population size in developing countries has increased hugely and (ii) all the world countries (even the poorest ones) experienced a remarkable rise in education attainment. Hence, contrary to common belief, it is not obvious at all that the relative intensity of the brain drain has increased over the last decades.

The Docquier-Marfouk's data set predicts a minor increase in the average rate of skilled migration between 1990 and 2000 (from 5.0 to 5.4 percent) at the world level. Simultaneously, although an increasing proportion of migrants originated from developing countries, the average skilled emigration rate of the later decreased from 7.7 to 7.4 percent.

Is this still true if we take a longer time horizon and compare the current situation to that prevailing in 1975? Using the same methodology as in DM06 but focusing on the six major destination countries (USA, Canada, Australia, Germany, UK and France), Defoort (2006) computed skilled emigration stocks and rates from 1975 to 2000 (one observation every 5 years). Figure 4 presents skilled emigration rates by region using this longer perspective. At the world level or at the level of developing countries as a whole, the average skilled migration rate has been extremely stable over the period.

Some regions experienced an increase in the intensity of the brain drain (Central America, Eastern Europe, South Central Asia and Sub Saharan Africa) while significant decreases were observed in other regions (notably the Middle East and Northern Africa). It suggests that the increased openness and quality-selective rules observed in developed countries evolved concurrently with the supply of skills in developing countries. It is uncertain whether the rise in the number of skilled migrants is mostly explained by out-selection policies at destination, migrants' self-selection or a mix of these two effects. Under the first hypothesis, one could reasonably expect a progressive decrease in the brain drain, at least if developed countries keep immigration and selection rates constant in future decades.

[INSERT FIGURE 4]

3. The brain drain: a threat for developing nations

Why should the brain drain be harmful for sending countries? The section explains and summarizes the traditional literature on the implications of the brain drain for sending countries.

– In an idealized world, free labor mobility is efficient. One the most fundamental results in economics is the ”first welfare theorem” demonstrated by Kenneth Arrow and Gerard Debreu. It says that, under some restrictive conditions, a competitive market economy leads to a Pareto efficient general equilibrium, i.e. maximizes the size of the pie to be shared between all the parties concerned. This theorem is usually seen as an analytical confirmation of Adam Smith’s ”invisible hand”, implying that Pareto efficiency can be obtained with very little government action[16].

As far as the brain drain is concerned, it typically means that when (skilled or unskilled) individuals take decisions that are good for them, an efficient allocation of resources is obtained. In particular, if skilled workers are moving to rich countries, they contribute to increasing the total amount of welfare at the world level. The rest is a matter of redistribution.

Such an optimistic attitude must be moderated by two arguments. First, the economic concept of efficiency is not the only thing that a society might care about. In particular, the theorem says nothing about the equity of the outcome. When redistribution is impossible or costly, although the brain drain unambiguously increases the size of the pie to be shared, some groups can be adversely affected. This argument should not be decisive in the long run, except under the existence of a very strong complementarity between skilled and unskilled workers on the labor market or if the fiscal cost of education large and totally supported by residents.

– The importance of human capital in developing countries. A more important problem is that the theorem requires a set of conditions which may not necessarily reflect the workings of real economies, i.e. (i) markets exist for all possible goods; (ii) markets are perfectly competitive and all agents are price-takers; (iii) transaction costs are negligible; (iii) there are no externalities. Related to our basic issue, we can reasonably fear the existence of strong externalities related to the brain drain. Recall that an externality occurs when a private decision

[16] The function of government can be restricted that of protecting property rights, allowing trade and factor

causes costs or benefits to agents other than the person making the decision. The new growth literature has stressed the existence of strong externalities related to human capital and education (see Lucas, 1988, Azariadis and Drazen, 1990), showing the social return to human capital exceeds the private return..

Human capital can alternatively be measured as the average years of schooling of workers, the proportion of workers having a given diploma or by the average literacy level of workers. It is commonly accepted that human capital accumulation induces positive externalities of various sorts (technological, fiscal, civic, etc). In particular, the appealing Schumpeterian theory of growth shows that human capital is a key factor of innovation and technology adoption[17]. By affecting the rate of technological innovation and adoption, human capital affects the long-run gap with the leading economies: the smaller is human capital, the higher is the gap with the leading economies.

These externalities justify why governments subsidize education. Consequently, by impacting on the level of human capital at origin, the brain drain is usually seen as inducing serious social losses for those left behind, then contributing to increase the world inequality.

A simple look at cross-country data shows that the relationship between human capital and output per worker is strong. On Figure 5, human capital is measured as the proportion of worker with tertiary education in the labor force. Human capital data are taken from the revised data set of Barro and Lee (2000). The cross-sectional static elasticity between output per capita and human capital is highly significant and amounts to 1.06, a value well above the commonly used value for the private elasticity of GDP to human capital.

[INSERT FIGURE 5]

– Ex-post, the brain drain reduces the average level of schooling. This argument is central in the traditional literature on the brain drain. As generations of economists and other social scientists have argued, the emigration of the most talented workers is likely to reduce the average level of human capital of the labor force. All other things equal, such a decrease in human capital has a direct negative impact on output per capita. It also induces redistributive effects from the low-skill to the high-skill workers.

However, in the medium and long run, a decrease in human capital seriously affects the country capacity to innovate and adopt modern technologies. Hence, the brain drain impacts

mobility.

[17] On the theory and empirics of the Schumpeterian theory, see Benhabib and Spiegel (2005), themselves building

negatively on the total factor productivity and increases the distance to the frontier.

The early economic literature of the 1960s (for example, Grubel and Scott 1966, Johnson 1967) had a tendency to downplay the negative externalities imposed on those left behind. During the 1970s, a new school of thought (for example, Bhagwati and Hamada 1974, 1975, McCullock and Yellen 1975, 1977) delivered more or less the following messages: i) the brain drain is basically a negative externality imposed on those left behind; ii) it is a zero sum game, with the rich countries getting richer and the poor countries getting poorer; and, iii) at a policy level, the international community should implement a mechanism whereby international transfers could compensate the origin countries for the losses incurred, for example in the form of an income 'tax on brains' (or 'Bhagwati Tax') to be redistributed internationally. Modern theories of endogenous growth have considerably renewed the analysis of the relationships between education, migration and growth. Unsurprisingly, the first models to address the issue of the brain drain in an endogenous growth framework also emphasized its negative effects (e.g., Miyagiwa, 1991, Haque and Kim, 1995).

– *More pernicious mechanisms.* These arguments based on the existence of technological externalities related to human capital accumulation can be strengthened by other more pernicious mechanisms.

Bhagwati and Hamada (1974) developed a seminal model in which the increasing international integration of the market for skilled workers induces a loss for the poor countries. They did not use the externality argument presented in the previous section but assumed that educated elites bargain for high wages. A higher integration of the skilled labor market makes international skilled wages observable and induces the educated elite to bargain for higher wages (*"our Joneses keeping up with their Joneses"*). Unskilled workers adjust their wage requirements on skilled wages. Hence, the higher integration of the skilled labor market generates some leapfrogging effects on low wages (*"our Joneses keeping up with our Joneses"*). In conclusion, although skilled emigration reduces unemployment of the educated and stimulates education, it also yields two detrimental responses: higher public education expenditures and taxes; higher wages and unemployment of the uneducated. On the whole, Bhagwati and Hamada derive the conditions under which integration induces a decrease in per capita income in poor countries.

Bhagwati and Hamada (1974) already recognized that migration prospects encourage students

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on Nelson and Phelps (1966),

to study more intensively, by increasing the expected returns to human capital. Nevertheless, the risk is that students could opt for internationally applicable diploma. Among others, Lucas (2004) reports that the choice of major field of study (medicine, nursing, maritime training) among Filipino students respond more to shifts in international demand than to national needs. When foreign and national countries have different needs, the perspective of migration can lead to important shortages in some sectors. Specific shortages can be strongly harmful for developing countries.

This effect can be reinforced by the fact that individual governments have fewer incentives to provide internationally applicable education when graduates leave their country. Poutvaara (2004) addresses this important issue in a theoretical model where the possibility of a brain drain distorts the provision of public education away from internationally applicable education towards country-specific skills. Country-specific skills may include tertiary education with national emphasis, like degrees in law and certain humanities, and also secondary education, which is less mobile. Correspondingly, internationally applicable education may include, in addition to science-based, commercial and other internationally applicable degrees in tertiary education, those held in secondary education (like nurses) which are internationally mobile. At the end, this means educating too few engineers, economists and nurses and doctors, and too many lawyers. Poutvaara shows that such an outcome could be avoided by introducing graduate taxes or income-contingent loans, collected also from migrants. By giving the providers of internationally applicable education a stake also in efficiency gains earned elsewhere, graduate taxes would encourage sending countries to invest more in internationally applicable education.

In a similar vein, Bhargava and Docquier (2006) show that the medical brain drain induces a greater number of deaths due to AIDS. In the long run, this will possibly mean a lower life expectancy, with possible depressing effects on investments in physical and human capital.

4. The brain drain: a source of positive feedback effects

By reducing human capital at origin, the traditional literature supports the view that skilled migration is unambiguously detrimental for those left behind. This is the case if the migrants' contribution to the economy is greater than their marginal product and/or if the education of skilled emigrants was strongly funded by taxes on residents.

The recent literature is less pessimistic. While recognizing the importance of human capital for

economic development, it puts forward a set of channels through which the brain drain may positively affect the sending economy. These include a range of "feedback effects" such as remittances, return migration after additional knowledge and skills have been acquired abroad, the creation of business and trade networks, the effects of migration prospects on human capital formation, the effects on governance and ethnic discrimination. This section offers a non technical discussion of these mechanisms and summarizes the existing empirical evidence.

– Ex-ante, the brain drain stimulates human capital accumulation. The main criticism of the brain drain is that it deprives the sending country of one of its scarcest resources, human capital. A recent wave of theoretical contributions (Mountford, 1997, Stark et al., 1998, Vidal, 1998, Beine et al., 2001, Stark and Wang, 2002) demonstrates that skilled migration can create more human capital ex-ante than the ex-post loss. These papers all develop probabilistic migration models in which the probability of migration depends on the achievement of a given educational requirement, which is observable, and not on individuals' ability, which is not perfectly observable (i.e., migrants are assumed to be randomly selected among those who satisfy some kind of prerequisite with informational content regarding their ability - in our case, education).

They all reasonably assume that the return to education is higher abroad and that skilled workers have a much higher probability to emigrate than unskilled workers (an hypothesis which is strongly supported by the data). Hence, migration prospects can raise the expected return to human capital and induce more people to invest in education at home[18]. Ex-ante, more people opt for education. Ex-post, some of them will be leaving. Under certain conditions detailed in these models, the incentive (or brain effect) effect dominates that of actual emigration (or drain effect), which creates the possibility of a net brain gain for the source country.

What is the empirical evidence on this "prospect" channel? In a cross-section of 37 developing countries, Beine, Docquier and Rapoport (2001) found that migration prospects have a positive and significant impact on human capital formation at origin, especially for countries with low initial GDP per capita levels. This was a first but imperfect study since they used gross migration rates as a proxy measure for the brain drain due to the lack of comparative data on international migration by education levels. In a subsequent study, Beine et al. (2003) then used the Carrington-Detragiache estimates of emigration rates for the highest (tertiary)

[18] Note that Bhagwati and Hamada (1974), as well as McCulloch and Yellen (1977), did account for such incentive effects in their pioneering works.

education as their measure of brain drain; with or without instrumentation, they again found a positive and highly significant effect of migration prospects on gross human capital formation, this time in a cross-section of 50 developing countries. By contrast, Faini (2003) finds a depressing but not significant effect of tertiary emigration on domestic enrollment in higher education, a finding he attributes to the choice by would-be migrants to pursue their studies abroad. As he himself acknowledged, however, these results must be taken with caution as they are based on enrollment data known to raise measurement problems.

Very recently, Beine et al. (2006) used DM06 data and found evidence of a positive effect of skilled migration prospects on gross (pre-migration) human capital levels in a cross-section of 127 developing countries. They obtain an elasticity of human capital growth (log-change in the proportion of tertiary skilled among natives) to skilled emigration prospects in the neighborhood of 5%. This elasticity is very stable across specifications and estimation methods. This is not negligible for countries where the average proportion of educated is typically between 5 and 10 percent.

Similar qualitative results are obtained when using alternative brain drain estimates controlling for whether migrants acquired their skills in the home or in the host country[19]. Finally, they also found a positive effect of skilled migration on youth literacy. The only mitigated result emerged when human capital is measured by school enrolment rates, confirming Faini's findings. In that case, results depend on the specification used[20]. Globally, within the limits of a cross-sectional analysis, their results point to a robust, positive and sizeable effect of skilled migration prospects on human capital formation in developing countries.

Beine, Defoort and Docquier (2006) estimate a similar equation in a panel setting (6 observations by country), controlling for unobserved heterogeneity and for the endogeneity of the emigration rate. They also found a significant incentive effect in developing countries. This result is essentially driven by a strong incentive effect in low-income countries.

Relying on their baseline model, Beine et al. (2003) use counterfactual simulations (equating the skilled emigration rate to the unskilled rate) to estimate the net effect of the brain drain for

[19] See the data presented in Section 2.3

[20] They do not find any evidence of an incentive effect of skilled emigration when using their baseline log-linear specification. The coefficient associated to the skilled emigration rate is never significantly different from zero. However, with alternative functional forms for the incentive effects, the effect of skilled migration becomes significant, with a negative impact on tertiary schooling and a positive impact on secondary schooling. The latter result is consistent with a story where skilled migration prospects lead more students to invest in secondary schooling at home to buy and then exercise the option of studying abroad at the upper level, an interpretation they do not want to push too far given the lack of robustness of the results.

each country and region. They find that the brain drain stimulates human capital accumulation among residents in some countries. It appears that the countries experiencing a positive net effect (the 'winners') generally combine low levels of human capital (below 5%) and low skilled migration rates (below 20%), whereas the 'losers' are typically characterized by high skilled migration rates and/or high enrollment rates in higher education.

There appears to be more losers than winners, and in addition the former tend to lose *relatively* more than what the latter gain. However, the main "globalizers" (e.g., China, India, Brazil) all seem to experience non-negligible gains. As shown in Table 3, the net effect for developing countries as a whole is driven by the situation of the largest countries: it is positive and amounts to 3.3 million skilled residents[21]. In contrast, the situation of many countries in Sub-Saharan Africa (-0.150 million skilled workers) and Central America (-1,150 million), in particular, is extremely worrisome. Figure 6 gives the reduced-form impact of the brain drain on residents' human capital. A quadratic adjustment function fits well the effect ($R^2 = 46\%$).

[INSERT TABLE 3]

[INSERT FIGURE 6]

– Skilled migration induces remittances. Migrants' remittances constitute an important channel through which the brain drain may generate positive indirect effects for source countries. It is well documented that workers' remittances often make a significant contribution to GNP and are a major source of income in many developing countries[22]. Such amounts must have a strong impact on poverty and economic activity. They impinge on households' decisions in terms of labor supply, investment, education (Hanson and Woodruff, 2002, Cox Edwards and Ureta, 2003), migration of relatives, occupational choice, and fertility, with potentially important aggregated effects. This is especially the case in poor countries where capital market imperfections (liquidity constraints) reduce the set of options available to members of low-income classes.

It is a theoretically unclear whether educated migrants would remit more than their uneducated compatriots. The former may remit more because of higher income or to meet their implicit commitment to reimburse the family for funding of education investments, but on the other hand, educated migrants tend to emigrate with their family, on a more permanent basis, and are

[21] The gain in large countries (population above 25 million) amounts to 4.3 million. Hence, altogether, medium-sized and small countries loose about 1 million skilled workers.

[22] According to the recent Global Economic Prospects of the World Bank (2006), recorded remittances in developing countries amounted to about $US 175 billion in 2005, roughly the same amount than foreign direct

therefore less likely to remit (or are likely to remit less) than someone moving alone on a temporary basis.

At an aggregate level, Faini (2006) shows that migrants' remittances decrease with the proportion of skilled individuals among the emigrants and concludes: "this result suggests that the negative impact of the brain drain cannot be counterbalanced by higher remittances". This does not imply that remittances by skilled migrants are negligible, especially if the proportion of temporary migrants increases; for example, Kangasniemi et al. (2004) show that nearly half of Indian medical doctors working in the UK remit income to their home country; these transfer on average 16% of remitters' income.

– Return migration and brain circulation are good for growth. Although the magnitude of return migration is badly known, the fact that migrants accumulate knowledge and financial capital in rich countries before spending the rest of their career in their origin country may generate beneficial effects on productivity and technology diffusion.

For example, Dos Santos and Postel-Vinay (2003, 2004) argue that a beneficial brain drain could emerge even if the share of educated workers decreases[23]. This is shown in a setting where growth is exogenous at destination and endogenous at origin, with the sole engine of growth being knowledge accumulation embodied in migrants returning from the more advanced country. Their caveat relies on knowledge diffusion, that is, on the idea that the advanced technology spillovers to the developing country is carried out by returning migrants. To the extent that returnees contribute to the diffusion of the more advanced technology they experienced abroad, emigrants' return is therefore a potential source of growth for their home country.

Are skilled migrants inclined to return? A recent and comprehensive survey of India's software industry stressed the importance of temporary mobility (strong evidence of a brain exchange or a brain circulation), with 30-40% of the higher-level employees having relevant work experience in a developed country (Commander et al., 2004). In their survey on medical doctors working in the UK, Kangasniemi et al (2004) also found that "many" intend to return after completing their training.

Nevertheless, many other studies tend to show that return migration is limited among the highly skilled. Borjas and Bradsberg (1996) demonstrated that, in general, return migration is

investments and about three times as large as the official development aid.

[23] Stark et al. (1997) also elaborate on the possibility of a brain gain associated with a brain drain in a context of

characterized by negative self-selection and is seldom among the highly skilled unless sustained growth preceded return. For example, less than a fifth of Taiwanese PhDs who graduated from US universities in the fields of Science and Engineering returned to Taiwan in the 1970s (Kwok and Leland, 1982); this proportion rose to about one half to two-thirds in the course of the 1990s, after two decades of impressive growth in these countries. A recent survey shows that in the Hsinchu Science Park in Taipei, a large fraction of companies have been started by returnees from the USA (Luo and Wang, 2001). Figures for Chinese and Indian PhDs graduating from US universities in the same fields during the period 1990-99 are fairly identical to what they were for Taiwan or Korea 20 years ago (stay rates of 87% and 82%, respectively). According to these papers, return skilled migration appears relatively limited, however, and is often more a consequence than a trigger of growth.

– ***The skilled diaspora facilitates technology transfers.*** A large sociological literature emphasizes that the creation of migrants' networks facilitates the further movement of persons[24], the movement of goods, factors, and ideas between the migrants' host and home countries. Such "diaspora externalities" are now analyzed by economists in the field of international trade. In many instances indeed, and contrarily to what one would expect in a standard trade-theoretic framework, trade and migration appear to be complements rather than substitutes[25] as ethnic networks help overcoming information problems.

In the same vein, whether FDI and migration are substitutes (as one would expect) or complements is a pertinent question. Using cross-section data, Docquier and Lodigiani (2006) find evidence of important network externalities in a dynamic empirical model of FDI-funded capital accumulation. Their analysis confirms that business networks are mostly driven by skilled migration. Skilled migration thus stimulates aggregate FDI inflows in the origin country. Covering 114 countries on the period 1990-2000, the elasticity of the FDI-funded capital growth rate to skilled migration is around 2 percent. These network effects are stronger in democratic countries as well as in countries exhibiting intermediate corruption index[26]. They provide a panel extension with 83 countries and 4 periods and confirm the existence of business network externalities. The elasticity of the capital growth rate to the stock of skilled emigrants obtained in the panel setting is between 2 and 3 percent. Using bilateral FDI and migration data, Rapoport and Kugler (2006) also found strong evidence of a complementarity

imperfect information with return migration.

[24] See Massey et al. (1994), Carrington et al. (1996), Kanbur and Rapoport (2004).

[25] See Gould (1994), Rauch and Trindade (2002), Rauch and Casella (2003).

[26] Very corrupted regimes face strong difficulties to attract foreign investments. Networks are less important in

between FDI and skilled migration, with an average elasticity of 3 percent.

Diaspora externalities would then constitute an important channel through which the brain drain positively affects sending countries. Even when the brain drain depresses the average level of schooling, it is likely to increase FDI inflows. The size of the diaspora matters. Business externalities are likely to be stronger in large countries. On the contrary, small countries are less likely to benefit from skilled diasporas.

– Skilled migration can affect the quality of governance. A couple of studies also examine the impact of skilled migration on governance, corruption, rent-seeking and ethnic discrimination.

In a political economy model of ethnic discrimination in developing countries, Docquier and Rapoport (2003) assume a rent-extraction basis for discrimination. They model discrimination as a financial penalty levied on educated minority members and equally redistributed among majority members. There are, therefore, two sources of ethnic inequality in our model: on the one hand, discrimination lowers the return to human capital for the minority group, which in turn decreases the number of minority members who invest in education. Focussing on the impact of migration prospects on the level of rent-seeking from the majority's perspective, they get the following results:

- First, taking the closed-economy (no mobility) as a benchmark case, they find the intuitive result that if there are unlimited exit options to a discrimination-free country (full mobility case), such migration prospects are likely to protect the minority *via* a decrease in the equilibrium domestic level of discrimination (providing that migration costs are sufficiently low). Under such circumstances, investment in education is fostered among the minority, and ethnic inequality decrease.
- Second, the equilibrium discrimination rate under full mobility has been shown to be such that the minority member with the highest ability is indifferent as to whether to emigrate. Consequently, no migration outflows are observed at equilibrium when there is free international mobility.
- Third, compared to the free migration case, they find that highly restrictive quotas are likely to increase the level of discrimination imposed on the minority group, thus inducing emigration from among its ranks. In such cases, immigration restrictions have the paradoxical effect of increasing ethnic discrimination in the source country and creating migration flows, which would otherwise have remained latent.

"clean" countries where informational costs are much lower.

Extending the corruption model of Murphy, Shleifer and Vishny (1991), Mariani (2006) develops a new mechanism through which the brain drain reduces corruption in the origin country. Agents have two possibilities of career, acting as rent-seekers or engaging in productive activities. Opting for the latter field, individuals have the possibility to export their human capital to a rent-free foreign country. Hence, the probability of migration reduces the relative return to rent-seeking, thus decreasing the fraction of skilled workers who opt for parasitic activities.

When education and self-protection investments are substitutes, it is possible that the intensity of corruption increases with the migration rate. Otherwise, the optimal skilled emigration rate is positive.

The stylized facts presented in Mariani's paper confirm such a relationship between skilled migration and the allocation of talents. Specialization in productive fields (measured by the proportion of students in Science and Engineering) is positively correlated with the lagged skilled emigration rate. Specialization in rent-seeking fields (measured by the proportion of students in law, theology and religion) is negatively correlated with the brain drain. Obviously, the causality between the brain drain and the allocation of talents is questionable and should be tested. Nonetheless, this disciplining mechanism offers another channel through which a limited amount of skilled migration can be beneficial for growth.

5. Conclusion

It is more than likely that skilled migration induces some positive effects on developing countries. Are these effects significant and sufficiently large to turn the brain drain into a brain gain? Recent empirical studies based on aggregate data suggest that these positive effects are of significant size. Hence, being primarily concerned with raising the development of the poorest countries, the optimal skilled emigration rate is limited but positive in many cases. The optimal skilled emigration rate varies across countries, and depends on many factors such as population size, political environment, education policy, level of development, etc.

From the macroeconometric studies reviewed in this paper, it seems that the threshold emigration rate above which the brain drain becomes harmful for development can be prudently estimated between 15 and 20 percent in low-income countries. The average optimal emigration rate (which maximizes country gains) probably lies between 5 and 10 percent. It is noteworthy that about 23 percent of developing countries exhibits a brain drain smaller than 5

percent (41 percent exhibit a brain drain smaller than 10 percent). Many of these countries (including most large and middle-sized countries) are reasonably benefiting from the mobility of their skilled labor force. On the contrary, the majority of sub-Saharan and central American countries are well above this threshold and suffer from the brain drain. Clearly, an analysis by occupation and sector would be desirable to account for specific shortages.

What do the theoretical and empirical findings teach us that can guide policy making? To the extent that immigration policies of destination countries can discriminate among migrants of different origins (which undoubtedly raises legal and moral questions well beyond the scope of this survey) and in different occupations, it would be possible to design quality selective immigration policies minimizing the losses and/or maximizing the gain from labor mobility. This could be coupled with specific incentives to return migration to those countries most negatively affected by the brain drain, and promote international cooperation aiming at more brain circulation.

Also, notwithstanding the 'feasibility' issues (see Desai, Kapur and McHale, 2004), it is not obvious that a general Bhagwati tax would benefit the source country. A tax on brain would have a beneficial impact on human capital formation at origin only in case of a detrimental brain drain (compensation principle). In contrast, in the case of a beneficial brain drain, such a tax could harm the migrants' home country. As for the "fair" migration policy, a "fair" tax rate on brains varies across countries. Small and low-income countries (the expected losers) clearly deserve a larger share of the pie than large middle income countries (the expected winners).

However, all these policy recommendations should be validated by further empirical works. Although new data sets can now be used to assess the magnitude of these effects, these data rely on many assumptions and are available for a limited number of years. Hence, the empirical literature remains poor to guide policymaking. In particular, due to data limitations, existing empirical studies are based on cross-sectional regressions and suffer from the bias of omitted variables, of small sample size, and makes it very difficult to solve potential endogeneity problems. It is crucial at this stage is to extend the empirical research on the growth effects of highly skilled migration for source countries. At the agenda, it would be helpful to build new micro survey explicitly conducted to capture the relationship between emigrants and their country of origin, to collect more data and case-studies on the sectoral impact of the brain drain, to improve the time dimension in available macro data sets, and the quality of human capital indicators of residents. International agencies should clearly devote more time and human resources to these problems.

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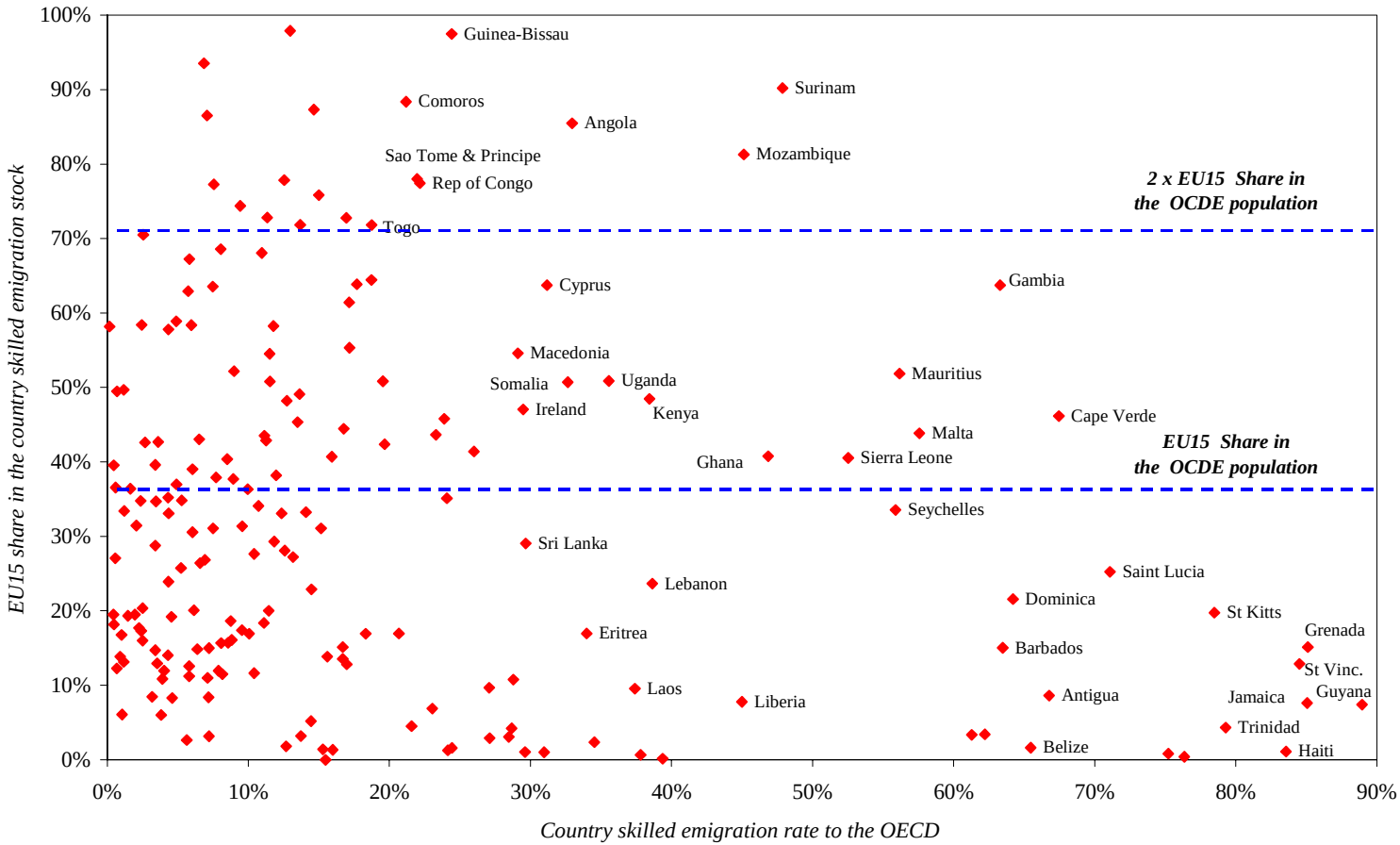
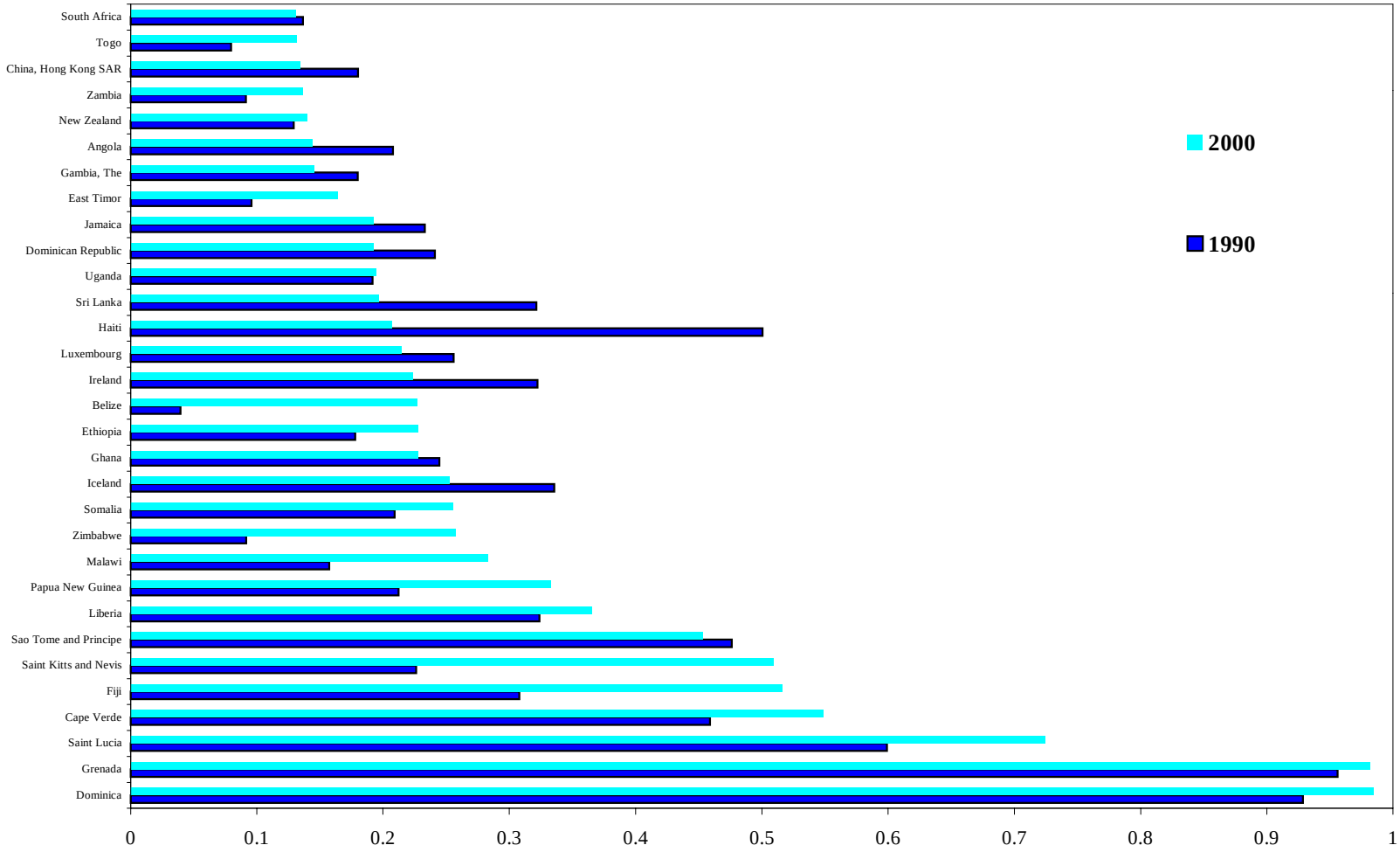
Figure 1. Contribution of the EU15 in the international brain drain



Source: Docquier, Lohest and Marfouk (2006)

Figure 2. Most affected countries by the medical brain drain



Source: Docquier and Bhargava (2006).

Figure 3. International migration in a globalized world

Fig 3.1. Globalization and world international migration

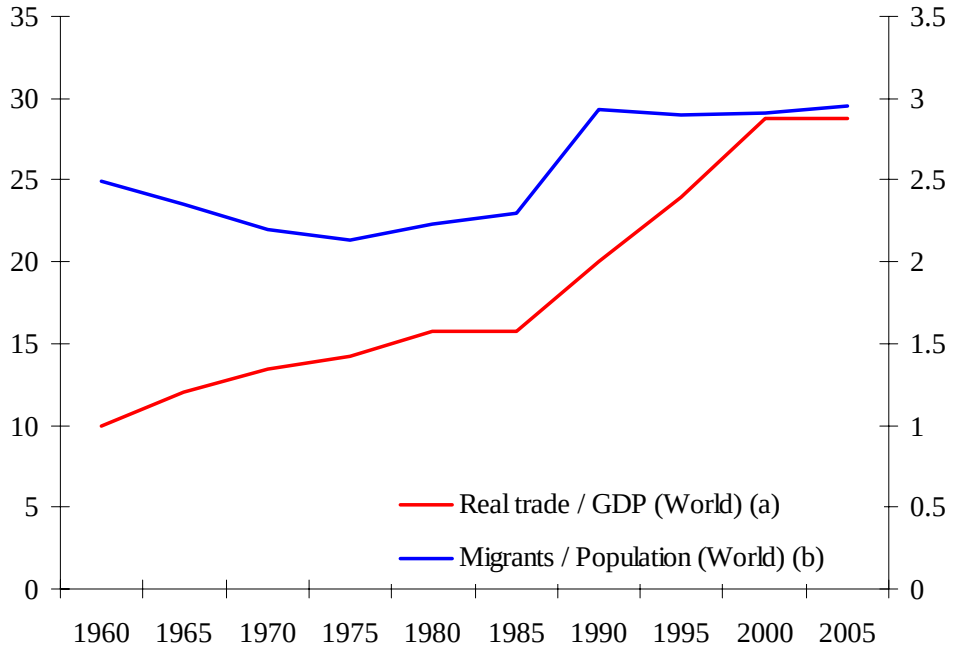
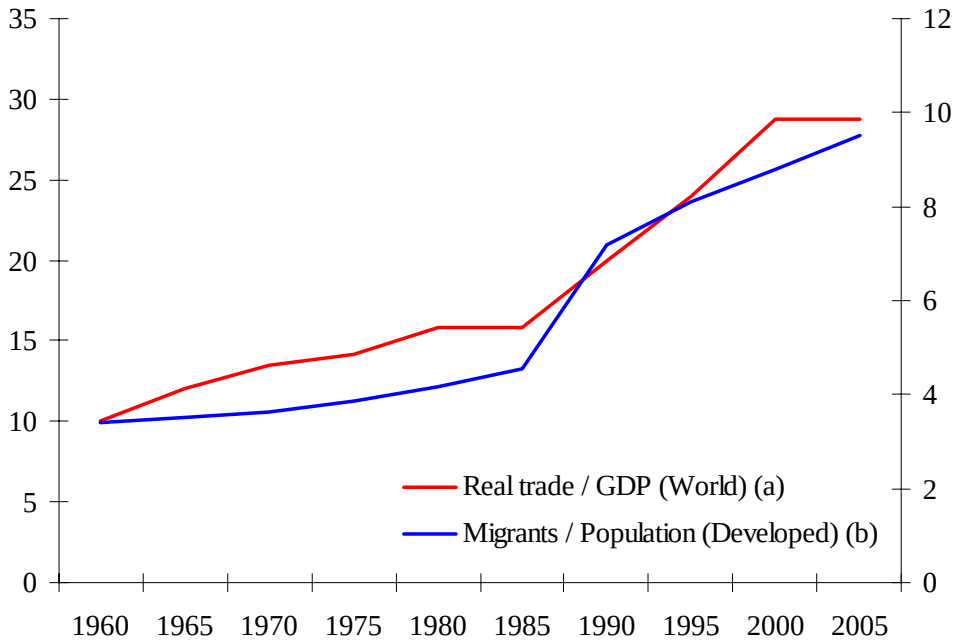


Fig 3.1. Globalization and immigration in the more developed coutries



(a) Barriel, M. and M.R.W. Dean (2004), "Why has World Trade Grown Faster than World Output?" . Bank of England Quarterly Bulletin, available at http://ssrn.com/abstract=700072 .
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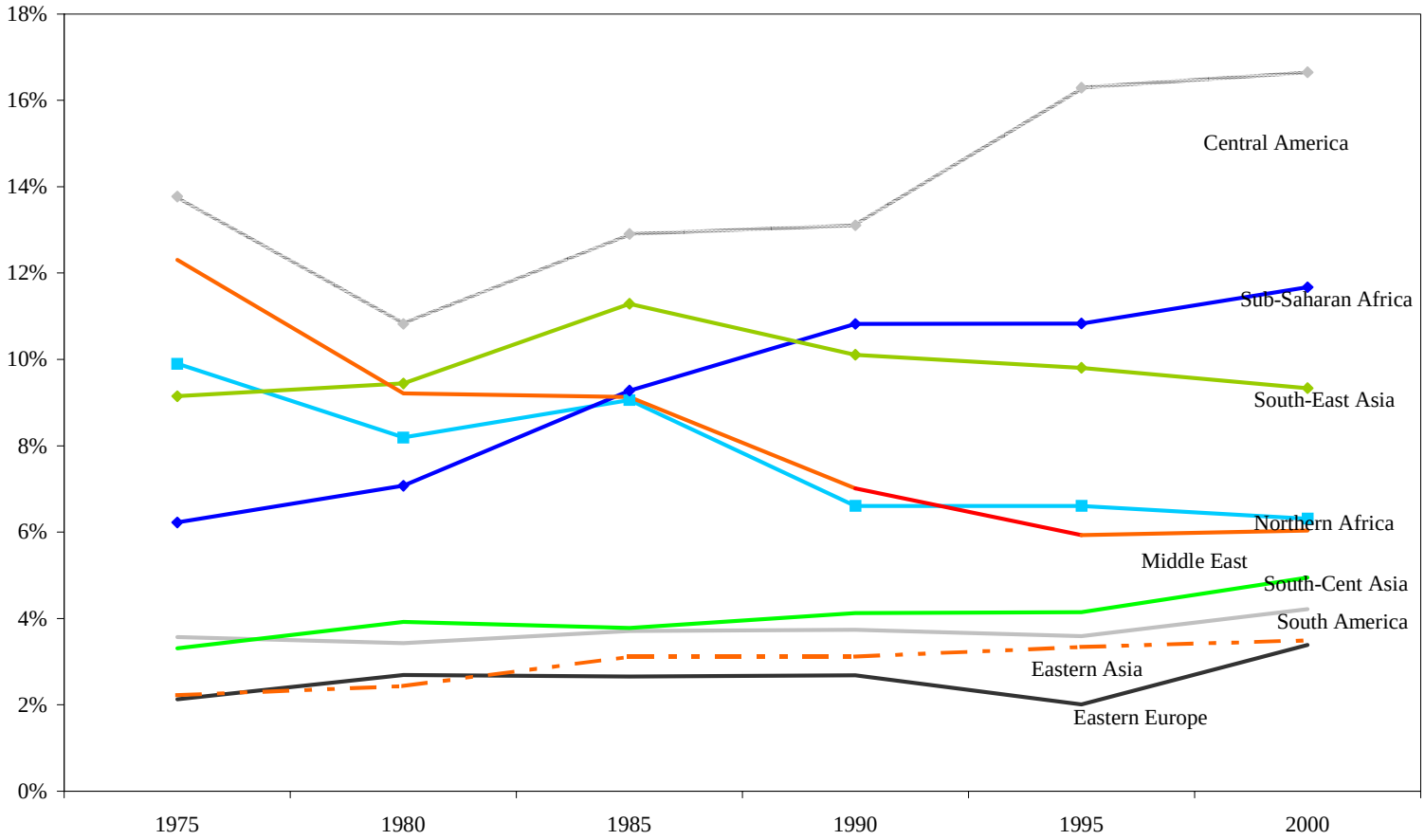
Figure 4. Long-run trends in skilled emigration



Source: Defoort (2006)

Figure 5. Human capital and GDP per capita (average 1995-2005)

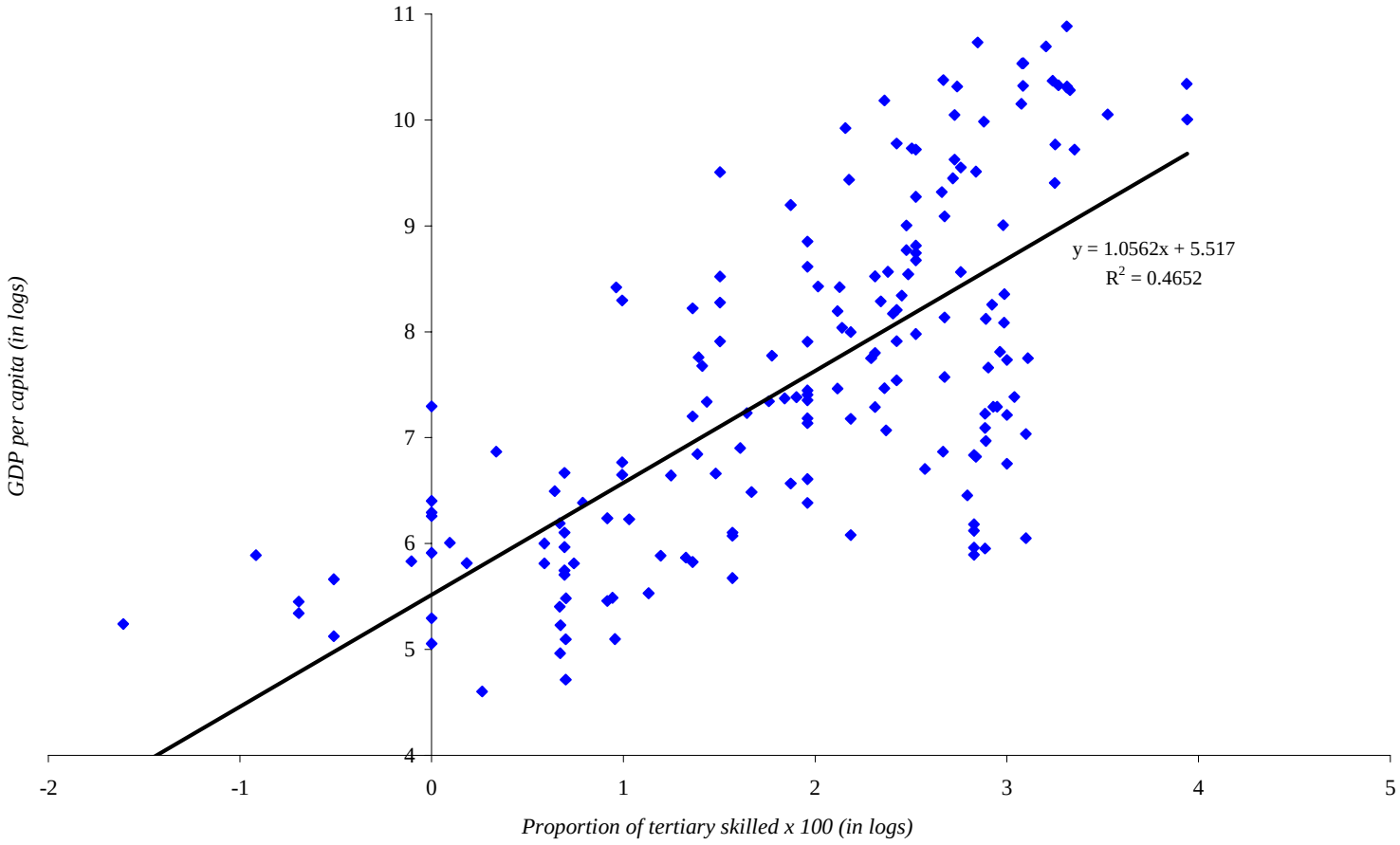


Figure 6. Simulated contribution of skilled migration rate (X-axis) to human capital (Y-axis)

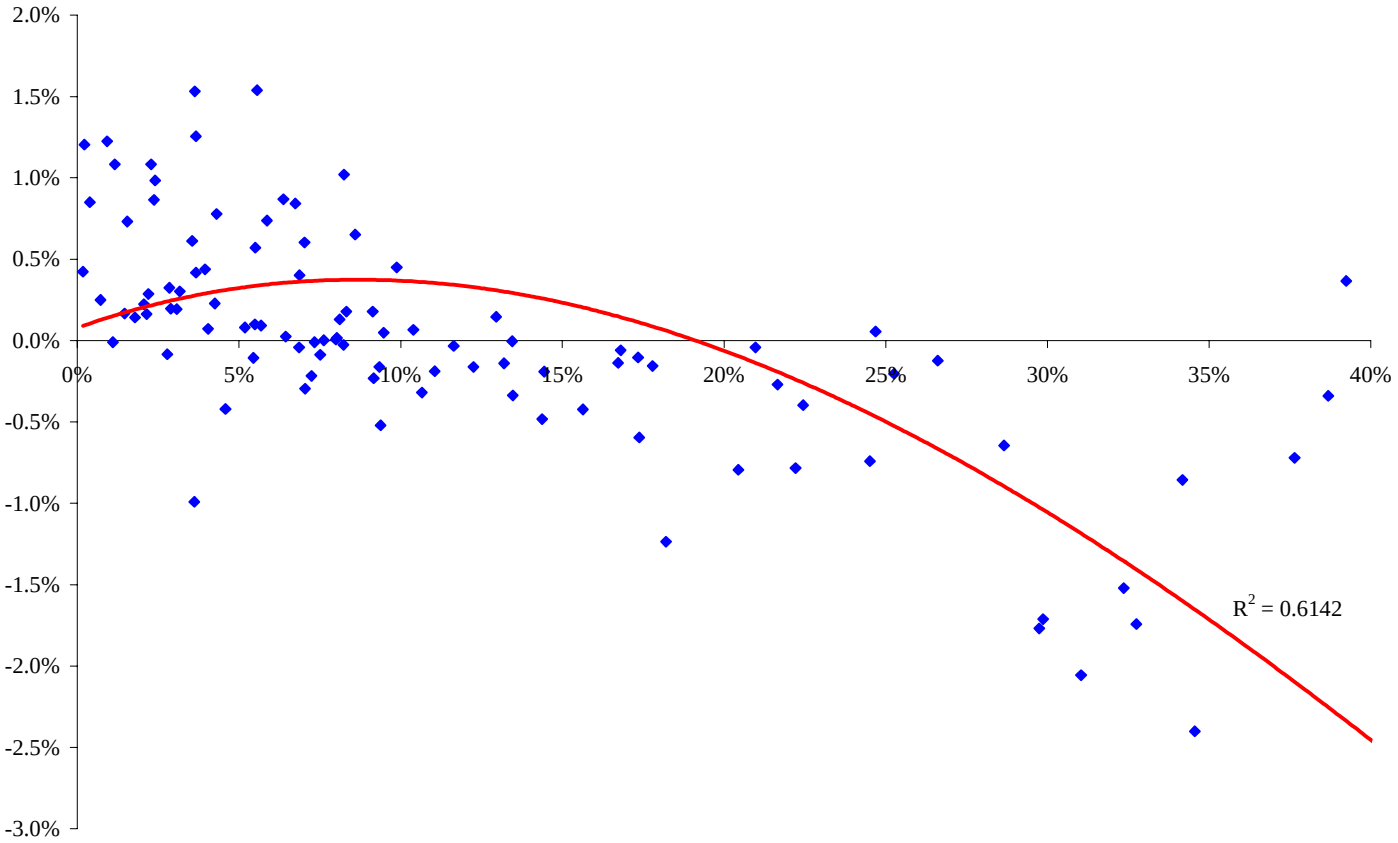


Table 1. Data by country group in 2000

	Rate of emigration			Share of skilled workers	
By country size	**Total**	**Skilled**	**Educ. gap**	**In residents**	**In migrants**
Large countries (Pop>25 million)	1.3%	4.1%	3.144	11.3%	36.4%
Upper-Middle (25>Pop>10)	3.1%	8.8%	2.839	11.0%	33.2%
Lower-Middle (10>Pop>2.5)	5.8%	13.5%	2.338	13.0%	33.1%
Small countries (Pop<2.5)	10.3%	27.5%	2.666	10.5%	34.7%
By income group	**Total**	**Skilled**	**Educ. gap**	**In residents**	**In migrants**
High Income countries	2.8%	3.5%	1.238	30.7%	38.3%
Upper-Middle Income countries	4.2%	7.9%	1.867	13.0%	25.2%
Lower-Middle Income countries	3.2%	7.6%	2.383	14.2%	35.4%
Low Income countries	0.5%	6.1%	12.120	3.5%	45.1%
By region	**Total**	**Skilled**	**Educ. gap**	**In residents**	**In migrants**
AMERICA	3.3%	3.3%	1.002	29.6%	29.7%
USA and Canada	*0.8%*	*0.9%*	*1.127*	*51.3%*	*57.9%*
Caribbean	*15.3%*	*42.8%*	*2.807*	*9.3%*	*38.6%*
Central America	*11.9%*	*16.9%*	*1.418*	*11.1%*	*16.6%*
South America	*1.6%*	*5.1%*	*3.219*	*12.3%*	*41.2%*
EUROPE	4.1%	7.0%	1.717	17.9%	31.7%
Eastern Europe	*2.2%*	*4.3%*	*1.930*	*17.4%*	*34.2%*
Rest of Europe	*5.2%*	*8.6%*	*1.637*	*18.3%*	*31.0%*
incl. EU15	*4.8%*	*8.1%*	*1.685*	*18.6%*	*32.5%*
incl. EU25	*4.9%*	*8.7%*	*1.789*	*17.6%*	*32.8%*
AFRICA	1.5%	10.4%	7.031	4.0%	30.9%
Northern Africa	*2.9%*	*7.3%*	*2.489*	*7.5%*	*19.6%*
Sub-Saharan Africa	*1.0%*	*13.1%*	*13.287*	*2.8%*	*42.5%*
ASIA	0.8%	5.5%	7.123	6.3%	46.8%
Eastern Asia	*0.5%*	*3.9%*	*8.544*	*6.3%*	*55.5%*
South-central Asia	*0.5%*	*5.3%*	*10.030*	*5.0%*	*52.5%*
South-eastern Asia	*1.6%*	*9.8%*	*5.980*	*7.9%*	*51.4%*
Near and Middle East	*3.5%*	*6.9%*	*1.937*	*11.4%*	*22.9%*
OCEANIA	4.3%	6.8%	1.578	27.8%	45.0%
Australia and New Zealand	*3.7%*	*5.4%*	*1.479*	*32.7%*	*49.2%*
Other Pacific countries	*7.6%*	*48.7%*	*6.391*	*3.1%*	*35.2%*

Source: Docquier and Marfouk (2006)

Table 2. Top-30 most affected countries - Various definitions

Population above 0.25 million				*Population above 4 million*							
Country	**BD0+**	**Country**	**BD22+**	**Country**	**BD0+**	**Country**	**BD12+**	**Country**	**BD18+**	**Country**	**BD22+**
Guyana	*89.0%*	*Guyana*	*81.9%*	*Haiti*	*83.6%*	*Haiti*	*82.0%*	*Haiti*	*78.3%*	*Haiti*	*73.7%*
Jamaica	*85.1%*	*Jamaica*	*74.6%*	*Sierra Leone*	*52.5%*	*Sierra Leone*	*52.1%*	*Sierra Leone*	*51.1%*	*Sierra Leone*	*48.4%*
Haiti	*83.6%*	*Haiti*	*73.7%*	*Ghana*	*46.8%*	*Ghana*	*46.0%*	*Ghana*	*44.9%*	*Mozambique*	*43.7%*
Trinidad Tobago	*79.3%*	*Trinidad Tobago*	*67.5%*	*Mozambique*	*45.1%*	*Mozambique*	*44.6%*	*Mozambique*	*44.4%*	*Ghana*	*42.3%*
Cape Verde	*67.4%*	*Gambia*	*60.4%*	*Kenya*	*38.4%*	*Kenya*	*37.0%*	*Kenya*	*35.7%*	*Kenya*	*33.4%*
Barbados	*63.5%*	*Cape Verde*	*55.5%*	*Laos*	*37.4%*	*Uganda*	*33.7%*	*Uganda*	*32.7%*	*Uganda*	*30.7%*
Gambia, The	*63.2%*	*Sierra Leone*	*48.4%*	*Uganda*	*35.6%*	*Somalia*	*32.2%*	*Somalia*	*31.4%*	*Somalia*	*29.9%*
Fiji	*62.2%*	*Barbados*	*47.5%*	*Angola*	*33.0%*	*Angola*	*30.6%*	*Angola*	*29.2%*	*Angola*	*26.4%*
Bahamas	*61.3%*	*Mauritius*	*45.1%*	*Somalia*	*32.6%*	*Laos*	*30.2%*	*Sri Lanka*	*26.1%*	*Sri Lanka*	*24.1%*
Malta	*57.6%*	*Fiji*	*44.5%*	*El Salvador*	*31.0%*	*El Salvador*	*28.1%*	*Laos*	*25.7%*	*Rwanda*	*23.9%*
Mauritius	*56.1%*	*Malta*	*44.1%*	*Sri Lanka*	*29.6%*	*Sri Lanka*	*27.6%*	*Rwanda*	*24.7%*	*Laos*	*21.9%*
Sierra Leone	*52.5%*	*Mozambique*	*43.7%*	*Nicaragua*	*29.6%*	*Nicaragua*	*27.3%*	*El Salvador*	*23.3%*	*Afghanistan*	*20.4%*
Suriname	*47.9%*	*Bahamas*	*42.3%*	*Hong Kong*	*28.8%*	*Rwanda*	*25.2%*	*Nicaragua*	*22.8%*	*Nicaragua*	*19.4%*
Ghana	*46.8%*	*Ghana*	*42.3%*	*Cuba*	*28.7%*	*Hong Kong*	*24.8%*	*Afghanistan*	*21.5%*	*Croatia*	*18.9%*
Mozambique	*45.1%*	*Liberia*	*37.7%*	*Papua N.G.*	*28.5%*	*Vietnam*	*23.2%*	*Hong Kong*	*21.2%*	*El Salvador*	*18.3%*
Liberia	*45.0%*	*Suriname*	*36.7%*	*Vietnam*	*27.1%*	*Papua N.G.*	*23.1%*	*Croatia*	*20.7%*	*Malawi*	*18.0%*
Lebanon	*38.6%*	*Kenya*	*33.4%*	*Rwanda*	*25.8%*	*Cuba*	*22.9%*	*Papua N.G.*	*19.8%*	*Hong Kong*	*18.0%*
Kenya	*38.4%*	*Uganda*	*30.7%*	*Honduras*	*24.4%*	*Afghanistan*	*22.7%*	*Cuba*	*19.4%*	*Papua N.G.*	*17.1%*
Laos	*37.4%*	*Somalia*	*29.9%*	*Guatemala*	*24.2%*	*Honduras*	*22.2%*	*Vietnam*	*19.0%*	*Cuba*	*17.0%*
Uganda	*35.6%*	*Eritrea*	*27.9%*	*Croatia*	*24.1%*	*Croatia*	*22.1%*	*Honduras*	*18.9%*	*Vietnam*	*15.8%*
Eritrea	*34.0%*	*Lebanon*	*27.4%*	*Afghanistan*	*23.3%*	*Guatemala*	*21.7%*	*Guatemala*	*18.4%*	*Honduras*	*15.2%*
Cyprus	*33.2%*	*Angola*	*26.4%*	*Dominican Rep*	*21.6%*	*Dominican Rep*	*19.2%*	*Malawi*	*18.2%*	*Togo*	*15.0%*
Angola	*33.0%*	*Sri Lanka*	*24.1%*	*Portugal*	*19.5%*	*Malawi*	*18.4%*	*Togo*	*16.9%*	*Zambia*	*14.5%*
Somalia	*32.6%*	*Macedonia*	*24.1%*	*Togo*	*18.7%*	*Togo*	*17.8%*	*Dominican Rep*	*15.7%*	*Slovakia*	*14.4%*
El Salvador	*31.0%*	*Rwanda*	*23.9%*	*Malawi*	*18.7%*	*Portugal*	*16.4%*	*Slovakia*	*15.4%*	*Guatemala*	*14.1%*
Sri Lanka	*29.6%*	*Ireland*	*23.3%*	*Cambodia*	*18.3%*	*Slovakia*	*15.9%*	*Zambia*	*15.1%*	*Portugal*	*13.1%*
Nicaragua	*29.6%*	*Bosnia Herz*	*21.9%*	*Senegal*	*17.7%*	*Zambia*	*15.7%*	*Portugal*	*14.7%*	*Dominican Rep*	*12.8%*
Ireland	*29.5%*	*Laos*	*21.9%*	*Cameroon*	*17.2%*	*Cameroon*	*15.5%*	*Cameroon*	*14.6%*	*Senegal*	*12.5%*
Macedonia	*29.1%*	*Cyprus*	*21.3%*	*Morocco*	*17.0%*	*Senegal*	*15.5%*	*Senegal*	*14.1%*	*Serbia Mont.*	*12.3%*
Hong Kong	*28.8%*	*Afghanistan*	*20.4%*	*Zambia*	*16.8%*	*Cambodia*	*14.8%*	*Morocco*	*13.4%*	*Cameroon*	*12.3%*

Beine, Docquier et Rapoport (2006)

Table 3 : Brain drain and human capital in developing countries
Counterfactual experiment : skilled emigration rate = unskilled emigration rate

	Observed nb of skilled (Yx1000)	In % of the labor force (y=Y/LF)	Counterfactual nb. of skilled - (Y'x1000)	In % of the labor force (y'=Y'/LF')	Brain drain in absolute number (Y-Y')	Brain gain as percent of the labor force (y-y')
By country size (in 2000)						
Large (>25 million)	97370	4.9%	93081	4.6%	**4288**	**0.2%**
Upper-Middle (from 10 to 25)	11968	6.6%	12066	6.6%	-97	0.0%
Lower-Middle (from 2.5 to 10)	6525	8.1%	7104	8.7%	-578	-0.6%
Small (<2.5 million)	632	6.3%	946	9.1%	-313	-2.8%
By Income Group (in 2000)						
Upper-Middle	26917	11.0%	26064	10.6%	**853**	**0.4%**
Lower-Middle	29990	10.9%	30356	10.9%	-367	0.0%
Low-Income	59589	3.4%	56776	3.2%	**2813**	**0.2%**
Least Developed	6801	2.4%	6939	2.5%	-137	0.0%
By region						
China	20508	2.7%	19067	2.5%	**1441**	**0.2%**
India	23060	4.8%	21547	4.5%	**1514**	**0.3%**
Indonesia	5199	5.0%	4748	4.6%	**451**	**0.4%**
Turkey	2816	8.5%	2757	8.3%	**59**	**0.2%**
Other Middle East	5494	8.8%	5478	8.7%	**16**	**0.1%**
Other Asian	23927	6.9%	24045	6.9%	-118	0.0%
ASIA	75510	4.4%	72163	4.2%	**3347**	**0.2%**
Egypt	3131	10.7%	2929	10.0%	**202**	**0.7%**
Other Northern Africa	2264	6.7%	2322	6.9%	-58	-0.1%
Nigeria	1245	3.1%	1247	3.1%	-2	0.0%
South Africa	2071	10.4%	1997	10.0%	**74**	**0.4%**
Other Sub-Sahara	3164	1.8%	3387	1.9%	-222	-0.1%
Sub-Saharan Africa	6480	2.8%	6630	2.8%	-150	-0.1%
AFRICA	11870	4.0%	11876	4.0%	-5	0.0%
MENA	13705	8.7%	13486	8.5%	**219**	**0.2%**
Mexico	5111	11.3%	5290	11.6%	-180	-0.3%
Caribbean	1545	9.3%	2304	13.1%	-759	-3.8%
Other Central-America	1498	10.3%	1665	11.2%	-167	-0.9%
Central America	8154	10.7%	9259	11.9%	-1105	-1.2%
Brazil	7313	8.4%	6688	7.7%	**625**	**0.7%**
Argentina	3970	19.7%	3678	18.2%	**292**	**1.5%**
Other South-America	7410	13.8%	7232	13.3%	**177**	**0.5%**
South America	18693	11.6%	17598	10.9%	**1095**	**0.7%**
LATIN AMERICA	26846	11.3%	26856	11.2%	-10	0.1%
TOTAL	116495	5.1%	113196	5.0%	**3299**	**0.2%**

Source: Beine, Docquier and Rapoport (2006)