

# Skilled migration: the perspective of developing countries\*

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## Abstract

In this paper we focus on the consequences of skilled migration for source (developing) countries. We first present new evidence on the magnitude of the "brain drain" at the international level and then discuss its direct and indirect effects on human capital formation in developing countries in a unified stylized model. Finally we turn to policy implications, with emphasis on migration and education policy in a context of international migration.

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\*The first author thanks the World Bank for financial support (Contract PO. 7620076 - UPI 269656). We thank Arye Hillman and Maurice Schiff for helpful comments. The usual disclaimer applies. Corresponding author: Frederic Docquier, CADRE, University of Lille 2, 1 Place Deliot, 59024 Lille, France. Email: f.docquier@skynet.be.

## **NON-TECHNICAL SUMMARY**

In this paper we focus on the consequences of skilled migration for developing countries. We first summarize the recent findings of Docquier and Marfouk (2004) on the international mobility of the highly-skilled; their estimates, based on immigration data collected from nearly all OECD countries in 1990 and 2000, show that the “brain drain” has gained in magnitude over the period covered, but that substantial differences remain across regions and income groups.

The central section presents the theoretical arguments of the “new” and “old” brain drain literatures in a fully harmonized framework. We first review the early brain drain literature, which tends to emphasize the losses to those left behind. We then ask whether the traditional detrimental effects stressed in the early literature may be offset by potentially beneficial effects emphasized in more recent contributions (remittances, return migration, creation of trade and business networks, and possible incentive effects of migration prospects on human capital formation at home), and provide empirical evidence on these different channels where available. According to most existing studies, it is unlikely that remittances, return migration or other ways through which highly-skilled emigrants continue to impact on their home country's economy are significant enough to compensate sending countries for the losses induced by the brain drain. By contrast, cross-country comparisons provide supportive evidence that migration prospects foster domestic enrollment in education. Additional investigations are clearly needed to assess the net effect of emigration on human capital formation at home.

The last section explores some of the policy implications of the analysis, with emphasis on migration policy and education policy. We show that from the perspective of developing countries, the “optimal” emigration rate for the highly-skilled is zero where liquidity constraints are strongly binding and then conforms to an inverse-U shape pattern with respect to the country's level of development. As to education policy, we discuss the role of taxes and education subsidies when human capital is mobile internationally and show how optimal policy responses to such mobility are affected by the parameters of the model.

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# 1 Introduction

The current wave of economic globalization has opened a window of opportunity for human capital to agglomerate where it is already abundant and yet best rewarded, i.e., in the most economically advanced countries. This natural tendency has been strengthened by the gradual introduction of selective immigration policies in many OECD countries since the 1980s. What started as an effort to increase the "quality" of immigration in countries such as Australia or Canada has developed into an international competition for attracting the highly educated and skilled. Together with traditional self-selection effects on the supply-side, this explains the overall tendency for migration rates to be much higher for the highly-skilled. While the world export/GDP ratio has increased by 51 percentage points between 1990 and 2000 (WTO, 2004), the total number of foreign-born individuals residing in OECD countries has increased in the same proportion (51%) over that period, a figure that jumps to 70% for highly-skilled migrants against only about 28% for low-skilled migrants (Docquier and Marfouk, 2004).

What are the consequences of this human capital flight for sending (developing) countries? In a world of perfect competition with complete markets, the free mobility of labor would seem to be Pareto-improving: migrants receive higher incomes, natives in the receiving countries can share the immigration surplus, and remaining residents in the sending countries can benefit from the rise in the land/labor and capital/labor ratios. However, in the case of highly-skilled migrants, such labor movements also generate a number of "externalities" that have to be factored in. First, skilled migrants are net contributors to the government budget and their departure, therefore, increases the fiscal burden on those left behind (fiscal externality). Second, skilled labor and unskilled labor complement one another in the production process; in a context of scarcity of skilled labor and abundant unskilled labor, as is the case in developing countries, skilled labor migration may have a substantial negative impact on low-skilled workers' productivity and wages (intragenerational spillover) and increase domestic inequality. Third, human capital depletion through emigration would seem to impact negatively on a country's growth prospects, inasmuch as human capital formation is now viewed as a central engine of growth (intergenerational spillover). Fourth, as demonstrated in various new economic geography frameworks (e.g., Fujita et al., 1999), skilled labor is instrumental in attracting FDI and fostering R&D expenditures (technological externality); hence, the mobility of human capital is contributing to the concentration of economic activities in specific locations, at the expense of origin regions.

On the other hand, high-skill migration may also induce positive feedback effects as skilled emigrants continue to affect the economy of their origin country. Such possible feedbacks include migrants' remittances, return migration after additional skills have been acquired abroad, and the creation of networks that facilitate trade, capital flows and knowledge diffusion.

Given the many channels involved, an evaluation of the exact impact of the migration of skilled labor (the "brain drain") for source countries is a very complex task. As we shall advocate in this paper, most of this impact may ultimately be captured through the effect of emigration on the composition of the labor force, that is, on the stock of human capital per worker remaining in the home country. Until recently, empirical attempts in this direction have been hampered by the lack of harmonized international data on migration by origin country and education level. In the absence of such empirical material, the debate has remained almost exclusively theoretical. The early "brain drain" literature of the 1970s emphasized its negative consequences for those left behind. The main conclusions were that skilled emigration contributes to increased inequality at the international level, with the rich countries getting richer at the expense of the poorer countries. By contrast, more recent contributions ask whether the traditional negative effects of the brain drain stressed in the early literature may be offset by possible beneficial effects arising from remittances, return migration, creation of trade and business networks, and possible incentive effects of migration prospects on human capital formation at home.<sup>1</sup> In particular, a new brain drain theoretical literature has emerged around the idea that migration prospects may well foster human capital formation in developing countries even after actual emigration is netted out; this literature studies the theoretical conditions under which the overall effect of the brain drain may be positive (i.e. brain drain reduces international inequality). During the last two decades, there has been a significant increase in the magnitude of the brain drain. However, as recent theories show, it could be that some developing countries have experienced a social gain from this brain drain.

We first summarize in Section 2 the data on the magnitude of the brain drain, and then provide new estimates on the international mobility of the highly skilled; our measures are based on immigration data collected from nearly all OECD countries for 1990 and 2000 by Docquier and Marfouk (2004). These data show that the brain drain has gained in magnitude over the period covered although substantial differences remain across countries and regions. Section 3 presents the theoretical arguments of the "new" and "old" brain drain literatures in a fully harmonized framework: we first review the early brain drain literature, and contrast it to more recent models. We also review the various channels whereby skilled migrants may impact on their home country after they have left (remittances, return migration, networks), and provide evidence on these different channels when available. Section 4 is dedicated to policy implications, with emphasis on migration policy and education policy in a context of international migration. Section 5 concludes.

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<sup>1</sup>Grubel and Scott (1969) already mentioned the various possible feedback effects of the brain drain for source countries (remittances, networks, innovation in the host country that may spillover to the origin country, etc), and argued that the short-term loss (due to intragenerational and fiscal externalities) could well be offset in the the long run. However, such possible feedbacks were considered too small to make a difference, and the brain drain literature of the 1970s focused on its detrimental (short-term) impact.

## 2 How big is the brain drain?

There is clear evidence that the brain drain has increased dramatically since the 1970s, both in absolute and relative terms. Nearly 30 years ago, the United Nations estimated the total number of highly-skilled South-North migrants for 1961-72 at only 300,000 (UNCTAD, 1975); less than a generation later, in 1990, the U.S. Census revealed that there were more than 2.5 million highly educated immigrants from developing countries residing in the U.S. alone, excluding people under the age of 25 (that is, without counting most foreign students). Country studies commissioned by the International Labor Organization also show that nearly 40% of the Philippines' emigrants are college educated, and, more surprisingly, that Mexico in 1990 was the world's third largest exporter of college-educated migrants (Lowell and Findlay, 2001). Since 1990, the chief causes of the brain drain have gained in strength and these increasing trends have been confirmed. Indeed, selective immigration policies first introduced in Australia and Canada in the 1980s have spread to other OECD countries: the Immigration Act of 1990 as well as the substantial relaxation of the quota for highly skilled professionals (H1-B visas) in the US constitute a very significant change in the immigration policy of the country that remains the destination of about 40% of the immigrants to the OECD area. Finally, a growing number of EU countries (including France, Germany, Ireland and the UK) have recently introduced similar programs aiming at attracting a qualified workforce (e.g., through the creation of labor-shortage occupation lists) (OECD, 2002).

Until very recently, there were no comparative data on the magnitude of the brain drain. The first serious effort to put together harmonized international data on migration rates by education level is due to William Carrington and Enrica Detragiache from the International Monetary Fund, who used US 1990 Census data and other OECD statistics on international migration to construct estimates of emigration rates at three education levels (primary, secondary and tertiary schooling) for about 60 developing countries.<sup>2</sup> The Carrington-Detragiache (henceforth CD) estimates, however, suffer from four main shortcomings. First, CD assumed for each country that the skill composition of its emigration to non-US OECD countries is identical to that of its emigration to the US; for example, Nigerian immigrants in the UK are assumed to be distributed across educational categories in the same way as Nigerian immigrants in the US. Consequently, the CD estimates are not reliable for countries for which the US is not the main destination. Second, at the time CD conducted their study, the OECD immigration data (regarding the EU, Japan, Switzerland, New Zealand...) did not allow for a full decomposition of the immigrants' origin-mix; more precisely, the OECD published statistics indicating the country of origin only for the top 5 or 10 sending countries. For small countries not captured in these statistics, the figures reported in the CD data set are therefore biased: the

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<sup>2</sup>See Carrington and Detragiache (1998, 1999). Relying on the same assumptions, Adams (2003) provides estimates for 2000.

total number of emigrants is under-estimated, and in some cases one is (mis)led to conclude that 100% their immigrants to the OECD area immigrated to the US; as acknowledged by Carrington and Detragiache, this may approximate the reality for Latin America, but is clearly erroneous, for example, in the case of Africa. Third, the CD data set excludes South-South migration, which may be significant in some cases (e.g., migration to the Gulf States from Arab and Islamic countries, to South Africa from neighboring countries, etc.). Finally, the definition of a migrant is simply a foreign-born individual residing in the receiving country; it is therefore impossible to distinguish between immigrants who were educated at the time of their arrival and those who acquired education after they settled in the receiving country; for example, Mexican-born individuals who arrived in the US at age 5 or 10 and graduated from US high-education institutions later on are counted as highly-skilled immigrants. Despite these various shortcomings, the CD estimates constitute a first and very useful step toward building a fully-harmonized data set on migration rates by education levels.

In an attempt to extend Carrington and Detragiache's work, Docquier and Marfouk (2004) collected data on the immigration structure by education levels and country of birth from most OECD countries in 1990 and 2000. They use the same methodology and definitions as Carrington and Detragiache (1998),<sup>3</sup> but extend their work in a number of ways. They use Census data or specific and detailed surveys for nearly all OECD countries: Census data reporting educational levels and countries of birth were used for 11 countries in 2000 and 8 countries in 1990. Survey data were used for 13 European countries. These data give the immigrants' origin for all source countries, not only for the top 5 or 10 countries, thus preventing an under-representation of small countries, as was the case for the CD dataset. In addition, for 24 out of 30 receiving countries, the data collected also give the exact education structure of immigration, while CD had to extrapolate this from the US data, with the US representing only about 44.1% total immigration to the OECD. On the whole, the estimates are based on accurate information on the immigration stock per country of origin and education level (primary, secondary, and tertiary schooling) for 88.8% of adult immigrants in 1990 and 92.7% of adult immigrants in 2000. Hence, Docquier and Marfouk (2004) provide "reliable" estimates (i.e., based on precise information for at least 80% of the total stock analyzed) for 175 countries in 2000 and 160 countries in 1990.<sup>4</sup>

Aggregating over countries, the total number of adult immigrants living in the OECD area and aged 25 or more is estimated at 58.5 million in 2000 and 39.8 million in 1990. Emigration rates by education levels are obtained by comparing the number

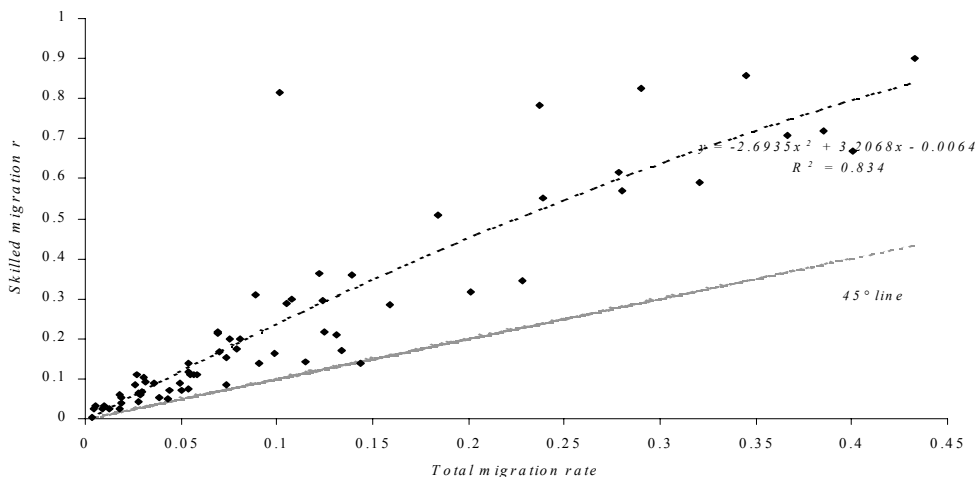
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<sup>3</sup>Their estimates are based primarily on national census and register data. Survey data were also used when census statistics were not available or not sufficiently detailed. In a limited number of cases where data by country of birth are not available, immigrants are defined as residents with foreign citizenship (e.g., Germany, Japan, Italy or Korea).

<sup>4</sup>At the same reliability rate, Carrington and Detragiache (1998) provided reliable estimates for about 25 countries.

of emigrants to the population from which they are drawn. The latter information is taken from the Barro and Lee (1993) data set on educational attainments. At the world level, 1.66% of the working age population is living in a foreign country. The worldwide average emigration rates amount to 0.94%, 1.64% and 5.47% for low-skill, medium-skill and high-skill workers, respectively. As apparent from Figure 1, emigration rates for high skilled workers are strongly correlated to (but always higher than) total emigration rates.

**Figure 1. Skilled workers' and total emigration rates**  
(with 2-order polynomial trend)



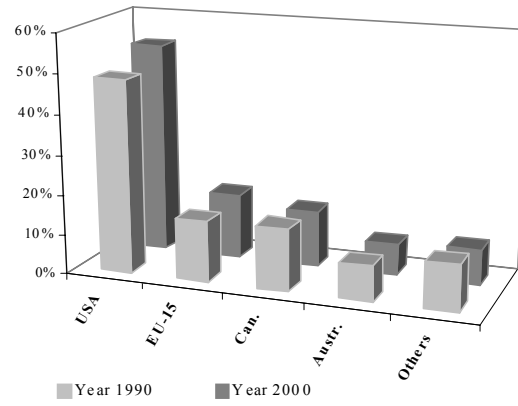
Regarding receiving countries, two major trends characterize the evolution of migratory patterns between 1990 and 2000: (i) Quality-selection is more and more important and, (ii) Low-income countries are increasingly affected by the brain drain. The worldwide average rate of emigration for skilled workers has increased by 0.75 percentage point over the period 1990 and 2000, against only 0.06 percentage point for low-skill workers and 0.41 for medium-skill workers. As shown on Figure 2, most skilled emigrants choose the USA as destination (fig 2.A)<sup>5</sup>. More importantly, the share of skilled workers in the total stock of immigrants has increased in all receiving countries, and more so in Canada and Australia, the two countries which were the first to introduce selective immigration policies officially (fig 2.B). In all OECD countries, the proportion of skilled immigrants originating from low-income countries has increased, especially in North America, with a notable increase of highly-skilled immigration from Asian countries (fig 2.C).

<sup>5</sup>In 2000, about 44% of the OECD adult immigrants lived in the US. This proportion jumps to 50% for skilled immigrants.

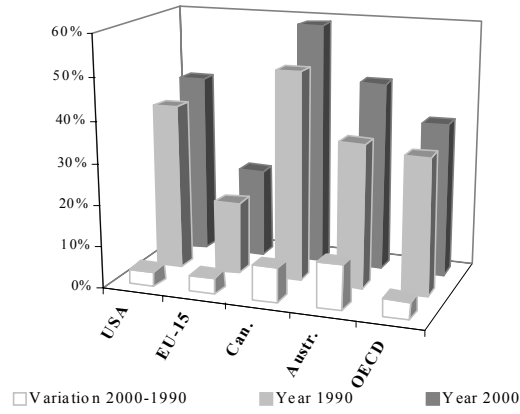


**Figure 2. Immigration structure in the OECD area**

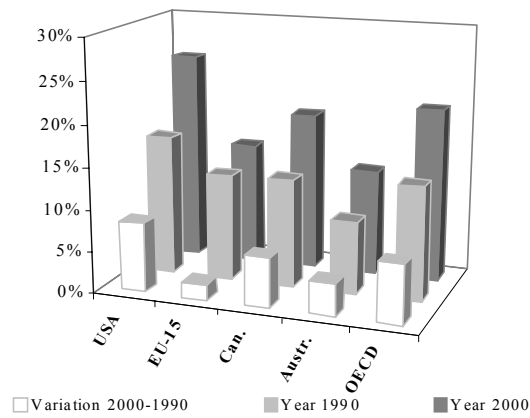
**A. Destination of skilled immigrants in percent of the OECD**



**B. Skilled immigrants in percent of the immigration stock**



**C. Percentage of skilled immigrants from low income countries**



Regarding sending countries, the intensity of the brain drain differs if it is measured in absolute or relative terms. Table 1 provides the 30 most affected and least affected countries in 2000. Only countries with a population higher than 4 million are included. Looking at absolute numbers the Philippines, India, China, Mexico but also the United Kingdom, Germany, and Canada appear as the major sending countries. When looking at relative numbers (i.e., in proportion of the local educated labor force at origin), skilled emigration appears to be particularly strong in Central America and the Pacific Region, with figures higher than 80% in countries such as Guyana, Jamaica, or Suriname.

**Table 1. Emigration (stocks or rates) of skilled workers in selected countries (excluding countries with population < 4 millions)**

	Emigration stock in 2000 <i>30 largest stocks</i>		Emigration rate in 2000 <i>30 highest rates</i>		Emigration rate in 2000 <i>30 lowest rates</i>	
1	United Kingdom	1 542 011	Haiti	81.6%	Sweden	4.4%
2	Philippines	1 260 879	Somalia	58.6%	Egypt	4.2%
3	India	1 021 613	Ghana	42.9%	China	4.2%
4	Germany	1 016 007	Mozambique	42.0%	India	4.2%
5	China	906 337	Sierra Leone	41.0%	Moldova	4.2%
6	Mexico	901 347	Vietnam	39.0%	France	3.9%
7	Canada	566 833	Nigeria	36.1%	Libya	3.8%
8	Italy	470 331	Madagascar	36.0%	Burma (Myanmar)	3.4%
9	Vietnam	446 895	El Salvador	31.5%	Venezuela	3.3%
10	United States	428 078	Nicaragua	30.9%	Brazil	3.3%
11	Korea, North	422 518	Lebanon	29.7%	Burkina Faso	3.3%
12	Korea, South	384 497	Croatia	29.4%	Belarus	3.0%
13	Poland	379 266	Cuba	28.9%	Nepal	2.7%
14	Cuba	336 419	Hong Kong	28.7%	Georgia	2.6%
15	Japan	331 892	Papua New Guinea	28.2%	Azerbaijan	2.6%
16	France	301 717	Sri Lanka	27.5%	Spain	2.6%
17	Iran	282 587	Kenya	26.3%	Argentina	2.5%
18	Taiwan	280 710	Angola	25.6%	Australia	2.3%
19	Russian Federation	263 041	Senegal	24.1%	Paraguay	2.3%
20	Jamaica	260 850	Honduras	21.8%	Thailand	2.2%
21	Hong Kong	254 805	Dominican Republic	21.7%	Indonesia	2.0%
22	Brazil	254 467	Uganda	21.6%	Japan	1.5%
23	Netherlands	240 494	Guatemala	21.5%	Russian Federation	1.3%
24	Ukraine	237 395	Burundi	19.9%	Kazakhstan	1.1%
25	Colombia	232 596	Rwanda	19.0%	Uzbekistan	1.0%
26	Ireland	220 545	Serbia and Montenegro	17.4%	Kyrgyzstan	0.7%
27	Romania	217 198	Ethiopia	17.0%	Saudi Arabia	0.7%
28	Peru	183 915	United Kingdom	16.7%	Tajikistan	0.7%
29	Pakistan	174 884	Tanzania	15.8%	United States	0.5%
30	New Zealand	172 582	Slovakia	15.3%	Turkmenistan	0.1%

Despite a strong within-group heterogeneity, Figure 3 illustrates interesting differences between groups. Average migration rates are computed by region, by income group (for the four categories distinguished by the World Bank) and by country-size groups (above 25 million, from 10 to 25 million, from 4 to 10 million and below 4 million). Regarding the regional distribution (see figure 3.A), the most affected

regions are Africa and Europe<sup>6</sup>. The Pacific region and Asia exhibit intermediate rates, and the figures for American countries as a whole are small.<sup>7</sup> The regional disparities are extremely stable between 1990 and 2000. Regarding income groups (see figure 3.B), it is worth noticing that the highest rates are observed in middle-income countries. High-income countries (less incentive to emigrate) and low-income countries (where liquidity constraints are more binding) exhibit the lowest rates. Between 1990 and 2000, the situation clearly improved in lower-middle-income countries and deteriorated in low-income countries. Finally, regarding country-size groups, there is a clear decreasing relationship between the emigration rate and the country size. Disparities are also extremely stable over time.

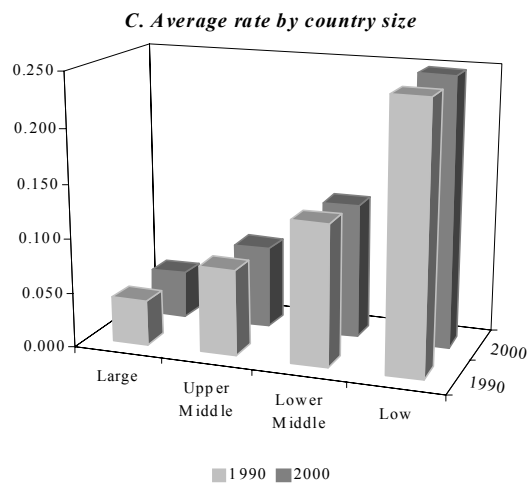
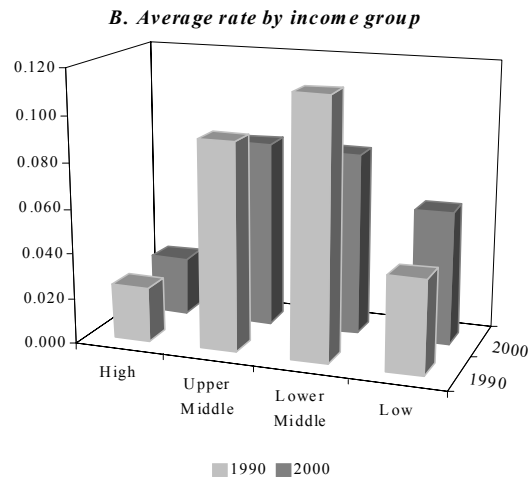
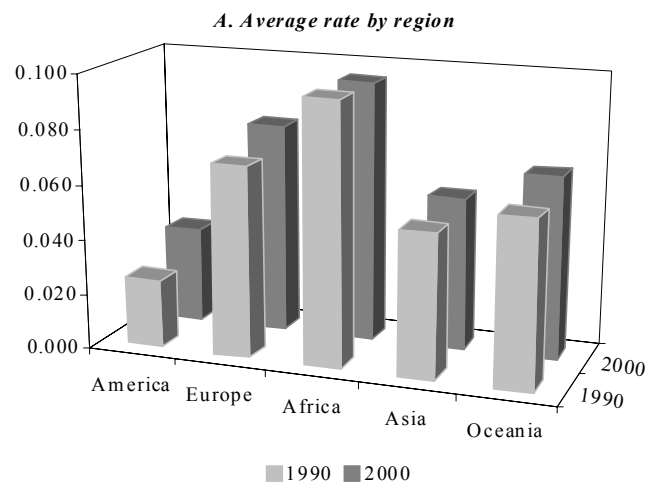
Spatial clusters may also be distinguished, as apparent from the world map in Figure 4. In North and South America, Western and Eastern Europe, South-Central and Eastern Asia, North and South Africa, brain drain is rather small. On the contrary, brain drain has a very important impact on the human capital structure of the labor force in the Caribbean, Central America, South-Eastern Asia, Western and Eastern Africa. The proximity with the USA is an obvious key factor explaining the situation of the Caribbean and Central America. Countries from South Eastern Asia (Vietnam, Philippines, Laos) have a more diverse portfolio of destinations as they send migrants to the USA, Canada and Australia. For African countries, colonial ties with European countries such as the UK (Gambia, Ghana, Somalia), France (Mauritania, Djibouti), or Portugal (Angola, Cape Verde, Mozambique) are key determinants of migrants' locations.

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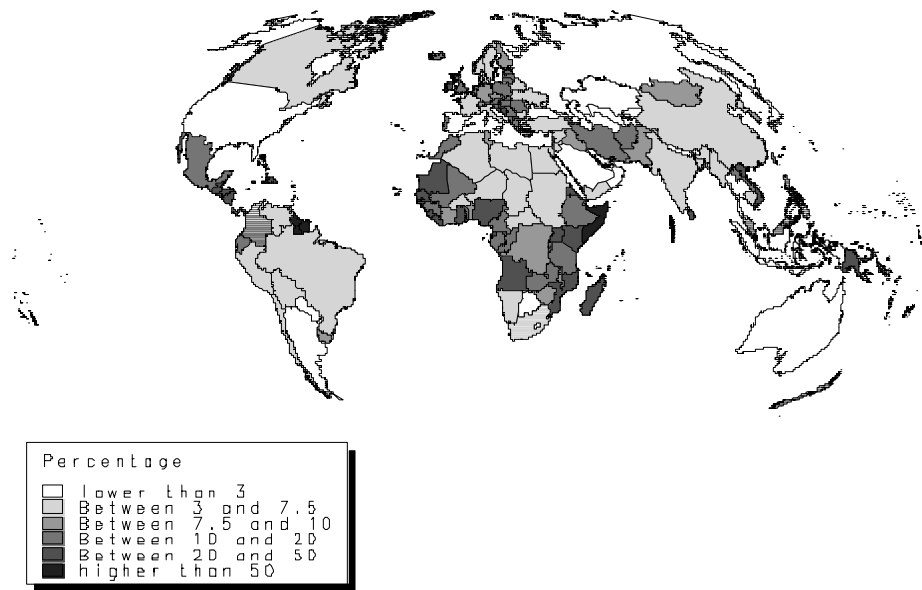
<sup>6</sup>Migration between European countries is counted.

<sup>7</sup>The American average rate is clearly driven by the US.

**Figure 3. Skilled workers emigration rates by country group**



**Figure 4. Emigration rate of the highly skilled - world map**



We now turn to the economic theories that have analyzed the determinants and consequences of international skilled-migration flows for developing countries.

### 3 Theory and evidence

This section provides an overview of the theoretical and empirical literature on the consequences of highly-skilled emigration for source countries. This issue has given rise to a large body of research since the late 1960s, with the early literature generally supporting the view that the brain drain is detrimental to those left behind and the more recent literature providing a more balanced view. We first present the general set-up, reformulate the results of early contributions within this framework, and then introduce the various channels emphasized in later research. We also present the existing evidence on each particular channel.

#### 3.1 The model

Consider a stylized small open economy populated by two-period lived individuals. At each period, a composite good is produced according to a Cobb-Douglas technology,  $Y_t = A_t K_t^{1-\alpha} L_t^\alpha$ . For simplicity, the stock of capital,  $K_t$ , is assumed to be composed of foreign investments only (no domestic savings), and the labor supply,  $L_t$ , sums up skilled and unskilled labor. Normalizing the number of efficiency units offered by an unskilled individual to 1, a skilled individual offers  $h > 1$  such units. The scale factor is time-variable and can be positively related to the economy-wide average level of human capital of the adults remaining in the country,  $H_t$ , itself a function of the proportion of skilled workers in that generation,  $P_t$ . Therefore, we have  $H_t = 1 + P_t(h - 1)$ , with  $P_t$  the share of skilled workers and  $h > 1$  their relative productivity, and  $A_t = A(H_t)$ , with  $A' \geq 0$ .<sup>8</sup>

This latter mechanism allows us to introduce the spillover effects associated to human capital formation. The international mobility of capital is such that the marginal productivity of capital equals to the world interest rate ( $r^*$ ) plus a risk premium ( $\pi_t$ ) associated to internal factors such as risk, political instability, corruption, individual freedom, etc. Hence, the domestic wage rate per efficiency unit of labor is given by:

$$w_t = \alpha \left[ \frac{1 - \alpha}{r^* + \pi_t} \right]^{\frac{1-\alpha}{\alpha}} [A(H_t)]^{\frac{1}{\alpha}} \equiv w(\pi_t, H_t)$$

with the derivatives  $w'_1 < 0$  and  $w'_2 > 0$ .

When young, people are offered the choice between working as unskilled workers or devoting part of their time to education. There is a single education program, the cost of which is proportional to the domestic wage rate  $w_t$ . However, individuals are

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<sup>8</sup>We will later restrict the values of  $h$  to  $]1, 2[$  to obtain interior solution when we assume an uniform distribution of abilities.

heterogeneous in the ability to learn and may therefore be characterized by different education costs, with high-ability individuals incurring a lower cost. The cost of education for a type- $c$  agent is denoted by  $cw_t$ , with  $c$  distributed on  $[0, 1]$  according to the cumulative distribution  $F(c)$ . When adult, skilled (educated) and unskilled agents work full-time, with education enhancing one's productivity and, thus, one's income, by an exogenous skill premium  $h \in [1, 2]$ .<sup>9</sup> Utility is linear in consumption and there is no time-discount rate. There is no domestic saving so that the stock of capital is totally owned by foreign investors.

Without migration, the lifetime income for an uneducated agent is  $w_t + w_{t+1}$ . By contrast, the lifetime income for an educated agent is  $w_t - cw_t + w_{t+1}h$ . Clearly, education is worthwhile for individuals whose education cost is lower than a critical value. At the steady state ( $w_{t+1} = w_t$ ), the condition for investing in education in an economy with no migration (henceforth denoted by the subscript  $n$ ) is:

$$c < c_n \equiv h - 1.$$

In poor countries, however, liquidity constraints are likely to impact on education choices. Assume, that the first-period consumption cannot be lower than a minimal threshold,  $\phi w_t$ , which is assumed to be proportional to wages. Hence, an agent with education cost above  $c_L \equiv 1 - \phi$  has no access to education, and the liquidity constraint may or may not be binding depending on whether  $c_L \gtrless c_n$ .

Consequently, the economy-wide average level of human capital of the current generation of adults may be written as:

$$H_n = 1 + P_n(h - 1)$$

where  $P_n = \text{Min}[F(c_n); F(c_L)]$  measures the proportion of educated adults.

Let us now examine the impact of skilled migration on the sending economy. In the model with private education funding, the impact of migration on remaining residents is related to the way it affects the composition of the labor force. What matters is the effect of migration on the equilibrium wage rate. If the stock of human capital per worker remaining in the home country decreases (resp. increases), the wage rate also decreases (resp. increases) and there is a loss (a gain) of welfare for those left behind. For different reasons, we are aware that the relationship between welfare and skilled migration is likely to depend on other channels which are not modeled here:

- As we shall argue in the policy discussion (see section 4.2), results can be different under public funding of education. Suppose maintaining the same average stock of human capital requires increasing subsidies and taxes, then uneducated workers (who receive no subsidies) experience a welfare loss due to the reduction in net wages (despite constant gross wages);

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<sup>9</sup>Given  $c \in [0, 1]$ , the restriction  $h < 2$  ensures that the proportion of educated is lower than one when  $c$  is uniformly distributed.

- As developed in section 3.5, a rise in welfare can be obtained with decreasing human capital when migration gives rise to international transfers. For the main recipients, disposable income can rise despite decreasing wage rate;
- Another possible criticism is that migration is likely to affect welfare through non-income channels. Building on the idea that individuals obtain pleasure from interaction with those with whom they share social capital (including norms, language, culture and more), Schiff (2002) models the negative externality of emigration per se for those left behind. Even if empirical evidence on social capital and migration is limited, the "social capital drain" is likely to reduce welfare despite constant income.

To avoid using a welfare criterion, our analysis focuses on the impact of the brain drain on the economic potential of the sending country, summarized by the average stock of human capital among remaining members.

### 3.2 The traditional view

The first "modern" economic papers on the impact of highly-skilled migration on source countries date back to the late 1960s (Grubel and Scott, 1966, Johnson, 1967). Their conclusions were not too pessimistic. For example, Grubel and Scott (1966) argued that the short-term loss to the source country (due to the intragenerational and fiscal externalities outlined above) could well be offset in the long run thanks to various possible feedback effects in the form of remittances, networks effects, or innovations that may spillover from the host to the origin country. However, such possible feedbacks were considered too small to make a difference, and the brain drain literature of the 1970s focused on its detrimental (short-term) impact.

The central conclusion of the early brain drain literature, namely, that the brain drain is detrimental to the welfare of those left behind, relies on a number of critical assumptions: (i) Migrants are self-selected among the pool of emigrants, (ii) there is free mobility and, hence, no uncertainty regarding future migration opportunities and, (iii) there is a complete disconnection between emigrants and their country of origin once they have left (no diaspora effect, no return migration, no remittances). In such conditions, clearly, emigration can only affect negatively the proportion of educated in the remaining population,  $P$ .

Building on the stylized model above, consider that workers now have the possibility to emigrate toward a developed country where, due an exogenous technological gap, one unit of human capital is paid  $w^* > w_t$ . The wage ratio can be written as  $\omega_t = w^*/w_t = \omega(P_t)$  with  $\omega' < 0$ . Migration involves a cost  $kw^*$  which captures transportation, search, assimilation and psychological costs of leaving one's home country. Individuals have to choose whether to educate or not (ED or NE), and whether to migrate or not (MI or NM). The lifetime income associated to each pair of decisions



is determined by

$$\begin{aligned}
U(NE, NM) &= w_t + w_{t+1} \\
U(NE, MI) &= w_t + w^*(1 - k) \\
U(ED, NM) &= w_t - cw_t + w_{t+1}h \\
U(ED, MI) &= w_t - cw_t + w^*(h - k)
\end{aligned}$$

At the steady state, the condition for a self-selection equilibrium to emerge (i.e., skilled workers only emigrate) is :

$$\omega(1 - k) < 1 < \omega\left(1 - \frac{k}{h}\right)$$

In this case, migration prospects impact on the critical ability level required for investing in education; the condition for investing in education becomes:

$$c < c_o \equiv \omega(h - k) - 1$$

which is higher than  $c_n = h - 1$  providing that the self-selection condition holds.

There is a great deal of evidence that migration prospects indeed impact on people's decisions to invest in higher education. For example, in their survey on medical doctors working in the UK, Kangasniemi et al. (2004) evaluate that the migration premium in the medical profession lies between 2 and 4 (in PPP values); about 30% of Indian doctors surveyed acknowledge that the prospect of emigration affected their effort put into studies; furthermore, the doctors surveyed estimate that migration prospects affect the effort of about 40% of current medical students in India. Focusing on the software industry, Commander et al. (2004) estimate that the migration premium for Indian IT workers contemplating emigration to the US lies between 3 to 5 (depending on the type of job) in PPP values.<sup>10</sup> According to the IOM (2003), the prospects of working abroad have increased the expected return to additional years of education and led many people to invest in more schooling, especially in occupations in high demand overseas.

Migration prospects stimulate domestic enrollment in education but actual emigration deprives the country of its educated citizens, the proportion of educated in the remaining population falls to zero, and the average level of human capital of remaining members falls to 1.

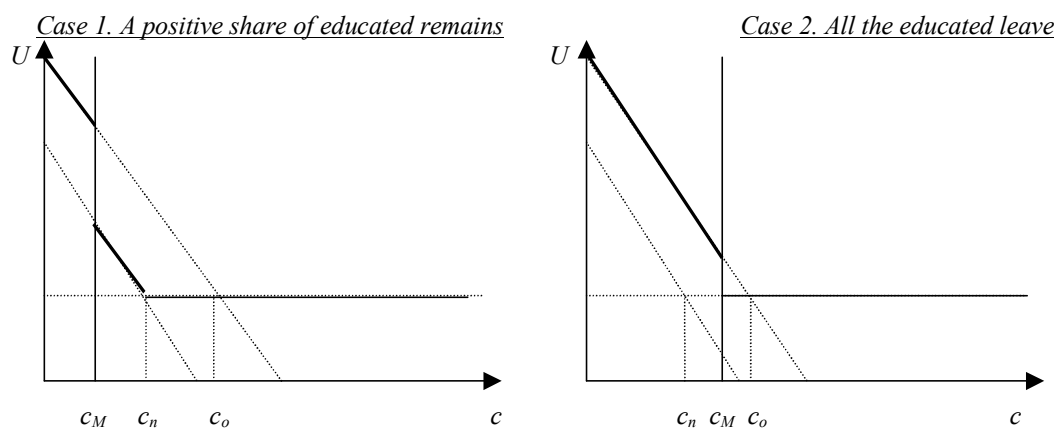
In the presence of a minimal threshold for consumption, migration can be limited by an additional liquidity constraint. Liquidity constraints are due to the monetary fraction of the migration costs only (as psychological costs of leaving and assimilation costs are incurred only once migration has occurred). Let us denote by  $k'w^* < kw^*$

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<sup>10</sup>In current \$, the migration premium is much larger (higher than 10 for many countries). Many migrants confess that they were unable to compare earnings on a PPP basis. The expected migration premium is likely to lie between the PPP and the current \$ values.

this monetary component of the migration cost. Agents with education costs above  $c_M \equiv 1 - k'\omega - \phi < c_L$  cannot both educate and migrate. A positive number of educated individuals thus remains in the source country when the threshold  $c_M$  is lower than  $c_n$ . In this case indeed, individuals with personal ability between  $c_M$  and  $c_n$  cannot afford paying for both migration and education costs but still have an incentive to invest in education (see case 1 on Figure 5). When  $c_M$  is higher than  $c_n$ , however, agents who cannot afford paying for migration costs have no incentive to educate and all the educated would leave the country at the end of period 1 (see case 2 on Figure 5).

**Figure 5. Brain drain, education choices and liquidity constraint**



Basically, the central prediction of the traditional view is that once migration opportunities are introduced, the average level of human capital among remaining residents decreases. The effect on natives' income depends on  $A(H_t)$ , through which various types of externalities can be considered. Building on the idea that the social return to education is higher than its private return, the literature of the 1970s generally concluded there was a detrimental effect based on the externality argument (Hamada, 1977, Usher, 1977, Blomqvist, 1986). In a similar spirit, Bhagwati and Hamada (1974) developed a model of wage determination in which the departure of skilled workers also reduces unskilled workers' expected earnings. The mechanism whereby skilled workers' emigration negatively impacts remaining workers' wages involve a mechanism of wage-setting that accounts for inefficiencies of labor markets in developing countries. Assume that there are two types of workers (educated and uneducated), and wages for the educated are determined by workers' unions and incorporates an element of international emulation (i.e., depend positively on wages abroad). Once skilled-workers wages are set, unskilled-workers wages follow with some rule of proportionality. In this setting, skilled migration reduces skilled unemployment, meaning that wage pressures become stronger. While the net effect on skilled employment depends on the elasticity of demand for skilled labor (deter-

mining whether the skilled labor wage bill increases or not), this tends to extend unemployment and reduces welfare among the uneducated.

Note that Bhagwati and Hamada (1974), as well as McCulloch and Yellen (1977), take into account the incentive effects of the brain drain on education decisions, with the increase in the expected-wage for skilled workers stimulating human capital investments; they also raise a number of questions regarding optimal public financing of education in such a context, an issue that we will deal with in Section 4.

Modern theories of endogenous growth have considerably renewed the analysis of the relations 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). At the same time, a series of studies have tried to promote the simple idea that one should also look at how a given stock of human capital is built up. In particular, it is likely that in the presence of huge inter-country wage differentials, as is the case between developing and developed countries, the prospect for migration deeply modifies the incentive structure faced by developing countries' residents when making their education decisions. When migration is temporary or when the education decision is made in a context of uncertainty regarding future migration opportunities, a beneficial brain drain or a brain gain may result for the source country.

### **3.3 Temporary migration**

Let us first introduce return migration and temporary visas. As documented in international reports (e.g., OECD, 1998), most receiving countries have recently made admission conditions for candidate immigrants more restrictive. On the one hand, as detailed in the introduction, selective procedures have been put in place; on the other hand, most new specific immigration programs targeting the educated and skilled are designed for temporary immigrants, the general trend being towards an increase in the share of temporary visas relatively to permanent visas. Assume, therefore, that candidate immigrants are allowed to spend only a fraction  $\gamma$  of their working life in the destination economy. Substituting temporary for permanent visas reinforces self-selection among migrants: the expected return to education being lowered, fewer people will invest in education and only those at the upper-end of the ability distribution will find it beneficial to do so. Obviously, the exact impact on those who would have invested in education would visas had been permanent visas, depends on the length of the migration period. In terms of our notations, the lifetime income for

educated agents are now given by:<sup>11</sup>

$$\begin{aligned} U(ED, NM) &= w_t - cw_t + w_{t+1}h \\ U(ED, MI) &= w_t - cw_t + \gamma w^*h + (1 - \gamma)hw_{t+1} - kw^* \end{aligned}$$

At the steady state, emigration is optimal for skilled workers when the following condition holds:

$$\gamma h(\omega - 1) > k\omega$$

If the latter condition does not hold, migration prospects have no effect on human capital formation. If it holds, the perspective of temporary migration stimulates human capital investments.

Without liquidity constraints, the condition for investing in education becomes:

$$\begin{aligned} c &< c_\gamma \equiv \gamma(\omega - 1)h + h - 1 - k\omega \quad \text{if } \gamma h(\omega - 1) > k\omega \\ &< c_n \equiv h - 1 \quad \text{if not} \end{aligned}$$

In the first alternative, and assuming a uniform distribution of abilities, the proportion of educated workers in the country becomes:

$$P_\gamma = \frac{(1 - \gamma)c_\gamma}{1 - \gamma c_\gamma}.$$

Graphically, the case of temporary migration is similar to the case of permanent migration, except that the incentive effect is proportional to  $\gamma$ . Nevertheless, the major difference is that, by contrast to the case with permanent visas, the incentive effect partly benefits to the sending country. Indeed, the probability  $P_\gamma$  can be lower or higher than  $P_n$ . Formally, a possibility of "beneficial brain drain" emerges if the derivative of  $P_\gamma$  with respect to  $\gamma$  is positive for low values of  $\gamma$ , i.e. a value such that skilled workers start opting for migration ( $\gamma = \frac{k\omega}{h(\omega-1)}$ ). We obtain

$$\left[ \frac{\partial P_\gamma}{\partial \gamma} \right]_{\gamma h(\omega-1)=k\omega} = \frac{(h-1)(h-2) + h(\omega-1) - k\omega}{[1 - \gamma(h-1)]^2} \stackrel{<}{\geq} 0$$

If this derivative is positive, there is an interval of  $\gamma$  for which the temporary migration of skilled workers can stimulate the share of educated workers in the source country and, in turn, the economy-wide average level of human capital.<sup>12</sup> Several elements are likely to mitigate this result, however. First, liquidity constraints are

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<sup>11</sup>Note that for simplicity we assume migration costs to be identical as in the case of permanent migration. This could be justified by assuming that higher transportation costs (since people now travel both ways) strictly compensate for reduced psychological costs, or that the latter are incurred at the first years following immigration. Alternatively, we could assume that in the case of a temporary migration, people incur a migration cost of  $k' + \gamma(k - k') \equiv k''$ .

<sup>12</sup>Clearly, for  $\gamma = 1$ , the traditional view applies: the effect of brain drain is unambiguously detrimental.

likely to limit the size of the incentive effect. If  $c_\gamma > c_L$ , some agents have no access to education in spite of the fact that education is optimal, which reduced the likelihood of a beneficial brain drain. Similarly, if liquidity constraints restrict migration prospects, the incentive effect is thereby weakened. In the particular case where  $c_M > c_n$ , the number of individuals engaging in education is constant and temporary migration reduces the share of educated workers.

Dos Santos and Postel-Vinay (2003) argue that a beneficial brain drain could emerge even if the share of educated workers decreases. This is shown in a setting where growth is exogenous at destination and endogenous at origin, with the sole engine of growth there 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 more advanced technology spillovers to the developing country as it is in a way 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. This means that return migrants come back with a productivity gain,  $\Theta h > h$ , which stimulates the average level of human capital. The average stock of human capital then becomes:

$$H = 1 + P_\gamma(\Theta h - 1)$$

which must be compared to the case of no migration,  $H = 1 + P_n(h - 1)$ .

In a companion paper, Dos Santos and Postel-Vinay (2004) show that a shift in immigration policy, with an increase in the share of temporary visas, may benefit to the sending countries of educated migrants. Two effects of the proposed shift in immigration policy are described: a decrease in the incentives to acquire education, which reduces the pre-migration stock of human capital at origin, and a higher proportion of returnees among emigrants, which increases the country's stock of knowledge, a complement of human capital. Their paper derives the theoretical conditions required for an overall positive effect to occur.

Using a different perspective, Stark *et al.* (1997) elaborate on the possibility of a brain gain associated with a brain drain in a context of imperfect information with return migration. In their setting, workers' productivity is revealed at destination only after a certain period of time during which people are paid according to the average productivity of their group. Some relatively low-skill workers will therefore find it beneficial to invest in education so as to migrate and be pooled at destination with high-skill workers; once individuals' ability are revealed, the low-skill workers return to their home country, which may therefore benefit from their educational investments.

There is limited evidence that return migration is significant among the highly-skilled, or that skilled returnees largely contribute to technology diffusion. We know that in general, return migration is characterized by negative self-selection (Borjas and Bradsberg, 1996) 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 1970s in the fields of Science and Engineering returned to Taiwan (Kwok and Leland, 1982) or Korea, a proportion that rose to about one half to two-thirds in the course of the 1990s, after two decades of impressive growth in these countries. Is it due to the economic boom at origin or to changes in the immigration policy at destination? Recent evidence is quite mitigated.

On the one hand, the 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) (OECD, 2002). This would seem to be confirmed by a recent survey which 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). In the case of India, Saxeenian (2001) shows that despite the quick rise of the Indian software industry, only a fraction of Indian engineers in Bangalore are returnees. According to these papers, return skilled migration appears relatively limited, however, and is often more a consequence than a trigger of growth.

On the other hand, a more recent and comprehensive survey of India's software industry was more optimistic and confirmed the presence of network effects and 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, Kangasmieni et al (2004) found that "many" intend to return after completing their training.

### 3.4 Uncertainty

Before 1965, the US immigration policy was based on country-specific quotas. This quota system was abolished but various types of requirements and restrictions imposed by the US and other countries' immigration authorities render the migration decision very uncertain. Implicit or explicit size-quotas are effectively in place, and receiving an immigration visa, whether temporary or permanent, requires being in a close relationship either with relatives or employers who must then demonstrate that the migrant's skills can hardly be found among native workers. Moreover, in some countries, point-systems are used to evaluate the potential contribution of immigrants to the host economy. This means that at all stages of the immigration process, there is a probability that the migration project will have to be postponed or abandoned. Individuals engaging in education investments with the prospect of migration must therefore factor in this uncertainty, creating the possibility of a net gain for the source country. The conditions required for this possibility to materialize have been the subject of a number of theoretical contributions (Mountford, 1997, Stark et al., 1998, Vidal, 1998, Beine et al., 2001).

To account for this within our general framework, assume that the probability of migration depends solely 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).<sup>13</sup> The model with uncertainty looks like an out-selection model where receiving countries accept a fraction  $p > 0$  of skilled candidates and reject all unskilled applications. Alternatively, it can be considered as a model of self-selection in which unskilled workers have no incentive to emigrate while skilled migration is optimal but limited.

Assume moreover that the subjective probability of getting a visa, as seen by a potential migrant, equals the proportion of the educated who effectively emigrated within the previous generation (i.e., at the steady-state). Denoting by  $p$  this probability, the lifetime income for educated agents is now given by

$$\begin{aligned} U(ED, NM) &= w_t - cw_t + w_{t+1}h \\ U(ED, MI) &= w_t - cw_t + pw^*h + (1-p)hw_{t+1} - pkw^* \end{aligned}$$

Uncertainty and return migration induce similar effects on the expected return to education, which is lowered in both cases by contrast to the case of certain permanent migration. However, several differences are worth noticing. First, the incentive mechanism here operates even for low values of  $p$  (remember that an incentive effect was obtaining with temporary migration only for  $\gamma \geq \frac{k\omega}{h(\omega-1)}$ ). Second, even for  $p = \gamma$ , uncertainty generates more incentives to educate than temporary migration. The reason for this is straightforward and has to do with the fact that uncertainty reduces expected migration costs. However, uncertainty *per se* cannot be seen as a source of knowledge diffusion.

At the steady state, the condition for skilled migration being optimal is the same as under certainty (i.e.,  $1 < \omega(1 - \frac{k}{h})$ ), but now education is worthwhile for people for whom:

$$c < c_p \equiv h - 1 + ph \left[ \omega \left( 1 - \frac{k}{h} \right) - 1 \right]$$

Clearly, we have  $c_p = c_n$  when  $p = 0$  and  $c_p = c_o$  when  $p = 1$ .

As in the case of temporary migration, there is a possibility of beneficial brain drain for the sending country partly to the incentive effect. The proportion of educated workers in the country becomes  $P_p = \frac{(1-p)c_p}{1-pc_p}$ . This proportion  $P_p$  can be lower or higher than  $P_n$ . A beneficial brain drain can be obtained for some ranges of  $p$ ,

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<sup>13</sup>Our simplified model assumes homogenous skill within educational groups. The size of the incentive effect would be different with heterogenous skills (see Commander et al, 2002). In reality, immigration authorities may be combining education with other selection devices such as tests of IQ or host-country language fluency. Would IQ be a perfect signal of ability and the only criterion retained, migration could only be detrimental to human capital formation at home. Still, and to the extent that IQ or other tests are imperfect signals of ability, an incentive effect exist for intermediate skilled workers (the probability to emigrate potentially increases with ability).

providing that the derivative of  $P_p$  with respect to  $p$  is positive at  $p = 0$ . We obtain:

$$\left[ \frac{\partial P_p}{\partial p} \right]_{p=0} = (h-1)(h-2) + h(\omega-1) - k\omega \leq 0$$

Note that this derivative corresponds to the numerator in  $\left[ \frac{\partial P_\gamma}{\partial \gamma} \right]_{\gamma^{h(\omega-1)=k\omega}}$ .

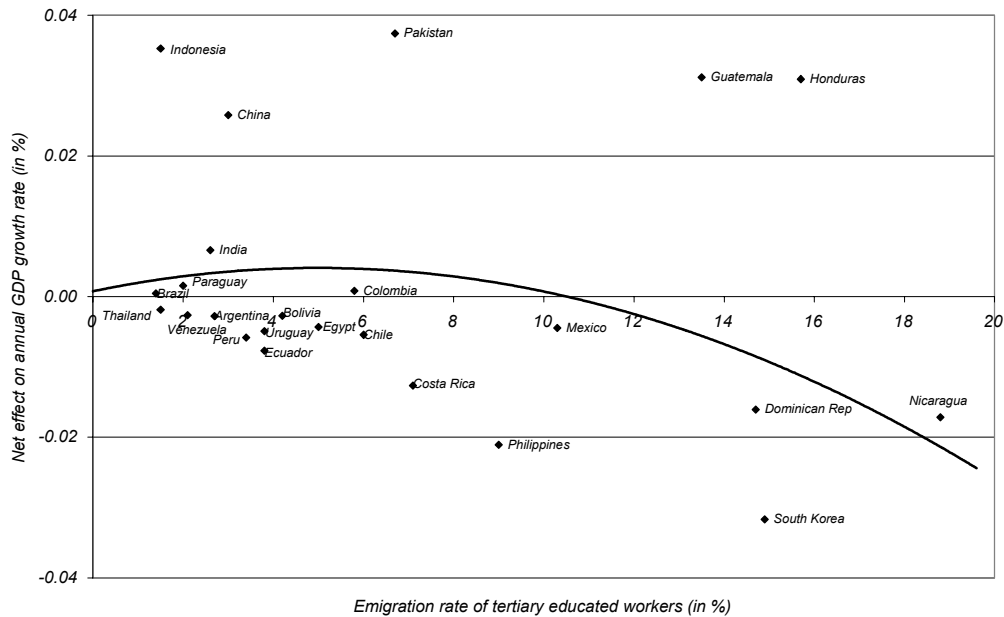
As in previous cases, liquidity constraints are likely to lower the size of the incentive effect. If  $c_p > c_L$ , the incentive effect will be limited to agents with education costs comprised between  $c_n$  and  $c_L$ . A similar constraint applies if  $c_p > c_M$ .

What is the empirical evidence on this "prospect" channel? To the best of our knowledge, the first study to attempt at estimating the growth effects of the brain drain using cross-country comparisons is that of Beine, Docquier and Rapoport (2001); in a cross-section of 37 developing countries, and after controlling for remittances, they 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 try 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) education as their measure of brain drain; again, they found a positive and highly significant effect of migration prospects on human capital formation, this time in a cross-section of 50 developing countries. They also computed country specific effects, with the following results. First, countries that experienced a positive growth effect (the 'winners') generally combined low levels of human capital and low migration rates, whereas the 'losers' were typically characterized by high migration rates and/or high enrollment rates in higher education (this is quite intuitive, since in this case most migrants are picked up from a stock of people that would have engaged in education even without contemplating emigration). Second, they showed that except for extreme cases such as Guyana and Jamaica, the growth effects of the brain drain were relatively limited: around plus or minus a maximum of 0.2% in terms of annual GDP per capita growth; this is not negligible, however, in a dynamic perspective. Finally, it was also striking that while there were more losers than winners, the latter included the largest countries in terms of demographic size (China, India, Indonesia, Brazil) and represented more than 80% of the total population of the sample. For the most part, these results are apparent on Figure 6; incidentally, it may be seen from the figure that the within-country result predicted by the theory outlined above (i.e., that some migration should be good as long as it is not excessive) is what comes out at the cross-country level apparent on Figure 6. The X-axis gives the Carrington-Detragiache migration rates for the highly educated and the Y-axis gives the net growth effect of the brain drain as computed by Beine et al. (2003). The variability across countries at given migration rates is due to the impact of other right hand side variables, and the curve itself is adjusted using a second-order polynomial.



**Figure 6. Brain drain and LDC's growth  
(with 2<sup>nd</sup> order polynomial trend)**



### 3.5 Remittances

Migrants' remittances constitute another 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. Remittances impinge on households' decisions in terms of labor supply, investment, education (Hanson and Woodruff, 2002, Cox Edwards and Ureta, 2003), migration, 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.

The literature on migrants' remittances shows that the two main motivations to remit are altruism, on the one hand, and exchange, on the other hand.<sup>14</sup> Altruism is primarily directed towards one's immediate family, and then decreases in intensity with social distance. By contrast, in principle, no such proximity is required in the case of exchange; the exchange-based theory of remittances posits that remittances simply "buy" various types of services such as taking care of the migrant's assets (e.g., land, cattle) or relatives (children, elderly parents) at home. Such transfers are typically observed in case of a temporary migration and signal the migrants' intention

<sup>14</sup>See Rapoport and Docquier (2004) for a comprehensive survey of the theoretical and empirical literature.

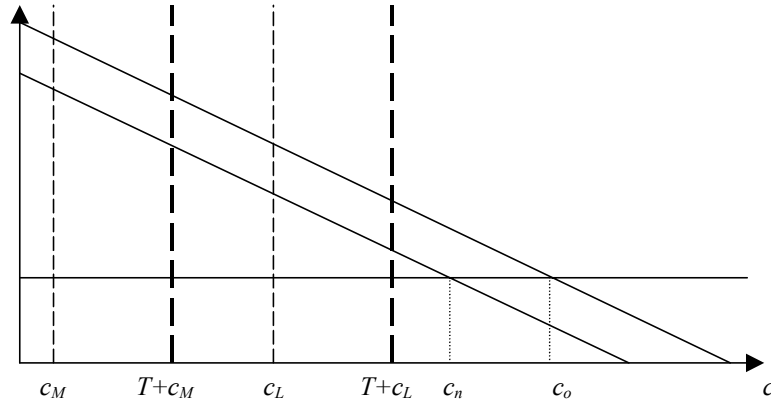
to return. A particular type of exchange takes place when remittances are de facto repayments of loans used to finance the migrants' investments in education and/or migration, with altruism and social norms and sanctions making the intergenerational contract self-enforcing. Hence, it is a priori unclear whether educated migrants would remit more than their uneducated compatriots; the former may remit more 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 therefore less likely to remit (or are likely to remit less) than someone moving alone on a temporary basis.

In our basic framework with constant marginal utility of income, remittances have no effect on the marginal cost and gain of education and influence human capital formation only when liquidity constraints are binding. Let us develop this particular case when the distribution of abilities is uniform. Without migration, the share of educated amounts to  $c_L$ . With migration opportunities, as some educated agents leave the country, two opposite effects are observed. Initially, the number of educated remaining in the country falls to  $c_L - c_M$ . If emigrants remit part of their foreign income, liquidity constraints become less binding for recipients in the source country. The traditional negative effect can therefore, in principle, be compensated by better access to education for those left behind, with the total effect depending on the amounts transferred and on recipients' location on the ability axis.

McCormick and Wahba (2000) obtain the result that highly-skilled migration may benefit to those left behind in a trade-theoretic model where migration, remittances and domestic labor-market outcomes are jointly determined and multiple equilibria arise, with the high-migration equilibrium pareto-dominating the low-migration equilibrium. In a setting closer to the one used throughout this paper, Cinar and Docquier (2004) develop a stylized model where skilled emigrants altruistically remit part of their earnings to relatives in the source country. They assume that each remaining resident receives an identical amount of remittances (which depends on the proportion of migrants, the intercountry wage gap, and the altruistic parameter) and characterize the transition path (i.e., the dynamics of transfers) and the long-run equilibrium of this economy.

Assume that at the steady state, this transfer amounts to  $T$ . As shown on Figure 7, the effect of remittances is to shift  $c_L$  and  $c_M$  to the right. With a uniform distribution, and given that  $(c_L + T) - (c_M + T) = c_L - c_M$ , the proportion of educated and the economy-wide average level of human capital are given by:  $P_T = \frac{c_L - c_M}{1 - c_M - T}$  and  $H_T = 1 + P_T(h - 1)$ . A beneficial brain drain obtains if  $H_T > H_n$ , that is, if  $T > c_M(\frac{1}{c_L} - 1)$ .

Figure 7. Brain drain and remittances



In other words, for a beneficial brain drain to obtain through remittances, the transfer received by each remaining resident must be relatively high so that a large share of the population gains access to education. This do not seem to portray the evidence from remittance data available in developing countries. Although remittances are generally positively correlated with donors' incomes, meaning that skilled emigrants are presumably important remitters, the results from household surveys are mixed. At an aggregate level, Faini (2002) shows that migrants' remittances decrease with the proportion of skilled individuals among the emigrants and concludes that "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 (45%) of Indian medical doctors working in the UK remit income to their home country and that remitters transfer on average 16% of their income.

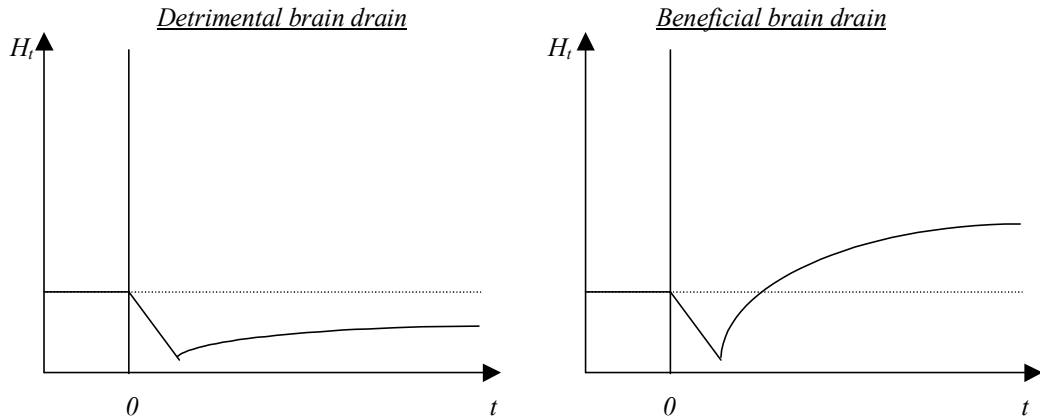
Instead of sending remittances to relatives at home, migrants may return after they have accumulated savings abroad and use such savings for promoting investment projects (generally in small businesses). There is much evidence that low-skill workers migrate with the aim of accumulating enough savings so as to access to self-employment and entrepreneurship (e.g., Mesnard, 2004, and Mesnard and Ravallion (2001) for Tunisia, Dustmann and Kirchkamp (2002) for Turkey, Ilahi (1999) for Pakistan, Woodruff and Zenteno (2001) for Mexico, or McCormick and Wahba (2001) for Egypt). The latter study offers additional insights in that it shows that in the case of literate migrants, both the amount of savings and the migration duration have a significant positive effect on the probability of entrepreneurship upon return, while the first proposition only holds true for illiterate migrants; this suggests that skill-acquisition may be more important for relatively educated migrants than the need to overcome liquidity constraints. In terms of our notations, increases in the stock of physical capital through repatriated savings and acquisition of entrepreneurial skills can be modeled as a negative shock on the risk premium,  $\pi$ , which rises the stock

of capital per worker, thus increasing local wages and decreasing the incentives to emigrate.

### 3.6 Network effects

Our analysis has so far focused on the long run steady state. In the short run, with unanticipated migration, emigration of educated workers is a net loss to the home country. As time goes by, however, successive cohorts adapt their education decisions and the economy-wide average level of education partly (as in Figure 8a) or totally catches up, with a possible net gain in the long run (as in Figure 8b) thanks to the various channels detailed above. On the transition path, additional effects are likely to operate. In particular, there is a large sociological literature emphasizing the creation of migrants' networks that facilitate the movement of goods, factors, and ideas between the migrants' host and home countries. In this section we consider two types of network effects: networks that facilitate trade, FDI and technology diffusion, and networks that facilitate further migration.

**Figure 8. The dynamic impact of brain drain**



An important socio-economic literature has emerge recently to analyze the consequences of the constitution of migrants' network on migration patterns. For example, Massey, Goldring and Durand (1994) outline a cumulative theory of migration, noting that the first migrants usually come from the middle ranges of the socioeconomic hierarchy, and are individuals who have enough resources to absorb the costs and risks of the trip, but are not so affluent that foreign labor is unattractive. Family and friends then draw on ties with these migrants to gain access to employment and assistance in migrating, substantially reducing the costs and risks of movement to them. This increases the attractiveness and feasibility of migration for additional members, allowing them to migrate and expanding further the set of people with network connections. Migration networks can then be viewed as reducing the cost, and perhaps also increasing the benefits of migration (Bauer et al., 2002, Munshi,

2003, and McKenzie and Rapoport, 2004, find strong evidence of such network effects); in other words, migration incentives become endogenous once network effects are introduced.

Building on this idea, Kanbur and Rapoport (2004) introduce networks effects at destination in a standard model of selective migration. In the spirit of Carrington et al. (1996), they assume that migration costs,  $k$ , are decreasing with the size of the network at destination, that is, with the number of migrants already emigrated abroad. As explained above, the role of migrants' networks is to diffuse information on job availability and provide hospitality and help in job search. Hence, past migration progressively raises the expected return to education (net of migration costs) and, therefore, domestic enrollment in education. For a given  $p$  or  $\gamma$ , this raises the optimal number of individuals engaging in education and the share of educated workers remaining in the country. In this sense, migrant networks have positive effects on human capital formation and serve to mitigate the short-run detrimental effects of the brain drain.

Another type of network effect consists in the creation of business and trade networks; such a "diaspora externality" has long been recognized in the sociological literature and, more recently, by economists in the field of international trade (Rauch and Trindade, 2002, Rauch and Casella, 2003). 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 (e.g., Gould, 1994). Interestingly, such a complementarity has been shown to prevail mostly for trade in heterogeneous goods, where ethnic networks help overcoming information problems linked to the very nature of the goods exchanged (Rauch and Casella, 2002, Rauch and Trindade, 2002). How the relationship of substitutability or complementarity between trade and migration is impacted by the skill composition of migration, however, remains unclear. In the same vein, whether FDI and migration are substitutes (as one would expect) or complements remains an unanswered question, although many case-studies suggest that migrants' networks favor what sociologists have labelled "brain circulation" or "brain exchange" (e.g., Saxeenian, 2001, Arora and Gambardella, 2004).

In terms of our notations, and as in the case of repatriated savings, such migrant networks favoring knowledge diffusion and foreign direct investment can be modeled as a negative shock on the risk premium,  $\pi$ , with similar effects on the capital/labor ratio and, thus, on domestic wages and incentives to invest in education.

## 4 Policy implications

It follows from the theoretical and empirical survey above that the consequences of the brain drain for source countries are ambiguous. Optimal policy responses are thus unclear. In this section, we discuss two important policy issues regarding the source countries, migration and education policies. Our discussion is based on the out-

selection model combining liquidity constraints and uncertain migration prospects (similar conclusions would be obtained in the self-selection model by combining liquidity constraints and temporary migration). We consider the uniform distribution of ability. Given the developments above, such a model can be summarized by the following set of equations:

$$\begin{aligned} c_{pl} &\equiv \text{Min} [c_n + ph\Omega; c_M] \\ P_{pl} &= \frac{(1-p)c_{pl}}{1-pc_{pl}} \end{aligned}$$

where  $\Omega = \omega(1 - \frac{k}{h}) - 1$  measures the foreign wage premium net of migration costs,  $c_n = h - 1$  is the critical agent in a closed economy, and  $c_M$  is the critical threshold level of the education cost when liquidity constraints are binding.

Intuitively, the premium  $\Omega$  varies with the level of development of the source country: it is high in a poor country and closer to unity in a middle-income or transition country. Liquidity constraints also depend on the level of development, with people living in poorer (and more unequal) societies being more credit constrained.

Finally, to formalize the role of education in the development process, we simplify the externality assumed in our general setting ( $A_t = A(H_t)$ ) and use a simple assumption regarding the socially optimal level of education. As in Azariadis and Drazen (1990), we assume a threshold externality induced by the average proportion of educated on the economy-wide productivity parameter. This can be written as  $w_t = \underline{w}$  for  $P_t < \bar{P}$  and  $w_t = \bar{w}$  for any  $P_t \geq \bar{P}$ . Hence, we consider that  $\bar{P}$  is proportion of educated allowing to exit out of the poverty trap. Moreover, the incentive to emigrate disappears when  $w_t = \bar{w}$ .

In such a framework, we examine the role of emigration (or immigration) policies and education policies on the interplay between migration and human capital formation at origin. In doing so, we make two implicit assumptions: (i) increasing  $H$  is a good thing and (ii) governments seek to maximize growth. We leave examination of these two assumptions for later discussion.

## 4.1 The optimal rate of migration

As documented in our introduction, international migration is constrained by immigration policies in receiving countries. Origin countries may also set barriers to the international mobility of their citizens, although there is an asymmetry here: for reasons beyond the scope of this paper, setting barriers to entry is seen as legitimate by the international community while setting barriers to exit is not.<sup>15</sup> Nevertheless, and before we turn to the policy implications of the analysis, it is interesting from the perspective of a given source country to ask whether the optimal rate of skilled emigration is positive.

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<sup>15</sup>In addition, such barriers to exit are generally not enforceable for the simple reason that you can catch and expell people once they are in but cannot force them to return once they are out.

Assume that liquidity constraints are not binding; then, a beneficial brain drain obtains if  $P_{pl} > c_n$ . This condition can be written as:

$$\Omega > \Omega_{BB}(p) \equiv \frac{1}{h} \times \frac{c_n(1 - c_n)}{1 - p(1 - c_n)}$$

which is represented as the  $BB$ -locus in the  $(\Omega, p)$  plan. Clearly,  $BB$  is increasing in  $p$ . The higher the migration rate of skilled workers, the higher the foreign-wage premium required to enhance human capital formation at home.

Similarly, and given the threshold externality introduced above, skilled emigration as a source of growth may allow the home economy to exit out of the low-wage trap if  $P_{pl} > \bar{P}$ . This take-off condition can be written as:

$$\Omega > \Omega_{TT}(p) \equiv \frac{1}{ph} \times \left\{ \frac{\bar{P}}{1 - p(1 - \bar{P})} - c_n \right\}$$

which is represented as the  $TT$ -locus in the  $(\Omega, p)$  plan. Clearly,  $TT$  is decreasing in  $p$ . Note that  $\Omega_{TT}(1) = \Omega_{BB}(1)$ . The intuition is clear: what matters here is the expected return to education, which is positively affected by  $p$  and  $\Omega$ , hence the possible tradeoff between the two.

However, liquidity constraints are binding if  $c_n + ph\Omega > c_M$ . This condition can be written as

$$\Omega > \Omega_{LL}(p) \equiv \frac{c_M - c_n}{ph}$$

which is represented as the  $LL$ -locus in the  $(\Omega, p)$  plan.  $LL$  is also decreasing in  $p$ . In the constrained case, a beneficial brain drain emerges if  $p < p_b \equiv \frac{c_M - c_n}{c_M(1 - c_n)}$  (this critical migration rate corresponds to the intersection between  $\Omega_{BB}(p)$  and  $\Omega_{LL}(p)$ ). A take-off obtains if  $p < p_g \equiv \frac{c_M - \bar{P}}{(1 - \bar{P})c_M}$  (this migration rate corresponds to the intersection between  $\Omega_{TT}(p)$  and  $\Omega_{LL}(p)$ ).

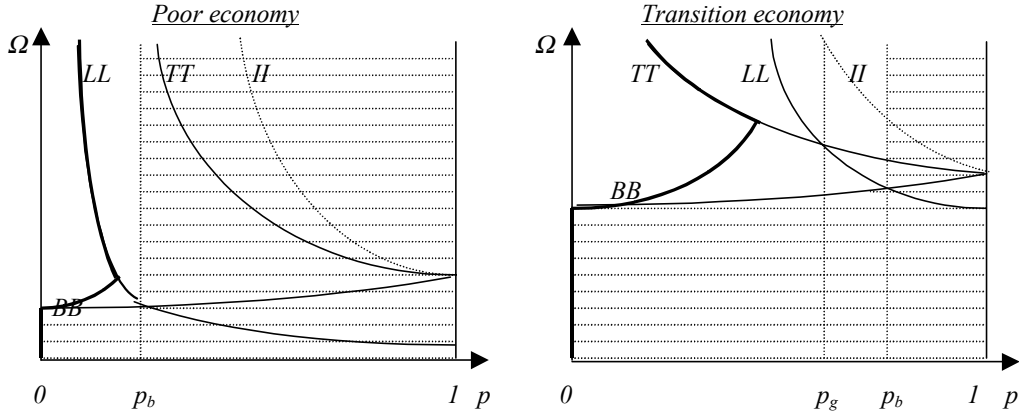
Figure 9 describes the cases of a poor and an middle-income economy. In poor countries, the  $LL$  curve is always below the  $TT$  curve, meaning that skilled emigration may bring about a net welfare gain in the long run but not to the point where an economic takeoff obtains. In the case of a middle-income economy, the  $LL$  curve intersects with the  $TT$  curve for  $p = p_g \in [0, 1]$ .

The optimal migration rate,  $p^*$ , is obtained by maximizing  $P$  with respect to  $p$ : the bold line in Figure 9 represents this solution. Below the  $BB$  curve, obviously, the optimal migration probability is zero. Above the  $BB$  curve,  $p^*$  is increasing with  $\Omega$ , at least as long as liquidity constraints are not binding. When  $p^*(\Omega)$  intersects with the  $LL$  curve, the latter then gives the actual optimal migration probability. Similarly, if  $p^*(\Omega)$  intersects with the  $TT$  curve, there are no longer migration incentives and the actual optimal migration probability is then given by this  $TT$  curve. It should be clear that once the  $TT$  curve is reached, the corresponding  $p^*$  applies for one generation only

since in subsequent periods, the proportion of educated in the remaining population is such that the threshold externality for education is attained and migration is not a relevant option anymore. To summarize, when incentive effects are limited by liquidity constraints, the optimal migration rate is given by the  $LL$  curve, and once the economy exits out of the low-wage trap, the optimal migration rate is given by the  $TT$  curve during the time interval required to reach the threshold proportion of educated; then, migration comes to an end.

Finally, it is noteworthy that at least in principle, a beneficial brain drain can be observed for high values of  $p$ . All individuals want to educate if  $c_n + ph\Omega > 1$ , or equivalently, if  $\Omega > \frac{1-c_n}{ph}$ . Such a condition is represented by the  $II$  curve, which intersects with the  $BB$  and  $TT$  curves at  $p = 1$ . Without liquidity constraints, a beneficial brain drain is unambiguously obtained even if  $p$  tends to 1. Given that the economy lies above the  $II$  curve, the small number of remaining agents are all educated. Such a situation is obviously unrealistic since liquidity constraints would limit education investments in a "sufficiently poor" economy. In terms of our notations, we can expect that liquidity constraints become more binding as we analyze poorer economies ( $c_M$  decreases with  $\Omega$ ).

**Figure 9. Migration rate, human capital and development**



*Notes. The dashed area corresponds a detrimental beneficial brain drain area. The bold line represents the optimal emigration probability given the migration premium  $\Omega$  (inverse representation)*

## 4.2 Education policy

Our analysis relies on the assumption that the cost of tertiary education is entirely borne privately. However, if the government (mainly because the social return to education is higher than its private return) subsidizes human capital investments,



public investment in primary, secondary and tertiary schooling are lost when educated workers emigrate. How does the presence of public expenditures in education affect our results? How should domestic government adjust their education policy to increasing migration rates?

Let us introduce lump-sum taxes and education subsidies in our basic model. The government levies a tax  $\tau wh$  on each remaining resident (educated or not) and provide a lump-sum transfer  $\theta w$  to each young opting for education. The lifetime income for both types of workers are given by

$$\begin{aligned} U(NE, NM) &= w + w - \tau hw \\ U(ED, MI) &= w - cw + \theta w + pw^*(h - k) + (1 - p)(wh - \tau hw) \end{aligned}$$

Agents for which education is optimal are defined by

$$c < c_\theta \equiv h - 1 + ph(\Omega + \tau) + \theta$$

The budget constraint of the government can be written as

$$\tau h = G + c_\theta m \theta + \vartheta(\tau, \theta)$$

where  $G$  is the amount of general public expenditure per capita,  $\vartheta(\tau, \theta)$  is a function measuring perception costs (increasing in both arguments),  $m$  is the number of children by remaining adult (emigrants leave the country with their children).

In an economy without migration, the critical level of ability would be given by  $c_n \equiv h - 1 + \theta_n$  with  $\theta_n$ , the amount of subsidy balancing the budget constraint (with a tax  $\tau_n$ ). It is worth noticing that the tax rate has no influence on the optimal investment in education since both educated and uneducated agents pay the same amount of tax. All other things unchanged (i.e. for given  $\theta$  and  $\tau$ ), skilled migration has now a double positive impact on human capital formation: the return is higher abroad and migration allows escaping paying domestic taxes.

Clearly, by stimulating education investment ( $c_\theta > c_n$ ), brain drain increases the amount of public expenditures. To keep the budget balanced, the government has to increase the amount of taxes or decrease the subsidy rate. Let us denote by  $\Delta\theta$  the decrease in subsidy decided by the government and by  $\Delta\tau$  the increase in taxes. The critical level of ability in the presence of migration can be rewritten as  $c_\theta \equiv c_n + ph(\Omega + \tau_n + \Delta\tau) - \Delta\theta$ . Compared to an economy without public education, two effects are obtained. On the one hand, the incentive effect of brain drain is larger since migration gives individuals an opportunity to escape fiscal pressure. On the other hand, by potentially reducing the amount of subsidy, brain drain can discourage education.

The conditions for a beneficial brain drain and for economic take-off become:

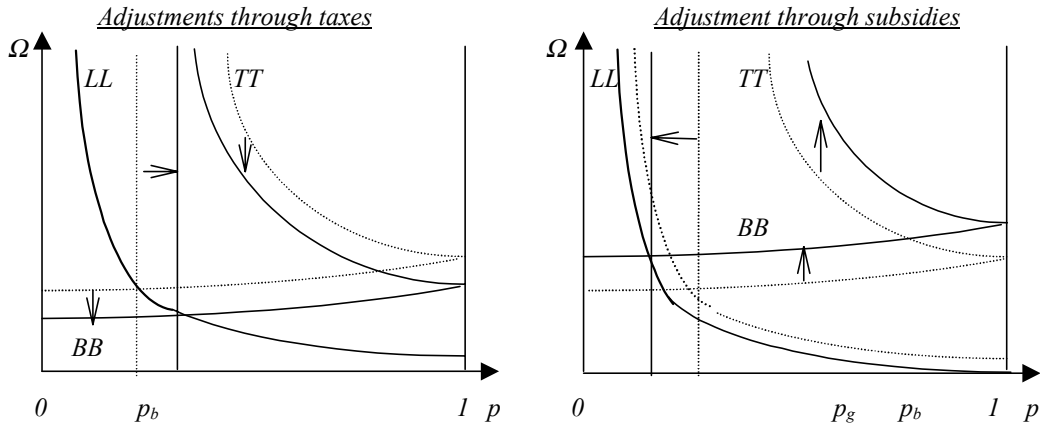
$$\Omega > \Omega_{BB}(p) \equiv \frac{1}{h} \times \frac{c_n(1 - c_n)}{1 - p(1 - c_n)} + \frac{\Delta\theta}{hp} - (\tau_n + \Delta\tau)$$

$$\Omega > \Omega_{TT}(p) \equiv \frac{1}{ph} \times \left\{ \frac{\bar{P}}{1 - p(1 - \bar{P})} c_n \right\} + \frac{\Delta\theta}{hp} - (\tau_n + \Delta\tau)$$

In both conditions, the first term corresponds to the condition in an economy without subsidies; the second term captures the cost of reducing subsidies (it makes the condition for a beneficial brain drain more restrictive); the third term captures the additional incentive effect of brain drain (the lower probability to pay taxes makes the condition for a beneficial brain drain less restrictive). The analysis can be completed by introducing liquidity constraints. Let us denote by  $c_M$  the level of ability above which liquidity constraints impede education in an economy without migration. In an economy with migration, this level of ability becomes  $c_M - \Delta\theta$  (a lower subsidy means stronger liquidity constraints). Balancing the budget through education subsidies shifts the  $\Omega_{LL}$ -locus upwards whilst balancing the budget through taxes has no effect on liquidity constraints.

Figure 10 compares the consequences of brain drain in an economy without public education (dotted lines) and without public education (continuous lines). If the budget is adjusted through taxes (constant subsidies), the case for a beneficial brain drain is stronger in the presence of public education. If the budget is adjusted through subsidies, the case for a beneficial brain drain is weaker.

**Figure 10. Brain drain and education subsidies**



*Notes. The dotted lines depict an economy without public subsidies  
 The continuous lines depict an economy with public subsidies*

This results suggests that brain drain should not induce developing countries to reduce education expenditures. It contrasts with the existing literature on the provision of public good and mobility. A study on education policy and brain drain can be found in Justman and Thisse (1997, 2000). They develop a two-region model where education is publicly funded and where skilled workers choose their location by maximizing utility. They show that the mobility of skilled workers leads to underinvestment in public education by local authorities. In the Nash uncoordinated equilibrium, the migration of skills induces deviation from the first best optimum. To

restore optimality, they recommend sharing the total burden of education between the local public sector and a supranational authority. Without supranational intervention, fiscal competition reduces the public funding of education.

Such results are not directly transposable to the very specific case of developing countries, in which the fiscal competition framework hardly appears as relevant. Economically speaking, developing countries are small. Migration and capital outflows (from one isolated sending country) are too small to affect the receiving countries' equilibrium wages and tax rates. Hence, changes in local education policies should not induce significant political reactions in receiving countries. Stark and Wang (2002) develop an interesting theory where brain drain can help the education system to reach optimality. Selective migration policies acts as a disguised education subsidy. In case of beneficial brain drain, they demonstrate that a positive probability of migration can enhance welfare of the remaining residents and nudge the economy toward the social optimum. Hence, less taxes and subsidies are required to reach the social optimum.

Such a result critically depends on the assumption that the first best can be decentralized. On the contrary, our framework could be seen as a second-best model where maximizing  $H$  is the best policy option (implicitly, it means that the maximal attainable level of human capital will be lower than the social optimum). That case seems particularly suited for analyzing developing countries. In this second-best world, we find out that a tax adjustment is likely to be the best option in case of detrimental brain drain.

## 5 Conclusion

The main conclusion to draw from the above analysis is that for any given developing country, the optimal migration rate of its highly educated population is likely to be positive. Whether the current rate is greater or lower than this optimum is an empirical question that must be addressed country by country. This implies that countries that would impose restrictions on the international mobility of their educated residents, arguing for example that emigrants' human capital has been largely publicly financed, could in fact decrease the long-run level of their human capital stock. This also suggests that rich countries should not necessarily see themselves as free riding on poor countries' educational efforts. The difficulty is then to design quality-selective immigration policies that would address the differentiated effects of the brain drain across origin countries without distorting too much the whole immigration system; this could be achieved, at least partly, by designing specific incentives to return migration to those countries most negatively affected by the brain drain, and promote international cooperation aiming at more brain circulation.

On a final note, it is important to underline that what seems crucial at this stage is to extend the empirical research on the growth effects of highly skilled migration for source countries. Two main directions are required: case-studies on the sectoral

impact of the brain drain, as suggested by Commander, Kangasniemi and Winters (2004); and extension of the cross-country comparisons. In particular, due to data limitations, existing empirical studies (Beine et al., 2001 and 2003) are based on cross-section regressions, meaning that they neglect the dynamics of migration rates as well as the dynamics of education levels; in addition, in the absence of a time series dimension, it is impossible to control for individual-country effects in the regression estimates. Given the strong heterogeneity of developing countries in terms of sizes, levels of development, etc., such country-fixed effects are likely to play some role in the value of the estimates. However, the new estimates computed for 1990 and 2000 by Docquier and Marfouk (2004) should make it possible for further empirical research to go part of the way toward addressing these concerns satisfactorily.

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