The Impact of Skilled Migration on the Sending Country: Evidence from African Medical Brain Drain

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This paper examines how Medical Brain Drain (MBD) creates incentives for the production of doctors in the sending country (brain gain) and its effects on the health status of the local population. Using Bharghava-Docquier dataset I find no relation between MBD and rates of enrolment to medical schools in the country of origin while there are incentives to pursue secondary school in the sending country and tertiary education abroad. Finally MBD induces an increase in the number of deaths due to HIV/AIDS: a case-study reveals that MBD affects more the "quality" of health services rather than their "quantity". [JEL Classification: O15, F22, I12, I21]

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1. - Introduction

According to the World Health Organization (WHO, 2006*b*) 4.3 million health workers need to be recruited globally and Sub-Saharan Africa alone currently needs one million more in order

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to achieve the Millennium Development Goals. Filling this gap will require scaling up investments to US$ 6 billion per year (CfA, 2005). Sub-Saharan Africa, moreover, has the lowest health worker/population ratio, nine times smaller than that of OECD countries (Table 1). Every year around 20,000 skilled health workers leave the African continent (WHO, 2006*b*). Save the Children (2006) reports that the brain drain of doctors has cost Ghana almost US$ 75 million and saved the UK around US$ 137 million in training costs between 1998 and 2006. These figures are to be coupled with the fact that the African continent suffers 24 per cent of the global burden of disease while disposing of less than three percent of the world's health workers and accounting for less than one per cent of the global health expenditure (WHO, 2006*b*).

TABLE 1

PHYSICIANS' AND NURSES' DENSITY IN THE HOME COUNTRY AND ABROAD BY WORLD BANK REGION. YEAR 2004

Region	Physicians per 1,000 people	Nurses per 1,000 people	Rate of Medical Brain Drain[i]
East Asia and Pacific	0.66	2.01	1.14%
East Europe and Central Asia	2,88	9.29	1.13%
Latin America and Caribbean	1.40	2.33	2.48%
MENA	1.43	2.70	5.88%
OECD	2.93	8.65	3.40%
South Asia	0.36	0.78	8.42%
Sub-Saharan Africa	0.16	1.30	19.04%

[i] Following BHARGHAVA A., DOCQUIER F. (2007) the regional rate of medical brain drain is:

$$m_{r,t} = \frac{M_{r,t}}{P_{r,t} + M_{r,t}},$$

where $M_{r,t}$ is the stock of physicians from region r working abroad at time t and $P_{r,t}$ the number of physicians working in the sending region r at time t as reported in WHO estimates (2006*a*).

Source: BHARGHAVA A. - DOCQUIER F. (2006); WHO (2006*a*).

These figures give a hint of the scale of the problem of the shortage of health workers in Africa, a shortage for which the emigration of skilled workers is generally blamed (together with the HIV/AIDS pandemic). Although the brain drain has always been seen as a "curse" to the sending countries at the benefit of the receiving ones, in the most recent years the literature has started to underline the existence of possible benefits for sending countries associated to the migration of skilled workers: such benefits would pass through four channels that are remittances, incentives to education (*i.e. brain gain*), return migration and networking between emigrated workers and the country of origin[1].

The contrast between these interpretations and the classical brain drain literature has fed a particularly vivid debate amongst economists although empirical contributions on this issue to date have been quite scarce because of a general lack of data and the results of those that have been carried out remain controversial.

This debate is then the scientific background to the widespread concern in the international community about the shortage of physicians, nurses and pharmacists which has a major impact on the health outcomes of a country, an issue that is at the heart of the Millennium Development Goals (MDGs).

This work aims at giving a contribution to the debate over the effects of brain drain analyzing the relationship between physicians' emigration, schooling decisions and health outcomes, in order to assess, whether and to what extent, the emigration of physicians to more developed countries can create incentives on those who remain to attain their studies in the field of medicine, how this outflows affect the main health outcomes of the sending country's population and to what extent the results obtained in Sub-Saharan Africa represent a special case.

This work will be structured as follows: section 2 provides a brief outline of the current state of the economic literature on the issues of brain drain from developing countries and on its effects on the country of origin; section 3 introduces the data that have been employed in the analysis and draws some pictures of the

[1] For an exhaustive review of these issues see ILO (2001).

current status of the medical brain drain phenomenon; section 4 is then dedicated to the empirical analysis: a comparison between the results obtained by Clemens (2007) and those obtained employing Bharghava-Docqueir estimates (2007); an analysis of the specificities of Sub-Saharan Africa's medical brain drain with respect to the rest of the world; the assessment of the existence of a brain gain phenomenon looking at the effects of migration on schooling decisions; and finally an analysis of the relationship between medical brain drain, the health status of the population in the sending country, its level of human development and the quality of its educational system. In section 5 a case study on Zimbabwe will provide evidence of some "hidden" effects of medical brain drain. Section 6 concludes.

2. - Theoretical Background

As mentioned in the introduction this paper is meant to be an empirical contribution to the debate on the effects of skilled migration on the country of origin, which has been raised by the so called *new brain drain literature*[2]. According to this view there would be some potential benefits, other than remittances, return migration and networking between emigrated workers and the country of origin, entailed in the brain drain phenomenon. Indeed the dynamics triggered by the emigration of skilled workers would be as follows (Schiff, 2005):

i. The brain drain raises the expected returns to education;

ii. This induces additional investment in education (a "brain gain");

iii. Which may result in a "beneficial brain drain" or net brain gain (*i.e.* a brain gain that is larger than the brain drain);

iv. A net brain gain raises welfare and growth.

Stark, Helmenstein and Prskawetz (1997, 1998) for instance

[2] MOUNTFORD A. (1997); STARK O. *et* AL. (1997, 1998); STARK O. and WANG Y. (2002); STARK O. (2004); BEINE M. *et* AL. (2001, 2003); DOCQUIER F. and RAPAPORT H. (2004) and VIDAL J.P. (1998).

argue that, under asymmetric information, the enlarged opportunities and the associated different structure of incentives due to the brain drain could give rise to a brain gain. Migration by high-skill members of its workforce notwithstanding, the home country would end up with a higher average level of human capital per worker which would just make the country better off.

If many theoretical models have confirmed the existence of such effects, the empirical analysis, though still scarce, has reported much more ambiguous results. On the one hand Beine, Docquier and Rapaport (2001) tested the brain gain hypothesis on a small sample of countries[3] finding a positive correlation between schooling and migration. They confirmed their findings two years later using a wider dataset (Carrington and Detragiache, 1998) whose analysis led to the conclusion that emigration of tertiary educated workers caused an increase in the total stock of tertiary educated.

This result was then revised by Faini (2003) who, using the same dataset, found that a positive probability of migration for workers with tertiary education had a significant positive impact on the rate of secondary school enrolment but a negative impact on the rate of tertiary school enrolment. This conclusion was interpreted as suggesting that prospective migrants may want to strengthen their chances of admission to the host country by pursuing their tertiary studies there. In this case, the brain gain argument would not hold as the outflow of skilled workers would more than offset the increase of secondary school graduates.

Eventually, Lucas (2005) contributed to this debate showing that the brain drain actually had a significant negative impact on the accumulation of human capital. He measured education in terms of both tertiary enrolment and increase of tertiary education at home and found that the emigration of skilled workers had a negative impact on both variables and that this impact was not only statistically significant but also substantial.

While the three contributions mentioned above have focussed

[3] Their sample is made of 37 countries amongst which only four are Sub-Saharan countries, namely Ghana, Kenya, Nigeria and South Africa.

on the effects of brain drain on human capital accumulation at the economy wide level, very few studies have investigated the possibility of a beneficial brain drain in specific sectors. A sectorial approach indeed could be useful to have an insight of the choices induced not only as to the length and level of school attendance but also regarding its professional specialization.

With regard to the health sector, several studies have been published which were aimed at investigating the link between the possibility of migration and the choice of becoming a doctor. Commander, Kangasniemi and Winters (2004) have studied the implications of physicians' migration by conducting a survey among overseas doctors working in the UK; their findings suggest that the links between migration possibilities and training choices are very weak as very few respondents answered that the possibility of migration had actually influenced their educational decisions.

On the other hand, Clemens (2007) carefully investigated the possibility of a positive brain gain in the health care sector from both a theoretical and empirical point of view employing a dataset (Clemens and Pettersson, 2006) that contained estimates of health workers' emigration from Africa to test the impact of these outflows on the number of health professionals in the country, on the main public health indicators and on the mass availability of basic primary care. He finds that the emigration of physicians from Africa has no impact on the stock of physicians left in the source country hence suggesting that the prospect of migrating would create incentives to become doctors and thus induce an increase in the number of medical graduates which would offset their outflow. Moreover Clemens finds no evidence of any correlation between the number of doctors in the country and the main health indicators both in terms of mortality ratios and in terms of health care services provided, such a result would be due to the fact that the principal causes of mass morbidity and mortality among the poor in Africa are diseases that do not require a skilled medical workforce to be embanked but just basic care (*e.g.* oral re-hydration during diarrhoea) that can be provided by less trained staff.

What was not included in the study conducted by Clemens was a systematic analysis of the relationship between medical emigration and educational choices, a key point to assess the existence and magnitude of a brain gain. The present work also aims at further investigating the links between medical emigration and health outcomes in Sub-Saharan Africa in order to evaluate the impact of physicians' emigration on the health status of the population.

3. - Data Description

The main source for this analysis has been a new panel dataset published by Docquier and Bhargava (2007) on medical brain drain. This dataset provides estimates of the stocks of physicians emigrated from 191 source countries to 16 OECD destinations, as well as data on the number of physicians still working in their home country. The dataset covers a time period of 14 years with data having been collected from 1991 to 2004. As far as the domestic stocks of physicians and nurses in the country are concerned, the estimates are based on the statistics compiled by the World Health Organization (2006*a*).

As shown in Table 1, Sub-Saharan African countries are, with no doubt, the poorest ones in terms of physicians and nurses with respect to the population. Indeed, the last fifteen countries in the world in terms of physicians per 1,000 people in 2004 are all Sub-Saharan countries, with values ranging between 0.011 and 0.047 physicians per 1,000 people, while the first fifteen are mainly OECD countries which show values that range from 1.3 of Turkey to 4.4 of Italy.

With regard to the number of physicians abroad, on the other hand, the estimates are computed by Bharghava and Docquier on the basis of the immigration data provided by the most important OECD destination countries. The countries that have been surveyed are Canada, United States, United Kingdom, France, Germany, Belgium, Denmark, New Zealand, Australia, Ireland, Portugal, Italy, Sweden, Switzerland, Austria and Norway. The authors have

attempted to define the emigrants on the basis of their country of qualification, *i.e.* the country in which they have attended medical school; such data have been found for Canada, France, New Zealand, Norway, United Kingdom and United States (73 percent of the sample for 2004). In the case of Australia, Austria, Belgium, Denmark, Ireland and Sweden, instead, migrants are defined on the basis of their country of birth (18 percent of the sample), while for Italy, Germany, Portugal and Switzerland on the basis of their country of citizenship (9 percent of the sample).

These data reveal that the biggest recipients are the United States and United Kingdom which respectively received 91,898 and 79,866 foreign physicians in 2004 (that is 32% and 28% of the total emigration).

I finally coupled these estimates of migration flows with indicators of health, education and wealth taken respectively from WHO, UNESCO and IMF databases. The overall picture we get is one of extreme inequalities, where Sub-Saharan Africa exhibits the highest levels of (infant and maternal) mortality together with the lowest levels of *per capita* GDP and health staff availability.

4. - Empirical Analysis and Main Findings

4.1 *A Comparative Study on the Effects of Medical Brain Drain*

The estimates employed by Clemens (2007) substantially differ from those of the Bharghava-Docquier dataset I employed in that they are built according to a different definition of an "African doctor": while Bharghava and Docquier define medical brain drain as the emigration of workers «who have attained tertiary education in the field of medical sciences in their country of origin», Clemens and Pettersson build their dataset assuming that an "African emigrant doctor" is «whoever, being born in an African country, is currently employed as doctor in another country outside Africa and has been residing there on a sufficiently permanent basis *circa* 2000 to be included in that country's most recent census» (Clemens, 2007).

Defining an "African emigrant doctor" according to his country of birth certainly entails several problems in that it includes people who may have become physicians after having emigrated and hence may not have chosen this profession (or may not have had the means to choose it) had they remained in their country of origin. The definition of Bharghava and Docquier, on the other hand, is more restrictive and may underestimate the actual number of emigrated physicians. Still, it has an important advantage with respect to that employed by Clemens and Pettersson as the latter does not allow us to evaluate the "fiscal costs" of brain drain: the vast majority of African doctors who have been trained in their country of origin have been trained with public funds, thus their departure represents for the local government a major net fiscal loss, which is to be added to the costs of replacing the departed staff.

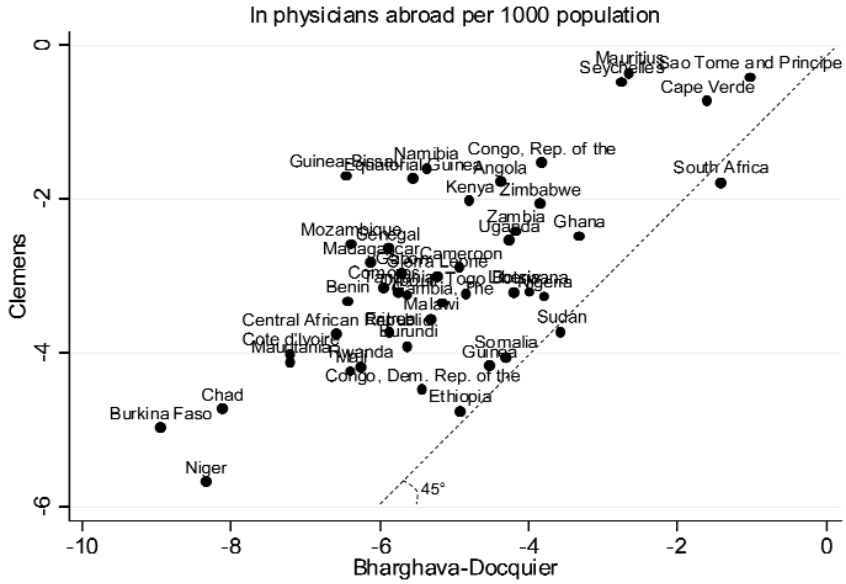
In conclusion the two methods can both be employed if interested in evaluating the loss of human capital from the sending country while only the one based on the country of training can be used to evaluate the loss of public financial resources. Another key difference between the two datasets is the number of destination countries included: Bharghava and Docquier include sixteen destination countries as a proxy of the whole world while Clemens only nine. Nevertheless the outflows estimated by Clemens are much more copious because of the less restrictive definition employed.

Despite these methodological differences, once we compare the data of the two datasets for year 2000 and restrict the sample to Sub-Saharan countries only, we find that the correlation between the number of physicians abroad in the two datasets is quite high (0.8251) as shown in Graph 1.

Following the study conducted by Clemens (2007) and limiting the scope of my analysis to the countries of Sub-Saharan Africa (whereas Clemens takes into account Algeria, Egypt, Libya, Morocco and Tunisia as well), I tested the relationship between the flow of emigrated doctors and the number of doctors left in the home country following the hypothesis that the prospect of

GRAPH 1

PHYSICIANS ABROAD PER 1,000 POPULATION
ACCORDING TO THE TWO DEFINITIONS



Source: BHARGHAVA A. - DOCQUIER F. (2006) and CLEMENS M. - PETTERSSON G. (2006).

emigrating raises the returns to education and, in particular, the returns to the "investment" of attaining tertiary education in medical sciences. The underlying idea is that there is a two equation system in which:

i. the potential for high returns for migration induces more people to undertake training, in this case for medical school;

ii. some of those people remain in the home country (either because they change their desires or are unable to migrate) so that it is possible that high returns overseas generate not only immigration but also a larger stock of doctors in the home country.

The relation between the stock at home and the stock overseas can thus be expressed in a reduced form as follows:

$$\hat{l}_i = \alpha + \beta l'_i + \varepsilon_i \quad (1)$$

where $\hat{l}_i$ is the stock of health workers per thousand people in the sending country, and l'_i is the number of physicians who have left the sending country per thousand people[4], according to the two different definitions of African doctor that we are now comparing. Following Clemens (2007), we suppose, by the way, that we observe only l^*_i which is the stock of health workers we count in the receiving country at a certain year. This assumption is plausible as we do not take into account all the destination countries but only a limited sample (nine in Clemens and sixteen in Bhargava and Docquier), and as it might happen that not all those who were doctors are still working as such. We consider, thus, that l'_i is a function of l^*_i and of some country specific constant c_i such that $l'_i = c_i l^*_i$. This implies that when running OLS regressions we risk getting biased estimations of β, because l^*_i is correlated, by definition, to the error term of the regression. Hence we will include in the regression some variables so as to control for factors that are likely to influence both l^*_i and c_i and then seek some instrumental variables that are likely to influence l^*_i but should not have any effect directly on $\hat{l}_i$.

In order to maintain the comparison with Clemens' analysis I include the same control variables that can simultaneously affect the number of doctors abroad and the number of those left in the home country: the country's wealth, measured in terms of *per capita* GDP; its political stability, measured through a dummy variable that detects the involvement of the country in at least one conflict since 1970; and, finally, the grade of literacy of the population measured in terms of primary enrolment rate.

I run the regressions for both datasets, as I now exclude from the analysis conducted by Clemens North African countries. The results are shown in Table 2: Model 1 is a basic OLS regression on the complete sample of countries, while Model 2 restricts the sample

[4] The number of doctors will always be related to the population of the sending country.

TABLE 2

MEDICAL BRAIN GAIN IN AFRICA:
A COMPARISON OF TWO DATASETS

Sample: Sub-Saharan Africa Year: 2000								
Dependent variable: ln Phys/1,000 population home country	OLS						2SLS[ii]	
	Model 1		Model 2		Model 3		Model 4	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Clemens	Bharghava-Docquier	Clemens	Bharghava-Docquier	Clemens	Bharghava-Docquier	Clemens	Bharghava-Docquier
ln physicians abroad/1,000 people	0.581*** (6.50)	0.347*** (4.60)	0.588*** (5.67)	0.383*** (4.82)	0.355*** (3.65)	0.216*** (3.16)	0.406** (2.48)	0.263 (1.70)
ln GDP/cap					0.607*** (4.94)	0.645*** (5.12)	0.576*** (3.89)	0.605*** (3.49)
ln Primary enrolment					-0.033 (0.10)	-0.116 (0.33)	-0.049 (0.14)	-0.158 (0.42)
Conflict since 1970					0.251 (1.04)	0.167 (0.67)	0.285 (1.10)	0.201 (0.75)
Constant	-0.680** (2.35)	-0.658 (1.63)	-0.580* (1.73)	-0.355 (0.82)	-5.147** (2.68)	-4.917** (2.37)	-4.751** (2.17)	-4.254 (1.49)
N	46	46	31	31	31	31	31	31
Adjusted R^2	0.4782	0.3094	0.5090	0.4261	0.7264	0.7008	0.7235	0.6953
Sargan Test, p-value							0.9497	0.4211

For all tables: Absolute value of t statistics in parentheses
* significant at 10%; ** significant at 5%; *** significant at 1%.

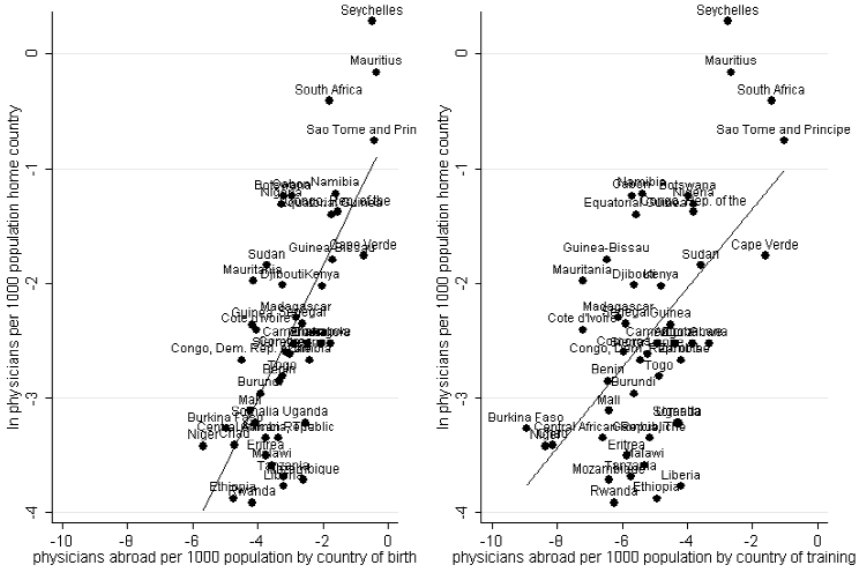
[ii] First Stage Regressors are: Francophone, ln land area, ln physicians' wages in host country, ln GDP/cap in host country, ln primary enrolment rate, conflict since 1970.

to the 31 countries for which all the data are available. In Model 3 I include control variables and finally, in Model 4, I run Two Stage Least Squares Regressions; for each regression I show on the left hand side the results obtained using the variables of Clemens-Patterson (columns 1, 3, 5 and 7) and on the right those obtained using Bharghava-Docquier dataset (columns 2, 4, 6 and 8).

The OLS regressions in Table 2, together with Graph 2, show that, when we employ, as independent variable, the number of physicians that emigrated after having been trained in their home country, rather then the number of doctors that were born in one of the sending countries of the sample and then emigrated, the effect on the stock of physicians left in the country of origin is smaller in size, though still positive and significant. This finding somehow weakens the brain gain hypothesis because, if the

GRAPH 2

THE EFFECT OF PHYSICIANS ABROAD ON DOMESTIC STOCKS OF PHYSICIANS: COMPARISON BETWEEN TWO DATASETS



Source: BHARGHAVA A. - DOCQUIER F. (2006) e CLEMENS M. - PETTERSSON G. (2006).

prospect of emigrating was to increase the incentives to become doctors, these incentives should be stronger if those who emigrate were already doctors at the time of departure. In this case, indeed, the advantages of becoming doctors would be more visible to those in the home country, than if the migrant had become a doctor after having emigrated.

In order to eliminate any possible endogeneity of the explanatory variable I instrument it with the following variables that are likely to influence the emigration stock of physicians and only through this the dependent variable "physicians per 1,000 people": a dummy variable for Francophone sending countries, the land area of the country of origin and the average level of physicians' salaries and of *per capita* GDP in the destination countries (both weighted for the inflows of physicians received by each destination country).

The validity of these instruments is widely documented in the literature (Beine, Docquier and Rapoport, 2006, or Clemens, 2007): linguistic and colonial ties are likely to favour emigration flows but there is no reason to expect an African French speaking student to be more likely to become a doctor than a non French speaking one if not for the prospect of emigrating. With regard to the level of GDP and of physicians' wages in the destination countries, these are meant to be proxies for the level of attractiveness of destination countries, thus we expect them to be positively correlated with physicians' emigration, while there is no reason to expect any direct relationship with the local stock of physicians. Finally, with regard to the country size, the validity of the instrument is more questionable: on the one hand we may imagine that a person might choose not to work as a physician in a place with few goods and services that complement his profession (*i.e.* a small country), but this is an effect that acts solely through migration and thus the instrument would undoubtedly be valid. On the other hand, we can imagine that a person born in a small country is less likely to become a doctor than someone living in a bigger one[5].

The results of these Two Stage Least Squares show that, once we include instrumental variables that influence the number of physicians abroad, its effect on the stock of physicians in the home country becomes less significant passing from 1% (columns 1, 3, 5) to 5% level of significance (column 7) in the case of data by country of birth, and from 1% (columns 2, 4, 6) to not significant (column 8), in the case of data by country of training. This confirms that the explanatory variable "ln physicians abroad per 1,000 people" is highly endogenous.

As far as the controls are concerned we find that the effect of the level of income *per capita* in the sending country is always positive and significant, thus suggesting that the richer the country

[5] For instance because the small country may lack a medical school. For this reason, from section 4.3, I will include among the instruments population density and the share of population living in urban areas as proxies for the cost of acquiring education (*e.g.* the higher population density and the share of urban population, the lower the distance to school). In this section, instead, I maintain the set of instruments employed by Clemens to keep the parallel with his analysis.

the more the individuals will be able to attend tertiary education and in particular, medical studies. Moreover, the result of First Stage Regressions for which doctors tend to leave richer African countries more than poorer ones confirms the widespread idea that, in the poorest countries, and there alone, economic development seems to encourage, rather than discourage, emigration by helping potential emigrants to overcome fixed costs associated with departing and settling overseas. Hence, the effect of *per capita* GDP is positive and significant on both the stock of physicians abroad and in the home country: the richer the country, the more doctors there will be and the more will leave it. To explain this result we can suppose that when an economy starts growing, there is an immediate increase in human capital due to an increase in individual wealth and to a widespread desire of faster social mobility, a desire that not everyone manages to achieve. Nevertheless such abundant offer of skilled work does not meet an adequate demand, that is the country is not able to absorb this workforce yet and the skilled workers have no choice but to emigrate[6].

The most important result we get, by the way, is that once we include all the control variables both for the dependent variable "physicians per 1,000 people" and for the variable "physicians abroad per 1,000 people" in the first stage regressions, the effect of migration on the domestic stock of physicians disappears and becomes not significant inducing us to reject the "brain gain" hypothesis suggested by Clemens (2007)[7].

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[6] With regard to the instrumental variables, instead, we only find the expected negative correlation between the area of the sending country and the emigration flows. Still this result only holds for Clemens' estimates. We underline, on the other hand, that neither the level of *per capita* GDP abroad, nor the level of wages of physicians in the destination country play any significant role in boosting emigration. This result might be seen as the reflection of the huge gap existing between sending and destination countries with regard to these two variables, thus a marginal increase in their values would not be a significant incentive to emigrate. The occurrence of an armed conflict since 1970 is also not significant: this result was quite predictable as the vast majority of countries did experience a conflict so the variable does not display much variation among the countries of the sample.

[7] The p-values of the Sargan Test of over identifying restrictions moreover indicate that the instruments are not exogenous enough when we employ Bharghava-Docquier estimates. Thus the model employed by Clemens loses its predictive power.

4.2 *Sub-Saharan Africa in the World Context*

Even though the emigration of physicians is a global phenomenon severely affecting many regions other than Sub-Saharan Africa, such as Middle East and Northern Africa or South Asia, a simple comparison between the outflows of physicians from each region and the stock of those left, quickly reveals that Sub-Saharan Africa is the region where the gap between these two variables is the lowest. This means that, in relative terms, it is the region that is loosing the most of its workforce[8]. For this reason most of the political debate on Medical Brain Drain evolves around Sub-Saharan African countries.

In order to highlight any possible specific character of Sub-Saharan Africa in the world context I set up a cross section regression for 149 countries and then split this sample into two subsamples, one for Sub-Saharan African countries and the other for the rest of the world. I also add to my set of control variables population density and the share of population living in urban areas as proxies for the cost of acquiring education (the higher population density and the share of urban population, the lower the distance to school); moreover I introduce in the world regression several regional dummies that allow me to isolate the fixed regional effects on the number of physicians per 1,000 people. Finally I plug in an interaction term that multiplies the stock of physicians abroad per 1,000 people for the Sub-Saharan Africa dummy. This term will let us find out the peculiar effect of Sub-Saharan Africa physicians' migration on the domestic density.

The results of this regression are reported in Table 3, Model 1 for the panel regression and Model 2 for the cross section. These bring to light the fact that the positive and statistically significant relationship between the outflow and the domestic stock of physicians is observable in Sub-Saharan Africa and there alone, while in the world sample this relationship is reversed though slightly significant. In other words, we find that, if a brain gain phenomenon is to exist, then it will take place in Sub-Saharan

[8] See Table 1.

TABLE 3

MEDICAL BRAIN GAIN IN THE WORLD. OLS ESTIMATES

	1991-2004			2004			2004
	Model 1			Model 2			Model 3
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Dependent variable: ln Phys/1,000 population home	Full Sample	Sub-Saharan Africa	Rest of the World	Full Sample	Sub-Saharan Africa	Rest of the World	Full Sample
ln physicians abroad /1,000 people	-0.027*	0.209***	-0.013	-0.029	0.241***	-0.007	-0.07
	(1.96)	(7.05)	(1.02)	(0.83)	(2.99)	(0.21)	(1.5)
ln GDP/cap	0.177***	0.546***	0.061**	0.234***	0.66***	0.093	-0.019
	(7.45)	(10.73)	(2.38)	(3.79)	(4.63)	(1.45)	(0.21)
ln Primary enrolment	0.741***	-0.042	1.382***	0.573*	-0.07	1.364***	
	(7.26)	(0.28)	(9.77)	(1.87)	(0.14)	(3.35)	
Conflict since 1970	-0.068*	-0.036	-0.055	0.025	0.127	-0.03	0.009
	(1.67)	(0.44)	(1.23)	(0.22)	(0.47)	(0.26)	(0.06)
ln population density	-0.003	0.035	0.013	-0.024	0.001	0.005	0.025
	(0.21)	(1.09)	(0.85)	(0.62)	(0.01)	(0.14)	(0.52)
ln share of population in urban areas	0.673***	0.401***	0.79***	0.535***	0.047	0.668***	0.447***
	(11.41)	(4.09)	(11.02)	(3.56)	(0.15)	(4.15)	(2.72)
ln primary attainment							0.307**
							(2.12)
ln secondary attainment							0.329***
							(2.69)
ln pupil-teacher ratio at primary							-0.788**
							(2.39)
ln pupil-teacher ratio at secondary							0.065
							(0.21)
East Europe and Central Asia	0.568***		0.357***	0.657***		0.449**	0.16
	(7.18)		(4.61)	(3.25)		(2.36)	(0.7)
South Asia	-0.824***		-1.12***	-0.703**		-1.045***	-1.066**
	(6.38)		(8.52)	(2.18)		(3.26)	(2.37)
East Asia and Pacific	-0.928***		-1.201***	-0.637**		-0.99***	-1.537***
	(9.64)		(12.45)	(2.45)		(3.91)	(4.61)
Sub-Saharan Africa	-0.761***			-0.805**			-0.642
	(5.42)			(2.32)			(1.51)
MENA countries	-0.569***		-0.672***	-0.476**		-0.607***	-0.385
	(7.84)		(9.56)	(2.52)		(3.44)	(1.52)
Latin America and Caribbean	-0.48***		-0.694***	-0.317		-0.585***	-0.088
	(6.87)		(10.16)	(1.71)*		(3.29)	(0.4)
(SSA*ln phys abroad/1,000)	0.279***			0.282***			0.183*
	(10.07)			(4.19)			(1.76)
Years	yes	yes	yes				
Constant	-7.113***	-6.088***	-9.588***	-6.245***	-5.353*	-9.13***	-0.777
	(14.02)	(8.03)	(13.83)	(3.92)	(2.00)	(4.45)	(0.51)
N	1,013	252	761	149	36	113	79
Adjusted R^2	0.8604	0.7149	0.7001	0.8628	0.7212	0.6604	0.8789

Africa as the analysis conducted up to this point seems to reveal that only in this region the more doctors leave the country the more there will remain, that is the emigration of physicians triggers some mechanism of replacement of the workforce emigrated. Understanding whether this mechanism is actually generated by the incentives induced by the emigration of doctors (thus confirming the hypothesis of the existence of a brain gain phenomenon) or by other factors will be the next step in this study.

4.3 *Assessing the Brain Gain: The Effects of Migration on Schooling Decision*

I consider that, in order to test the existence of a brain gain dynamics, the domestic density of physicians is not the most suitable dependent variable as it may depend on other factors and, most of all, is inconsistent from a temporal perspective: an increase in emigration can not be automatically translated into an higher density of physicians given that training a physician requires around seven years, so the model should at least be tested with a seven years' lag. Instead, I believe that a simpler way to test it is to use as dependent variable the number of students who choose to attend medical school the year *after* that in which we register the outflow of doctors. I thus consider that educational enrolments better represent the investment in human capital formation than educational levels or the number of professionals[9].

I run the regressions in a comparative perspective, looking at the general and medical brain drain and at secondary and tertiary enrolments. In order to keep the comparison between Sub-Saharan Africa and the rest of the world I introduce an interaction

[9] This setting is consistent with that employed in FAINI R. (2003) to test the brain gain hypothesis for secondary and tertiary education. A relevant difference, nevertheless, is the use of the lagged dependent variable in this context. Another important difference with the analysis conducted by Faini is that he employed CARRINGTON W.J. - DETRAGIACHE E. data (1998), while this study is based on DOCQUIER F. - MARFOUK A. (2005) and BHARGHAVA A. - DOCQUIER F. (2007) estimates of emigration flows which are computed according to the country of training and not simply to census data.

term for general brain drain and one for medical brain drain; the results are reported in Table 4, Model 1.

These seem to suggest that increased returns to higher (tertiary) education boost the incentives to acquire lower (secondary) education in Sub-Saharan Africa only. The fact that this result does not hold in the case of tertiary school might suggest that prospective migrants may want to strengthen their chances for admission to the host country by pursuing their graduate studies there. Hence the most talented individuals would face an incentive to migrate after having completed secondary school as indicated by the result on secondary enrolments. The same reasoning holds with respect to enrolments in medical school: the lack of any significant effect of migration on the number of individuals enrolled in medical schools, coupled with the positive effect on secondary enrolments, seems to suggest that individuals would rather emigrate before attaining tertiary education and becoming doctors. With regard to the control variables the only relevant result we obtain is the strong positive link between urbanization and tertiary education.[10]

These results, thus, suggest us to reject the hypothesis of the existence of a brain gain; indeed we find no evidence of any kind of positive effect of emigration on schooling decisions, neither in the OLS nor in the 2SLS. Moreover, if a weak positive incentive effect can exist for secondary enrolments in Sub-Saharan Africa, this is not certainly the case neither for tertiary nor for medical schools. We interpret this evidence as the existence of an incentive to complete secondary school in the home country and pursue graduate studies abroad, *e.g.* in the OECD country where the individuals might desire to migrate, so as to increase the chances of admission in that country or to attend more prestigious schools and thus be advantaged when searching for a job.

On the one hand, these findings partially downsize the costs

[10] In order to maintain a parallel with the analysis conducted up to this point, I also run 2SLS, whose results are not shown in this paper, following the scheme of section 4.2. These regressions confirmed the results of the above OLS further revealing a positive and significant (at 10% level) effect of tertiary emigration on secondary enrolment at world-wide level.

TABLE 4

MIGRATION AND SCHOOLING DECISIONS. OLS ESTIMATES

Sample: Full Year: 2000						
Dependent variable:	ln enrolled in secondary school per 1,000 people, 2001		ln enrolled in tertiary school per 1,000 people, 2001		ln enrolled in tertiary school, medical studies per 1,000 people, 2001	
	(1)	(2)	(3)	(4)	(5)	(6)
ln tertiary educated migrants/1,000 people	0.04	0.016	0.004	-0.004		
	(1.45)	(0.36)	(0.06)	(0.04)		
ln physicians abroad /1,000 people					0.013	0.005
					(0.1)	(0.02)
ln GDP *per capita*	0.036	-0.044	0.155*	-0.143	0.096	-0.204
	(0.93)	(0.67)	(1.82)	(0.95)	(0.42)	(0.99)
ln primary enrolment	0.779***		1.289***		2.081	-0.774
	(4.27)		(3.30)		(1.11)	(1.59)
Conflict since 1970	-0.094	-0.045	0.143	-0.199	0.234	-0.044
	(1.36)	(0.4)	(1.02)	(0.93)	(0.63)	(0.28)
ln population density	-0.031	-0.034	-0.087	-0.044	0.047	1.49
	(1.28)	(0.82)	(1.55)	(0.53)	(0.37)	(1.24)
ln share of population in urban areas	0.082	0.5***	0.727***	1.338***	1.566**	0.262
	(0.85)	(2.91)	(2.97)	(3.88)	(2.15)	(0.93)
ln primary attainment		-0.079		-0.032		-0.254
		(0.85)		(0.16)		(1.32)
ln secondary attainment		-0.053		-0.139		-0.749
		(1.05)		(1.34)		(0.88)
ln pupil-teacher ratio at primary		-0.371*		-1.007**		0.336
		(1.70)		(2.10)		-0.28
ln pupil-teacher ratio at secondary		0.206		0.879**		-0.774
		(1.09)		(2.21)		(1.59)
Regional Dummies	yes	yes	yes	yes	yes	yes
(SSA*ln tertiary educated migrants/1,000)	0.194***	-0.005	0.088	-0.306		
	(3.38)	(0.05)	(0.74)	(1.22)		
(SSA*ln physicians abroad/1,000)					-0.889	-0.197
					(1.67)	(0.3)
Constant	0.233	3.769***	-6.791***	0.475	-16.037	-1.569
	(0.25)	(3.41)	(3.31)	(0.19)	(1.65)	(0.29)
N	141	57	105	42	53	24
Adjusted R^2	0.6191	0.6495	0.7598	0.8386	0.6508	0.8796

of brain drain for the sending countries as they suggest that they do not have to pay for the tertiary education of migrants. But on the other hand this system implies that the sending country has to pay for the higher education of "those who are left behind" who are very much likely to be the less talented individuals. This means that the sending country has not only to bear the cost of

losing its best students but also to invest in the education of its less talented and to pay for secondary education of students who will emigrate. These mechanisms create a very inefficient system where governments of Sub-Saharan Africa countries make very unprofitable investments by financing either less talented individuals or potential migrants. In the first case this creates low returns to the investment while in the latter only a deadweight loss (unless the migrant later returns to his home country).

It is finally to be underlined that it is often the sending country that finances the education of its students abroad through public grants and scholarships, this creates an additional cost for Sub-Saharan countries and again there will be no returns to these investments if the migrant does not ever return.

4.4 *Impact of Medical Brain Drain on Health Status*

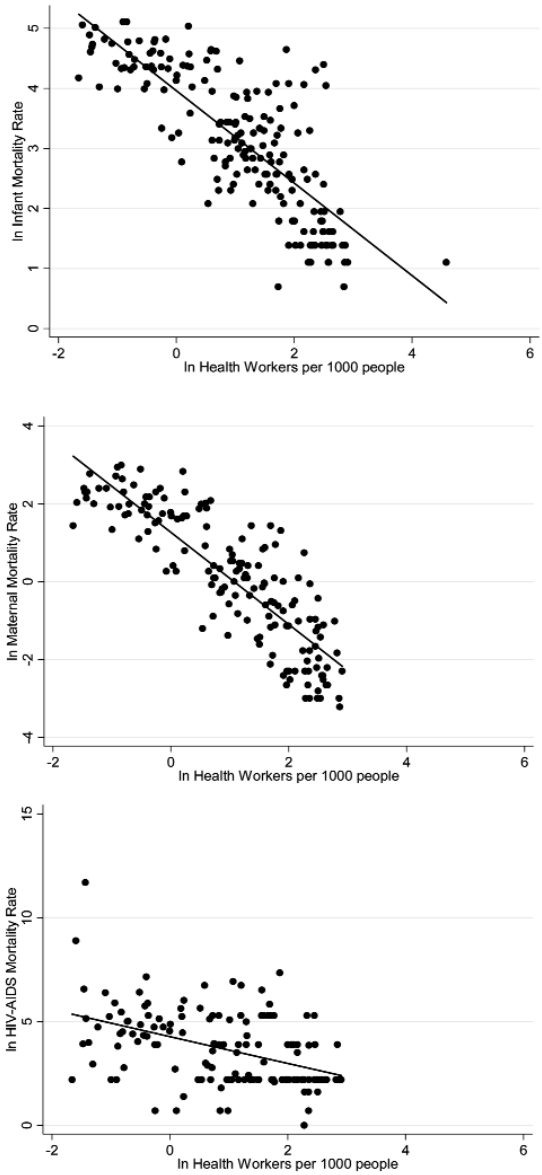
As mentioned in the introduction, most of the debate on development issues is today focused on the achievement of the Millennium Development Goals (MDGs). Although migration and brain drain do not appear among the priorities on the international agenda, still, there is a very tight link between these issues and (at least) the three health-related MDGs[11].

The availability and preparation of health personnel plays a primary role in the pursuit of these goals determining the coverage rate of both basic and more complex health care services. There is, indeed, ample evidence that workers' availability is linked to infant and maternal survival rates as well as with HIV/AIDS mortality. The data in Graphs 3 and 4 show these relationships: I employed Bharghava-Docquier data on physicians' density and associated them with the main health indicators derived from WHO (2006*a*) databases for the whole world. The indicators I chose measure both mortality rates (Graph 3) and health care provision (Graph 4).

[11] These are: *to Reduce Child Mortality (MDG 4), to Improve Maternal Health (MDG 5) and to Combat HIV/AIDS, malaria and other diseases (MDG 6)*.

GRAPH 3

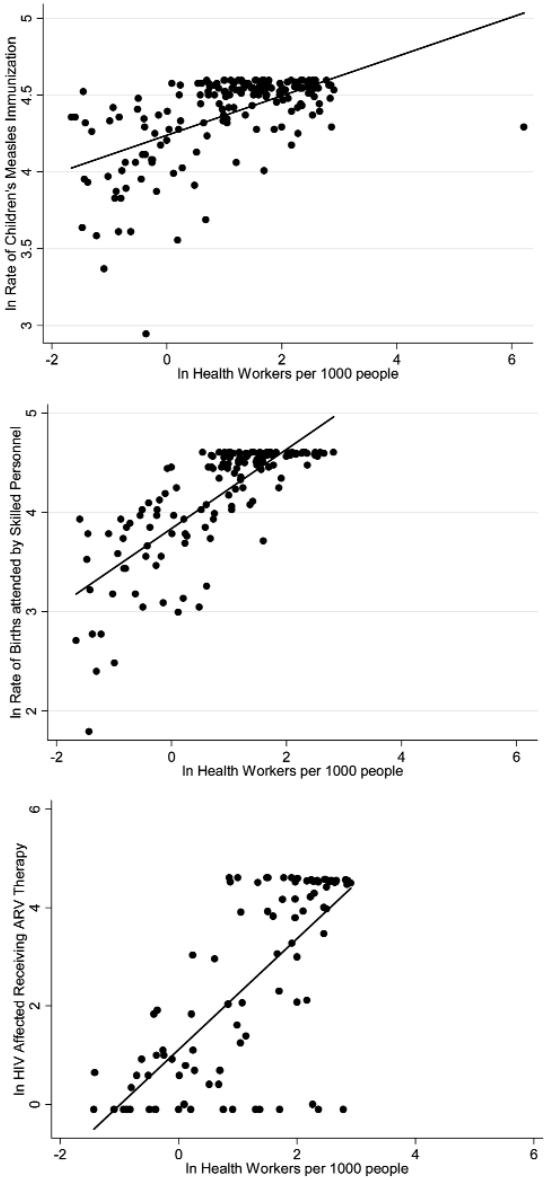
HEALTH WORKERS' DENSITY AND MORTALITY RATES.
FULL SAMPLE. YEAR 2004



Source: WHO (2006*a*) and BHARGHAVA A. - DOCQUIER F. (2006).

GRAPH 4

HEALTH WORKERS' DENSITY AND HEALTH SERVICE COVERAGE. FULL SAMPLE. YEAR 2004



Source: WHO (2006*a*) and BHARGHAVA A. - DOCQUIER F. (2006).

In order to test the magnitude and significance of the effects of physicians' availability and medical brain drain on the health status of the population in the sending country I regressed the logarithm of the three mortality[12] indicators on the stock of health staff available and on the number of emigrated physicians abroad (both per 1,000 people) using the usual set of controls: GDP *per capita*, primary enrolment rate, conflict since 1970, population density and share of population living in urban areas (Table 5).

As we could predict I find a strong and negative effect of physicians' availability on infant, maternal and HIV/AIDS mortality rates: the more doctors in the country, the lower the rates of mortality. Other variables that turn out to play a significant role in lowering the rates of mortality are the level of *per capita* GDP and the level of urbanization. Also it impresses how the incidence of an armed conflict strongly increases infant mortality rate in Sub-Saharan Africa.

Moreover the results of Table 5 show that the emigration of doctors dramatically boosts the number of deaths due to HIV/AIDS and that this effect is much stronger for Sub-Saharan Africa than for the rest of the world.

What is somehow puzzling, instead, is the fact that these results seem to reveal that the emigration of physicians negatively influences the rates of infant and maternal mortality and positively the rate of coverage of health services[13]. What I suggest is that

[12] Similar regressions have been run employing indicators of health assistance coverage: rate of measles immunization of children aged one, rate of births attended by skilled personnel, rate of HIV affected receiving antiretroviral (ARV) therapy. For all the three indicators I found a positive incidence of medical staff availability on the services' coverage rates (though this is not significant in the case of ARV therapy). In the case of Sub-Saharan Africa, nevertheless, it is systematically either the population density variable or the share of urban population one that capture the positive effect on the rate of coverage of health care rather than the stock of health workers itself (this is because among very poor countries such as those of Sub-Saharan Africa it is more the level of development of the country rather than the number of doctors available which determine the rate of coverage of health care. In other words those countries which are relatively better off present higher rates of coverage of health services no matter the availability of doctors).

[13] The results relative to the provision of health care services are not reported in the present work for brevity. The services considered are: rate of measles

TABLE 5

MIGRATION AND HEALTH OUTCOMES. OLS ESTIMATES (2004)

Dependent variable:	ln infant mortality rate			ln maternal mortality rate			ln deaths due to HIV/AIDS		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	Full Sample	Sub-Saharan Africa	Rest of the World	Full Sample	Sub-Saharan Africa	Rest of the World	Full Sample	Sub-Saharan Africa	Rest of the World
ln total stock of medical staff per 1,000 people	-0.254***	-0.004	-0.226***	-0.739***	0.04	-0.719***	-0.566***	-0.308	-0.161
	(4.30)	(0.04)	(3.39)	(8.17)	(0.21)	(6.50)	(2.72)	(0.42)	(0.76)
ln physicians abroad/1,000 people	-0.045*	-0.038	-0.047*	-0.036	-0.123*	-0.019	0.236**	0.546**	0.239**
	(1.87)	(0.86)	(1.81)	(0.79)	(1.77)	(0.36)	(2.36)	(2.14)	(2.40)
ln GDP *per capita*	-0.447***	-0.354***	-0.432***	-0.444***	-0.67***	-0.425***	-0.229	-0.359	-0.221
	(9.80)	(3.68)	(9.04)	(6.07)	(4.15)	(5.18)	(1.38)	(0.64)	(1.42)
ln Primary enrolment	0.022	0.275	-0.217	0.539	0.527	0.619	-1.036	0.868	-1.331
	(0.1)	(1.09)	(0.68)	(1.53)	(1.36)	(1.16)	(1.33)	(0.68)	(1.32)
Conflict since 1970	0.038	0.284*	0.072	0.049	0.225	0.109	-0.732**	-0.267	-0.44
	(0.42)	(2.01)	(0.73)	(0.34)	(1)	(0.65)	(2.14)	(0.33)	(1.29)
ln population density	0.101	0.181	0.016	0.151	0.157	0.167	-0.468	-0.818	-0.096
	(0.91)	(1.14)	(0.13)	(0.84)	(0.62)	(0.77)	(1.17)	(0.96)	(0.24)
ln population in urban areas	-0.085***	-0.171***	-0.044	-0.123**	-0.191**	-0.067	-0.251**	-0.552**	-0.096
	(2.84)	(3.74)	(1.35)	(2.57)	(2.63)	(1.17)	(2.36)	(2.25)	(0.91)
Constant	6.516***	4.91***	7.546***	1.52	3.017	0.607	14.753***	11.399	12.857**
	(5.44)	(3.26)	(4.57)	(0.79)	(1.3)	(0.21)	(3.48)	(1.48)	(2.40)
N	146	36	110	138	34	104	122	33	89
Adjusted R^2	0.8417	0.6729	0.8065	0.8287	0.6926	0.7474	0.2741	0.0612	0.0524

these results are due to the fact that the skilled emigration variable may hide some characteristics of the country of origin related to its level of human development. This idea would be confirmed by the high level of significance of the variables "*per capita* GDP" and "share of population living in urban areas" which are proxies for the level of economic and human development of the country.

4.5 *Quality of Education and Brain Drain*

The link between the level of human development of a country, its rate of brain drain and its outcomes in terms of health status

immunization of children aged one, rate of births attended by skilled personnel, rate of HIV affected receiving ARV therapy.

of the population may pass through the differences in terms of quality of the educational system and levels of educational attainment in the country.

What I suggest is that the positive impact of emigration onto the health status of the sending country's population may indicate that the emigration variable absorbs part of the effect of unobserved quality differences in educational systems. In other words, it is likely that professionals who have been trained in a high quality educational system have a higher probability of being hired in developed countries. Thus a high number of physicians trained in their country of origin and currently working in OECD countries may reflect a high quality of education in that specific sending country. This may rationalise the finding that a greater number of physicians abroad is negatively correlated with mortality rates and positively correlated with the rate of health services' coverage.

To get indirect evidence on this conjecture, I introduce several more regressors to proxy for the country's level of human development and the quality of its educational system. Thus, I include Barro and Lee (2000) measures of educational attainment for population aged 25 and over[14] and the ratios of pupils to teacher at primary and secondary school (Barro and Lee, 2001) to control for the quality of the educational system of the sending country.

Indeed I believe that traditional education indicators such as school enrolment ratios or literacy rates do not adequately measure the aggregate stock of human capital of which the country disposes at a certain point in time as an input for production. Together with these indicators, pupils/teacher ratios let us control for the quality of the educational system. Indeed, Barro and Lee (2001) provided evidence that more school resources, especially smaller class sizes, are the main determinants of educational quality, as measured by internationally comparable test scores, repetition rates and dropout rates.

[14] These are "Percentage of primary school complete in the total population" and "Percentage of secondary school complete in the total population".

I will thus reproduce the estimations of the effect of migration onto the stock of physicians in the sending country, the number of students enrolled to secondary, tertiary and medical school and the main health outcomes, introducing this new set of controls (Table 3, Model 3; Table 4, Model 2; Table 6).

These results seem to confirm the hypothesis on the spurious character of the emigration variable; indeed, in Table 3, Model 3, when computing the OLS estimates of the determinants of the stock of physicians operating in their country of origin, I find that the level of educational attainment has a highly significant and positive (for both primary and secondary school) effect, while the number of pupils per teacher at primary school is negatively (and significantly) correlated with the dependent variable. Further more the coefficient associated to the interaction term which in Model 1 and Model 2 suggested the existence of some medical brain gain for Sub-Saharan Africa becomes now much smaller and less significant.

In Table 4, Model 2, I look at the effects on enrolment rates adding the new set of controls. The brain gain effect I had found for the rates of enrolment to secondary school for Sub-Saharan Africa now completely disappears, all the effect being captured by the quality of the educational system. On the other hand, adding the new control variables, no brain gain effect is revealed either at tertiary level or for medical studies, as had been suggested in section 4.3.

Finally in Table 6, I analyzed the effects of physicians' emigration on the health status of the sending country's population, introducing the variables for the quality of education and the level of school attainment. The results seem to confirm the idea that the brain drain variable actually hides some characteristics linked to the level of human development of the sending country and to the quality of its educational system in particular. Indeed, not only has now the negative relationship between emigration and mortality rates of Table 5 disappeared, but, in the case of deaths due to HIV/AIDS, the positive coefficient I had found in Table 5 has become greater and still highly significant. This means that, once the educational variables have

TABLE 6

MIGRATION, HEALTH OUTCOMES AND QUALITY OF EDUCATION. OLS ESTIMATES

Sample: Full Year: 2004						
Dependent variable:	ln infant mortality rate		ln maternal mortality rate		ln deaths due to HIV/AIDS	
	(1)	(2)	(3)	(4)	(5)	(6)
ln total stock of medical staff per 1,000 people	-0.048	0.004	-0.179	0.063	-0.437	-0.313
	(0.43)	(0.03)	(1.01)	(0.24)	(1.1)	(0.55)
ln physicians abroad/ 1,000 people	-0.001	-0.07	-0.007	-0.083	0.737***	0.608***
	(0.02)	(1.32)	(0.1)	(0.92)	(4.97)	(3.82)
Controls[ii]	yes	yes	yes	yes	yes	yes
ln primary attainment	-0.205**	0.018	0.012	0.175	-1.343***	-0.203
	(2.04)	(0.13)	(0.07)	(0.79)	(3.43)	(0.37)
ln secondary attainment	-0.07	-0.015	-0.192	-0.144	-0.146	-0.256
	(0.86)	-0.11	(1.29)	(0.66)	(0.46)	(0.62)
ln pupil-teacher *ratio* at primary	0.699**	0.492	1.063**	0.873	0.954	0.708
	(2.46)	(1.47)	(2.19)	(1.6)	(0.93)	(0.67)
ln pupil-teacher ratio at secondary	-0.057	-0.158	-0.029	0.006	-1.499	-1.118
	(0.23)	(0.46)	(0.07)	(0.01)	(1.63)	(0.9)
(SSA*ln physicians abroad/1,000)		-0.071		-0.043		-0.27
		(1.23)		(0.48)		(1.45)
Constant	4.979***	5.566***	0.78	1.193	17.423***	10.431*
	(3.80)	(3.36)	(0.35)	(0.46)	(3.55)	(1.90)
N	78	48	72	46	66	44
Adjusted R^2	0.8547	0.8877	0.825	0.8691	0.3978	0.3829

[ii] Controls are: ln GDP *per capita*, conflict since 1970, ln population density and ln population in urban areas.

been introduced, the emigration of physicians determines a substantial increase in the number of deaths due to HIV/AIDS[15]. The introduction of the interaction terms for Sub-Saharan Africa in Columns 2, 4 and 6 reveals that there is no difference between the effects of brain drain for Sub-Saharan Africa and the rest of the world.

In conclusion, these results confirm the hypothesis that the apparent virtuous effects of brain drain on education (*i.e.* brain gain) and on health actually hide some characteristics relative to

[15] I tested the effect of MBD on the rate of provision of the health services indicated in footnote 13 adding the variables on the quality of education and on educational attainment. With regard to the provision of these services again the emigration variable turns out to be not significant once I control for the quality of education. Indeed the level of educational attainment is always significant and positively related to the rate of coverage of health services.

the quality of the educational system of the sending country. The introduction of Barro and Lee indicators has let us see the "pure" effect of emigration on educational choices and health outcomes.

By the way, once we reject the hypothesis that the emigration of physicians may be beneficial for the sending country, still its effect has not been completely clarified by this analysis as its coefficients have almost systematically remained not significant. With regard to the health status of the sending country's population the analysis has suggested that the outflows of physicians towards the most developed countries have no impact, neither positive nor negative, on mortality rates and on the levels of provision of health services (except for the strong positive effect on HIV/AIDS mortality). In order to test this finding I eventually turned to a case study to shed light on the effects of physicians' emigration that have not been captured by the econometric analysis.

5. - Case Study: Lessons from Zimbabwe

Zimbabwe is one of the countries most severely hit by the medical brain drain phenomenon. Despite the presence of a very competitive medical school at the University of Zimbabwe which trains every year around 80-90 doctors, the massive emigration of its graduates does not allow the country to benefit from its investment in the training of prospective doctors.

Indeed data obtained from the Zimbabwean Central Statistical Office (CSO) and reported by Chikanda (2005) show that the number of registered doctors and specialists in the country has increased slightly from 1,575 in 1995 to 1,629 in 2000 (3% increase). Given the number of doctors trained every year at the Medical School of the University of Zimbabwe, this means that there was an overall increase of only 54 doctors rather than the expected 400 plus over the five-year period. The data employed in this study reveal that emigration is the main responsible for such a discrepancy.

The massive phenomenon of medical brain drain from

Zimbabwe is not limited to physicians but also involves nurses, with CSO data reporting that the country is currently experiencing a decline in its domestic stock of nurses started in the late 1990s (in 1999 there were 15,476 registered nurses while in 2001 there remained only 12,477 as the result of a growing emigration).

The outflow of medical staff from Zimbabwe also represents a significant fiscal loss for the country, which not only loses its best professionals but also bears the cost of their formation. The International Organization for Migration (2007) reports that the cost of training a doctor, for a government, is about $60,000 and that of training a nurse about $15,000. This means that if Zimbabwe has trained 450 doctors between 1995 and 2000, and 400 of them have left the country, the government has lost an amount of around $24 million for doctors and around $45 million for the 3,000 nurses lost between 1999 and 2001. These costs are to be added to those the country faces in order to replace the health workers emigrated recruiting health personnel from abroad. In the case of Zimbabwe the government is facing its shortage of physicians through the stipulation of agreements with other countries: Zimbabwe has an agreement with Cuba which brought to the country 117 doctors in 2002 and one with the Democratic Republic of Congo which brought to Harare 54 doctors, 11 pharmacists and three radiographers in 2003. Such agreements are, nevertheless, extremely expensive for Zimbabwe as the government not only has to pay their salaries and travel expenses but also has to bear the costs of teaching English and Shona to them. Moreover, as these staffs are recruited only on a temporary basis these costs are to be borne periodically[16].

The effect of these outflows on the health status of the population and on the provision of health cares is hardly identifiable through the analysis of the estimates provided by WHO. Indeed, in spite of a dramatic shortage of physicians (there are currently 5.7 physicians per 100,000 people) and of a substantial emigration of doctors (according to Bharghava-

[16] For instance, in the case of the agreement with DRC the doctors were foreseen to stay in Zimbabwe for three years.

Docquier estimates 3.3 physicians per 100,000 people have been trained in Zimbabwe and currently work in OECD countries), the country exhibits a rate of one year old children immunization and of births attended by skilled personnel of 80%. Thus it seems that, despite its shortage of health personnel, Zimbabwe currently manages to assure its population a sufficient level of basic health cares.

Surveys conducted among the health personnel of Zimbabwe in the context of the Southern Africa Migration Project (Chikanda, 2005 and Tevera, 2005) reveal, in fact, that the real gap is not just in terms of "quantity" of services provided but much more in terms of their "quality".

Indeed medical brain drain affects the quality of health care *via* two channels: on the one hand the "best" workers are the first ones to leave the country, which hence remains with the less qualified ones, on the other hand the shortage of health workers caused by migration heavily increases the workload of those who remain and forces them to offer services they are neither supposed nor qualified to render. In many health centres the so-called "nurse aides" have to carry out nursing responsibilities, while nurses perform doctors' duties. The survey conducted by Chikanda (2005) revealed that, among the respondents, 66% of the doctors and 55% of the nurses claimed they sometimes had to offer services they are not supposed to render, but do so because of the absence of specialised personnel.

Moreover nurses and doctors can spend a very short time on each single patient, interviews with health professionals revealing that more than half of them (55%) took less than ten minutes to attend a single patient. This unavoidably hurries the diagnoses and prescriptions of treatments with obvious consequences in terms of accuracy. The excessive workload, associated with the stress of dealing with so many dying patients and the fear of HIV contagion due to inadequate hygienic conditions, generates a widespread sense of frustration on the job which affects the quality of care and induces these health workers to opt to emigrate making the phenomenon of medical brain drain a vicious circle.

In conclusion, medical brain drain and the consequent

shortage of health staff seems to affect more the "quality" of the services provided than their "quantity". It is worth highlighting that this result holds as long as we look at the provision of basic health care, indeed when we consider some more complex therapies such as ARV for HIV/AIDS affected people, the rate of people with advanced HIV infection receiving ARV combination therapy in Zimbabwe falls to 15% (WHO, 2006*a*) and the empirical results reported in Tables 5 and 6 confirm that the emigration of physicians generates an increase in the rates of HIV/AIDS mortality.

6. - Concluding Remarks

In conclusion this research revealed that, in the health sector, there is no evidence of any kind of *brain gain* phenomenon as I did not find any significant variation neither in the number of physicians in the country nor in the number of individuals who choose to enrol in medical school in response to the outflows of physicians towards more developed countries. The results obtained by Clemens (2007) are thus considerably weakened once we just employ a different and more restrictive definition of "African doctor" and focus the analysis on Sub-Saharan Africa only.

Moreover I found that, in Africa, and there alone, high rates of emigration are associated with high densities of physicians in the home country and low levels of mortality rates. I suggested that this correlation may be spurious, as the emigration variable may proxy for the quality of the educational system of the country, and thus of its level of "human development": a higher level of human development would imply both higher rates of brain drain and lower mortality rates. Indeed when controlling for the level of human development, the level of the population's educational attainment and the quality of the educational system, this effect disappears.

The empirical analysis moreover revealed that the availability of medical staff has no impact on the amount of health services provided and on mortality rates. The case study of section 5,

nevertheless, allowed us to find some "deeper" effects of physicians' emigration on the home country's health system: the experience of Zimbabwe, showed that the most important effect of emigration is not on the "quantity" of services provided but rather on their "quality" and on the working conditions of those left: staff that received a good professional formation manages to provide the population with basic health care but is less effective in more complex therapies because the emigration of doctors and nurses generates enormous workload for those who remain. It is for this reason that physicians' emigration turned out to have a positive significant effect on the number of deaths due to HIV/AIDS, as I suggested, this might be due to the more complex nature of the therapy required, which cannot be administered by less skilled personnel.

All these results, by the way, should be taken with caution because of the small size of the sample due to the scarce availability of data for Sub-Saharan Africa. In particular I believe that educational choices should be analyzed in a more comprehensive setup where private returns to education are considered both in the home country and in potential destination countries. Unfortunately data on doctors' wages in Sub-Saharan Africa are rarely available and extremely variable both across and within countries. Another key aspect is certainly the quality of medical structures which in Sub-Saharan Africa is often very poor and thus often triggers "escape strategies" for doctors and nurses. Also it must be taken into account that the medical profession is particularly problematic because it entails a strong vocational component. Hence I believe that collecting data at individual level would probably be a useful exercise for better understanding the mechanisms behind individuals' educational choices and the relationship between these and migration prospects.

For the moment what this study showed was that no evidence of any kind of brain gain phenomenon can be found for Sub-Saharan Africa and that medical brain drain entails some negative externalities on the home country's population which is the reason why this phenomenon currently raises major concern among policy makers and international organizations.

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