“Brain drain”, aid and growth

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(Comments are welcome)

Abstract

This paper incorporates brain drain into the analysis of the effect of foreign aid on growth. While migration tends to grow, until now there were no reliable measures about the extent of the brain drain. We use a new dataset to test the hypothesis that the brain drain is detrimental for growth in a cross section of 112 sending economies. We find that aid policy is effective to reduce the mid-term growth impact of the human capital flight in sending economies.

Key Words: Foreign Aid, Growth, Development, Migration, Brain Drain.

JEL Classification: F35, H50, J61, O15.

1. Introduction

In the 90s many OECD countries introduced immigration policies increasingly selective to attract qualified workers from other countries. The aim of these policies was to contribute with highly skilled migrants to the national economies. Australia, Canada and the USA established quota or visa systems favoring candidates with specific skill profiles. EU countries are also defining special programs aiming to attract qualified workers in specific technology fields. The result of this renewed attitude towards migration is an increasing "brain drain" [1] in the developing world.

In most OECD economies, workers from developing countries have increased dramatically in absolute and relative terms[2]. Between 1990 and 2000 the foreign born individuals residing in OECD countries have increased in 51 per cent. This trend will likely continue in the future and will become a global challenge for policy makers in both developed and developing countries. Moreover, migrant characteristics are not neutral; they are relatively young and skilled. Recent data show that highly skilled migrants have risen 71 per cent, while low skilled migrants have increased only in 28 per cent (Docquier and Marfouk, 2004). In this paper we investigate the growth effect of the brain drain and evaluate the role of aid policy to overcome the detrimental consequences of the human capital flight for sending economies.

Recent "aid effectiveness" debate is largely focused on determining the criteria by which aid can stimulate growth, and on how should be allocated. Burnside and Dollar (2000) find that the effect of aid promoting growth depends on the policy regimes of recipient countries. Based on the same approach, Collier and Dollar (2002) incorporate poverty into the analysis. They find that aid reduces poverty across recipients depending on the level of poverty and on the policy regime.

The previous methodology has been extended to new research areas, such as aid and growth in post-conflict scenarios (e.g. Collier and Hoefler, 2004), aid and trade shocks (Collier and Dehn, 2001), aid and structural vulnerability (Guillaumont and Chauvet, 2001), or aid and public expenditure composition (Gomanee el al., 2004; Mosley et al., 2004). One common finding is that introducing different shocks into the "aid

[1] The "brain drain" expression was coined to describe the outflow of engineers and scientist to the USA and Canada that took place in the 50s and 60s. In this paper, by "brain drain" we mean the migration of tertiary educated workers from developing countries to the OECD.
[2] OECD (2004).

effectiveness" framework allows for a better insight into the policy regime role. By omitting such shocks into the growth equation, the role of policy may be exaggerated.

The human capital flight is not properly a shock; but having a large part of a poor country's human capital living abroad yields numerous distortions in the sending economy that do affect growth. Can aid be a useful policy option to overcome the potential negative growth effect of the brain drain? Aid tends to be allocated as much as political and strategic considerations, as by the economic needs and policy performance of the recipient economies (Alesina and Dollar, 2000). To our knowledge, there is no evidence that workers' movement across borders is driving aid flows. We take this assumption as given to show that aid might play an important role in mitigating the effect on growth of migration of highly skilled workers.

Models of brain drain contain explicit policy recommendations aimed to avoid the detrimental effects on welfare and growth. The more simple policy conclusion is to prohibit brain drain, but it has serious difficulties to be enforced. Bhagwati and Hamada (1974) propose a tax on emigrants collected by the developed country and transferred to the sending economy. Apart from the distributional implications, enforcing a tax on non-residents may be a difficult task and requires from the receiving country an adequate assistance.

In a brain drain dynamic model Wong and Yip (1999) argue that policies that increase investments in education (raising the educator-student ratio) in the sending economy will accelerate the growth rate. Official Development Assistance (ODA) may also have static welfare benefits for the economy in the sense it relaxes the tax burden to finance public education for those left behind. Moreover, Mosley et al. (2004) and Gomanee et al. (2004) document that aid is associated with higher levels of public expenditure that affect the provision of social services, such as health or education. Given this support we interpret that aid might reduce brain drain directly, by increasing income levels, and indirectly, by increasing education expenditure.

If OECD governments establish specific programs to attract skilled workers from developing countries, one useful way of reducing the impact of brain drain in sending economies is to subsidize education through foreign aid. Investing in local education becomes a necessary condition to replace human capital flight.

In this paper we extend the standard methodology to study the effectiveness of aid in labour exporting countries. We focus on the study of the effect of "brain drain" on growth rates on a period of ten years (1990-2000) over a cross-section of developing countries. We use a new dataset of foreign population stocks based in the educational profile of migrants. The major difficulty of the paper is that migration is not properly an external shock, but it is a response to an economic and policy environment, and it can not be used in a growth equation because it is an endogenous variable. The literature on migration has studied the causes of migration for a long time. We identify the effect of the brain drain on growth estimating by the two stages least squares procedure. We use a set of instruments based on a standard model of migration.

The paper is organized as follows. In the next section we show the magnitude of the brain drain phenomenon during the last decade. An inverted U appears when we plot migration rates and GDP per worker across countries. Poorest countries do not show higher rates of skilled migration. In the third section we describe the methodology and the results. We will show that countries where the most qualified workers have emigrated to the OECD countries tend to grow less and that aid may compensate those effects. In the fourth section we conclude discussing several policy implications.

2. Measuring the "brain drain"

While the level of international migration tends to grow, until recently there were no consistent data to measure the brain drain. The first attempt was done by Carrington and Detragiache (1998), who estimate based on population censuses from receiving countries for 1990 the amount of immigrants in OECD economies. In a first step, they classify foreign born population in the United States in three groups (primary, secondary and tertiary educated) and extrapolate that profile to the rest of OECD economies to compute emigration stocks for 61 countries. In a second step, they calculate migration rates by educational level, by combining these estimates with the data on educational attainment from Barro and Lee (1993). Ultimately, they compute a measure of the fraction of the population in each educational category that has emigrated to the OECD.

The second attempt is due to Docquier and Marfouk (2004). They report data on migration rates by educational level for 170 countries in 1990 and 2000. This new database covers the 92.7% of the OECD immigration stock and is based on a more

careful methodology where the educational profile of migrants is extracted from data on national population censuses.

Migration rate variable ($m_{t,s}^{j}$) is defined for three educational levels ($s = pri$ for workers with primary education, $s = \sec$ for workers with secondary education and $s = ter$ for workers with tertiary education) following Barro and Lee (2000) measures:

$$m_{t,s}^{j} = \frac{M_{t,s}^{\cdot j}}{N_{t,s}^{\cdot j} + M_{t,s}^{\cdot j}} 100 , \qquad (1)$$

where $M_{t,s}^{\cdot j}$ is the stock of emigrants over 25 years old of skill *s* in country *j* at time *t* and $N_{t,s}^{\cdot j}$ is the stock of individual aged over 25 of skill *s* in country *j* at time *t*. Hence, $m_{t,ter}^{j}$ is a measure of the intensity of highly skilled workers born in country *j* living in OECD economies, i.e. a measure of the brain drain for each country.

Figure 1 shows the relationship between migration and GDP per capita. It can be seen that, in general, more income implies less emigration. However, the plots also show that there is a minimum level of income below which the migration rate is lower because the cost of emigration can not be assumed. As a result, the plots show an inverted U relationship between the two variables. If we look at the different levels of skills, we can see that the effect is not the same in each case. Specifically, the differences in migration rates for each level of per capita income increase with the level of skills, i.e. skilled workers tend to emigrate more. The reason is that better qualified workers can afford the cost of emigration because its income is higher than the one of unskilled workers.

In Figure 2 we represent the changes in the migration rates of the tertiary educated workers. The change is calculated as the difference between the brain drain rate in 2000 and 1990. The graph shows that brain drain has increased in more than half of the 170 countries with available data. Countries with lower rates in 1990 tend to experience a faster change in brain drain rates with some exception.

Data for the different countries sorted by regions are shown in Table 1. The regions who had a higher brain drain in 1990 are the Caribbean, Central America, Western and Eastern Africa, and looking at the changes in the brain drain, it is shown that the most significant changes happen in Eastern and Western Africa and Central America. (Docquier and Marfouk, 2004). Talking about countries, there are some countries with a

brain drain rate above 80%; those are Caribbean countries or countries in the north coast of South America. With Table 1 data was elaborated Figure 3, where is easy to identify where the brain drain is higher. Indeed, the Caribbean countries and Eastern and Western African ones, jointed with some Pacific Islands are the countries who have rates upper 60%.

3. Aid, brain drain and growth

There is one idea we want to explore in this analysis. We want to test whether the effect of aid on growth is conditioned by the level of brain drain, once we take into account the political and institutional environment. To measure brain drain we use the fraction of the population over 25 with tertiary educational level that has emigrated to the OECD economies in 1990 relative to total population over 25 tertiary educated (*bd*). We regress the growth of real GDP per capita (g_i) during 1990 and 1999 versus the natural logarithm of real GDP per capita in the beginning of the period ($\ln y_i$), the aid (*a*) variable, the brain drain measure (*bd*), the interaction of brain drain and aid (*bd x a*) and an institutional/policy variable (*i*) that might affect growth. The equation takes the following form:

$$g_i = \beta_0 + \beta_1(\ln y)_i + \beta_2(a)_i + \beta_3(bd)_i + \beta_4(bd)x(a)_i + \beta_5(i)_i + e_i \quad (2)$$

where e_i is a random term.

We follow the literature on institutions and growth to measure institutional and policy quality. We use the institutional composite[3] from Kaufmann, Kraay and Matruzzi (2003) since is available for more than 150 countries starting in 1996 and allow us to gather a sample of 112 countries in our regressions[4]. The KKM index composite is an average of six different indicator of a country's governance: voice and accountability, political stability, government effectiveness, regulatory quality, rule of law and control of corruption. We interpret the average of these indexes as an overall assessment of sound institutions and policies that facilitates growth performance during the decade.

[3] Burnside and Dollar (2004) employ this index to revisit the evidence on aid, institutions and growth in a cross section of countries.
[4] Dollar and Kraay (2003), Rodrik, Subramanian and Trebbi (2004) use the rule of the law component from KKM.

Finally, aid is included, following the literature, as net Official Developed Assistance (ODA) in current US dollars as a proportion of real GDP in purchasing power parity (ppp) averaged for the decade, as is done, for instance in Burnside and Dollar (2004). The source of ODA is OECD-DAC and, the real GDP in constant international dollars is from Penn World Tables 6.1.

If we have a look at the variables included in the growth equation, is not difficult to see that there might be some endogeneity problems. First of all, it is likely that high brain drain rates at the beginning of the period causes less growth, but also future growth prospects affect the decision of people to emigrate. Second, in the case of institutions, it is possible the case of reverse causality, but also it is more likely that countries with higher growth rates tend to be rated with better institutions. In this case a positive significant coefficient is not showing that countries with better institutions tend to grow more but the other way around. Third, measurement errors in initial GDP per capita might bias downwards the correlations with subsequent growth. And fourth, aid donor's behaviour may be endogenous because they might take into account external shocks, giving more resources to countries that tend to growth less because they are more vulnerable to suffer shocks. All these reasons justify treating the right hand side variables as endogenous.

The set of instruments have been chosen from recent empirical studies and include geographical, demographical and historical variables. Hall and Jones (1999) show that the distance from the equator, the proportion of the population that speaks English and the proportion that speaks a major European language are closely related to institutional quality and GDP per worker in 1990. On the other hand, Alesina and Dollar (2000) find that the colonial past and the size of the population play an important role in allocating ODA among developing countries. And finally, there are several studies that identify geographical barriers as determinants of migration cost. We compute as a proxy of the cost of migration the distances to North America, Europe and Asia. We add a dummy that takes the value 1 when the country is contiguous to an OECD country and 0 otherwise. And finally, we add a dummy for landlocked countries and a dummy for tropical climate. It is hard to instrument for so many variables at once. Our objective is to estimate the brain drain variable and the brain drain interacted with aid, so we will add to the list of instruments several interactions of the exogenous variables.

The null hypothesis to be tested is that the effect of aid on growth is the same regardless the brain drain rate. Thus, if the null is rejected then the coefficient on the aid-brain drain interactive variable (β_4) will be significantly different form zero. We start OLS regressions treating all the right hand side variables as exogenous. Initial GDP per capita, Aid and the interaction with the Brain Drain variable are negatively correlated with subsequent growth, and Brain Drain and the KKM institutional composite are positively related to growth, however neither are significant (Table 3, Column 1). These results are very poor and reveal that there may be potential outliers that are affecting both coefficients and overall fit of the model. We will deal with this issue below. Moving towards the instrumental variable estimates (Table 3, Column 2), the brain drain is significant and negatively related to growth at 5 per cent level. This means that brain drain is affecting subsequent growth directly. However, neither Aid nor Institutions seems to have significant consequences for growth. The interaction of aid and brain drain is positive and significant at 5 per cent level. That is, the effect of aid on growth is positive and increasing depending on the level of brain drain.

Table 3, Columns 3 and 4 report the OLS and IV estimates controlling for regional effects. We add five dummies based on World Bank's regional classification. OLS coefficients (Column 3) do not report anything new and the effects of brain drain, aid and institutions on growth are totally absent. However, IV estimates (Column 4) confirm previous findings that brain drain is significant and negatively related to growth and that aid stimulates growth in those countries where a large fraction of their human capital is living abroad. These results imply that the effect of aid on growth through the brain drain is not regionalized and seems to affect all the cross section of developing countries.

Looking at the OLS results, the low overall fit of the model and the fact that coefficients are no longer significant make us to suspect of the existence of outliers. We detect that a single country, Equatorial Guinea, is having a rapid growth during the 90s but having a poor institutional environment and receiving three times more ODA than the median. In Table 4 we re-run the four specifications excluding this country. Now the explanatory power of the model increases by large. Note also, that OLS and IV estimates do not differ qualitatively in all the covariates. First, all the columns show a negative and significant coefficient in GDP per capita in 1990 (conditional convergence). Second, Aid per se is affecting negatively to all the countries' growth once we take into account

other factors. Third, Brain Drain reduces decadal growth in all the economies, but the coefficient is only significant in IV estimates. Fourth, the effect of Aid interacted with Brain Drain on growth is positive in all the specification and significant in IV regressions. Moreover, to the extent that Aid is stimulating growth through the Brain Drain, its effect is not regionalized. And finally, Institutions seems to spur growth in all the specifications (at 1 per cent level).

IV estimation is based on the assumption that the instruments are uncorrelated with the error term. Since we have more instruments than endogenous variables, we calculate Sargan test for over-identifying restrictions. In all the specifications (Columns 2 and 4 in Table 3 and Table 4) the hypothesis of exogeneity can not be rejected. This means that the sort of instruments we are using affect growth in the 90s through their effect on GDP per capita and on the brain drain rate in 1990 and through the rest of the regressor.

The performance of the IV estimator depends crucially on the level of instrument relevance. How to assess the choice of instruments? We find in specification 2 in Table 3 R-squared in the first stage regressions in a range from 0.35 (in aid-brain drain interaction variable) to 0.68 (in brain drain variable). However, in models with more than one endogenous variable, multicollinearity among instruments turn IV estimator very poor, even when R-squared is high for each explanatory variable.

To test for the instrument relevance we use Shea (1997) procedure. Table 5 report the coefficients of the partial R-squared for each explanatory variable. All of them are relevant since the R-squared is above 0.10 and the p-values are below 0.001.

4. Conclusions

During the 90s several OECD economies established especial programs to attract qualified workers from developing countries. The effect of such policies supposes an external shock for most developing countries that are trying to retain their better human capital at home. We present evidence that brain drain has a direct negative effect in next decade growth, once we control for institutions, initial GDP per capita and aid. Early models of brain drain in the 60s and 70s predicted adverse consequences for sending economies. Our estimates suggest that an increase of ten percentage points in human capital flight is reducing per capita growth rates in about 0.8 percent each year.

But also, this paper suggests that official development assistance is a helpful policy tool to compensate the detrimental growth effects of the brain drain. That is, countries with higher brain drain rates tend to growth less; however, the more proportion of a country's human capital is living abroad the more effective is external aid to spur growth once we take into account institutions and other factors.

In the past aid has been allocated following criteria not closely related to growth. Over the past decade new evidence has launch a new debate whether aid must be allocated to countries with good institutions. Our paper supports this view, but we have considered a new criterion to allocate aid among developing countries. Aid may compensate brain drain detrimental effects on mid-term growth by two channels. One is by replacing emigrated highly educated workers financing the education of new highly educated workers. This seems to be a necessary condition to make neutral the human capital flight. But, aid per se is not able to avoid the flow of tertiary educated workers in a world where labor markets are increasingly integrated. Countries may reduce the brain drain through adopting high quality institutions that increase income levels and retain workers at home. This way aid may act as a second channel on negative brain drain effects on growth by conditioning the aid allocation to countries that pursue sound institutions and policies.

Finally, OECD countries that face a shortage on certain skilled categories and promote migration policies to attract qualified workers from developing countries should be more concerned about the consequences of the brain drain for sending economies. Hence, aid donors with migration policies more open to highly qualified workers in the past should weight brain drain rates in aid allocation.

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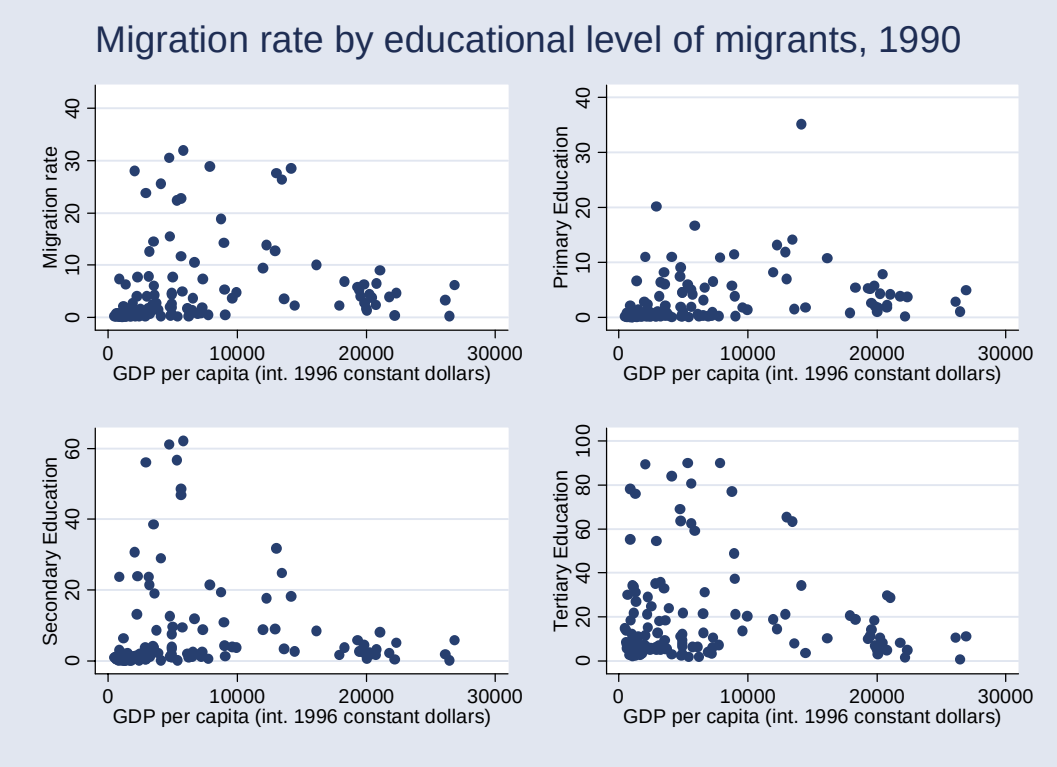

Figure 1. Migration rates in 1990

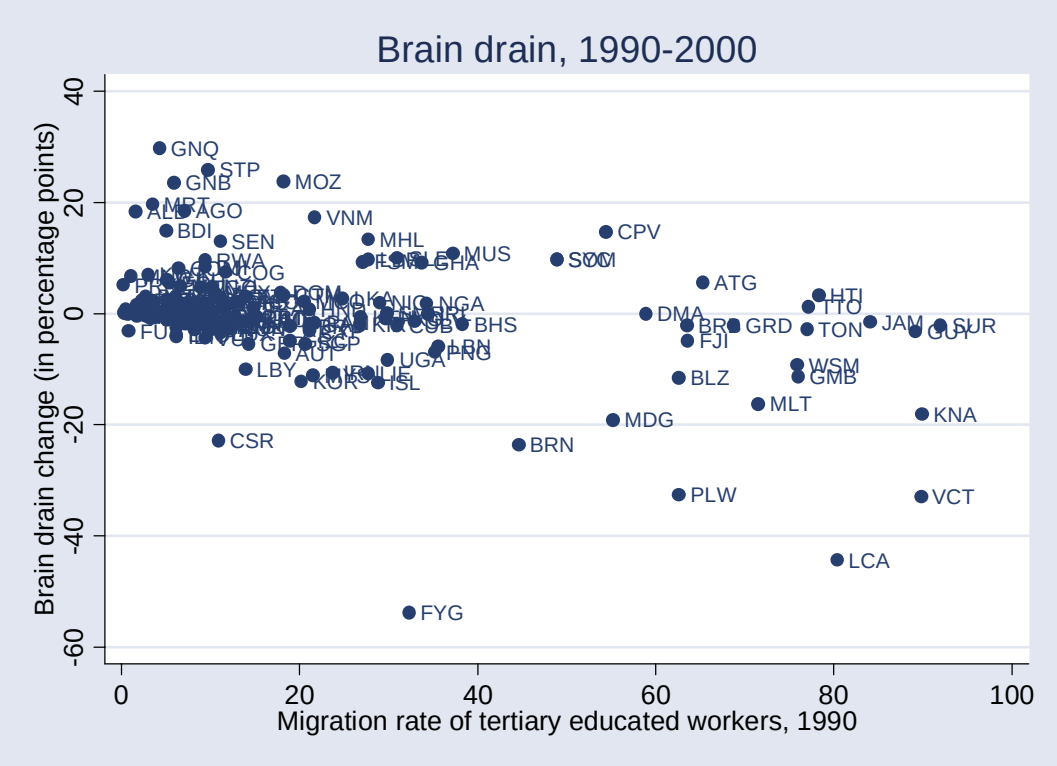

Figure 2. Changes in brain drain, 1990-2000

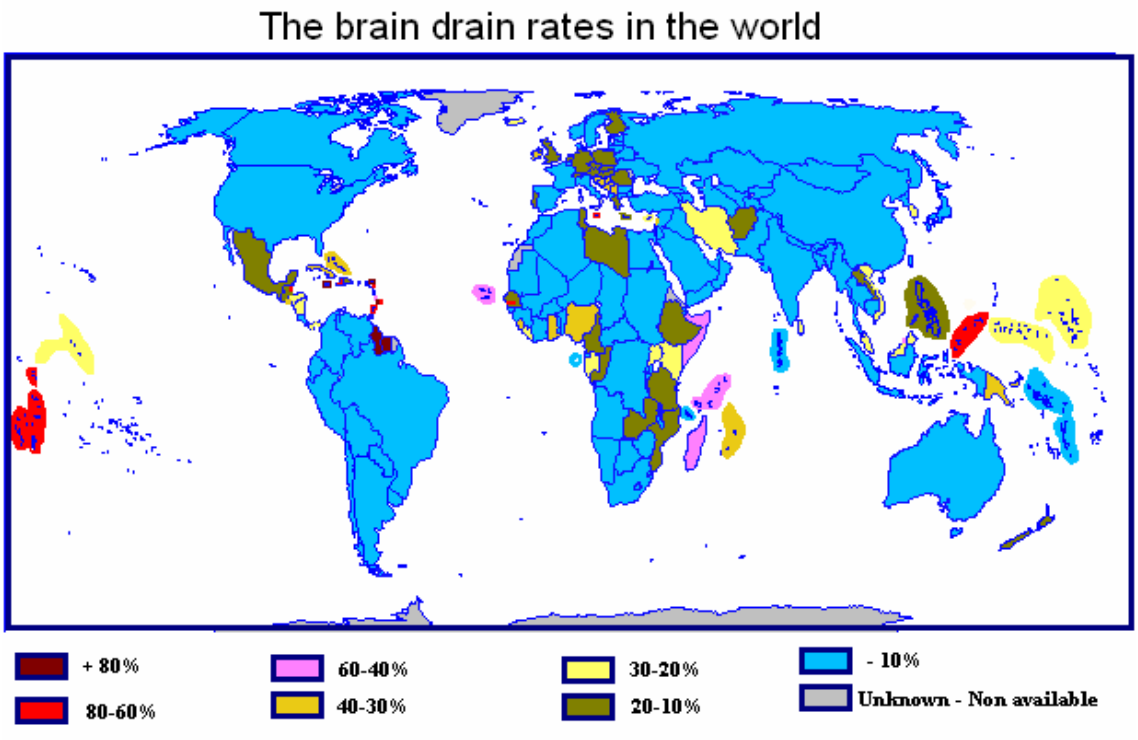

Figure 3. Brain drain rates in the world (1990).

Table 1. Brain Drain by regions (level in 1990 and change)

	Brain drain in 1990	Brain drain change 2000/1990	
		Variation in percentage points (*)	Ratio (rate in 2000 / rate in 1990) (*)
AMERICA			
Northern America	**0.8**	**0.2**	**1.2**
Central America	**12.9**	**3.1**	**1.2**
The Caribbean	**41.4**	**-0.5**	**1.0**
South America	**4.7**	**1.0**	**1.2**
EUROPE			
Northern Europe	**16.2**	**-1.9**	**0.9**
Western Europe	**10.4**	**-3.2**	**0.7**
Southern Europe	**11.2**	**-2.2**	**0.8**
Eastern Europe	**2.3**	**2.2**	**1.9**
AFRICA			
Northern Africa	**6.8**	**-0.6**	**0.9**
Central Africa	**9.8**	**3.5**	**1.4**
Western Africa	**20.7**	**6.0**	**1.3**
Eastern Africa	**15.5**	**3.0**	**1.2**
Southern Africa	**6.9**	**-1.6**	**0.8**
ASIA			
Western Asia	**6.9**	**-1.1**	**0.8**
South-Central Asia	**4.0**	**1.1**	**1.3**
South-Eastern Asia	**10.3**	**-0.5**	**1.0**
Eastern Asia	**4.1**	**0.2**	**1.1**
OCEANIA			
Oceania	**6.1**	**0.6**	**1.1**

Table 2. Summary of statistics

	Obs	Mean	Std. Dev.	Min	Max
Variable					
GDP per capita growth, 1990-2000	112	1.4	3.1	-7.7	23.4
Log GDP per capita 1990	112	7.9	0.9	6.2	9.8
Aid (% GDP)	112	2.3	2.6	0.0	14.5
Brain Drain	112	21.0	24.1	0.3	89.9
Institutions	112	-0.2	0.6	-1.9	1.7

Table 3. Growth, brain drain and aid

	(1) OLS	(2) IV	(3) OLS	(4) IV
Log GDP per capita 1990	-0.59	0.48	-0.502	2.272
	[0.728]	[1.225]	[0.869]	[1.690]
Aid/GDP	-0.097	-0.432	0.044	-0.191
	[0.267]	[0.432]	[0.292]	[0.548]
Brain Drain	0.002	-0.084	0.003	-0.079
	[0.012]	[0.041]**	[0.013]	[0.043]*
Aid*Brain Drain	-0.002	0.036	-0.002	0.037
	[0.005]	[0.017]**	[0.006]	[0.019]*
Institutions	1.63	1.41	1.317	-0.987
	[1.301]	[1.678]	[1.388]	[2.018]
South Asia			1.464	4.055
			[0.915]	[3.024]
Middle East and North Africa			1.058	1.414
			[0.754]	[1.973]
East Asia and Pacific			1.708	3.637
			[0.948]*	[2.195]
Sub-Saharan Africa			-0.416	0.988
			[0.780]	[2.420]
Latin America and Caribbean			0.472	0.428
			[0.639]	[1.935]
Constant	6.55	-1.263	5.129	-17.851
	[6.239]	[10.289]	[7.546]	[14.653]
# Observations	112	112	112	112
R-squared	0.07		0.11	
Joint F test on Aid and Aid-Brain Drain interactive term		2.42		2.88
p-value		0.094		0.06
OID: Sargan test		13.369		8.802
p-value		0.419		0.787

Notes: Standard errors Huber/White/Sandwich corrected are in brackets
* significant at 10%; ** significant at 5% *** significant at 1%

Table 4. Growth, brain drain and aid (excluding Equatorial Guinea)

	1	2	3	4
	OLS	IV	OLS	IV
Log GDP per capita 1990	-1.257	-1.737	-1.306	-1.241
	[0.358]***	[0.727]**	[0.353]***	[0.908]
Aid/GDP	-0.353	-0.773	-0.22	-0.564
	[0.126]***	[0.248]***	[0.125]*	[0.281]**
Brain Drain	-0.003	-0.037	-0.003	-0.035
	[0.011]	[0.021]*	[0.011]	[0.021]*
Aid*Brain Drain	0.003	0.019	0.002	0.02
	[0.003]	[0.009]**	[0.003]	[0.009]**
Institutions	2.848	3.757	2.611	2.595
	[0.533]***	[0.990]***	[0.511]***	[1.092]**
South Asia			1.008	1.016
			[0.814]	[1.527]
Middle East and North Africa			1.254	1.375
			[0.725]*	[0.982]
East Asia and Pacific			1.372	1.593
			[0.859]	[1.104]
Sub-Saharan Africa			-0.647	-0.276
			[0.738]	[1.199]
Latin America and Caribbean			0.447	0.286
			[0.620]	[0.963]
Constant	12.275	17.05	12.1	12.014
	[3.077]***	[6.120]***	[3.105]***	[7.875]
# Observations	111	111	111	111
R-squared	0.35	0.17	0.43	0.25
Joint F test on Aid and Aid-Brain Drain interactive term		4.92		2.62
p-value		0.0091		0.078
OID: Sargan test		17.897		17.699
p-value		0.161		0.169

Notes: Standard errors Huber/White/Sandwich corrected are in brackets
* significant at 10%; ** significant at 5% *** significant at 1%

Table 5. Adjusted Partial Shea-squared

	Log GDP per capita 1990	Aid (% GDP)	Brain Drain	Aid * Brain Drain	Institutions
Log GDP per capita 1990	1.00				
	[7.07]***				
Aid (% GDP)		1.00			
		[5.73]***			
Brain Drain			1.00		
			[5.94]***		
Aid * Brain Drain				1.00	
				[2.95]***	
Institutions					1.00
					[6.23]***
Observations	112	112	112	112	112
R-squared	0.32	0.27	0.32	0.15	0.26

Notes: Robust t statistics are in brackets
* significant at 10%; ** significant at 5% *** significant at 1%