

# Brain drain and Human Capital Formation in Developing Countries. Are there Really Winners?

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## Abstract

We examine the empirical relationship between the migration rate of skilled workers and human capital formation in developing countries. In particular, we revisit Beine, Docquier and Rapoport (2007), who find evidence of an incentive effect. Our results suggest that an incentive effect is weak if not absent, since positive correlation among brain drain and human capital *ex-ante* is not robust to small changes in the specification.

**JEL classification:** F22, J24, O15.

**Keywords:** brain drain, migration, education, incentives.

## 1 Introduction

Many developing countries have experienced a sharp increase in the portion of skilled workers that decide to search for a job in an industrial economy. For instance, in 2000 the number of migrants with a tertiary education living in the OECD area amounted to 20.4 million. Moreover, during the 1990s the number of immigrants with a tertiary education residing in this area increased by 8 million, meaning that 41% of skilled immigrants living in OECD countries in the year 2000 had migrated in the past decade (Docquier and Marfouk, 2006).

The debate about the effect of human capital flight on developing economies can be divided into two theoretical streams. The traditional perspective has viewed the phenomenon as detrimental for source countries. Grubel and Scott, 1966 and Johnson, 1967 stress the idea that skilled and unskilled workers are complementary factors and domestic contribution of skilled workers to domestic welfare is beyond their marginal product. Bhagwati and Hamada, 1974 note, moreover, that when education is publically funded, skilled migration generate further losses by raising the tax burden paid by non-migrant workers. On the other extreme, some recent papers argue that the higher the probability of migration for skilled workers, the higher are the incentives of individuals left behind to invest in their own education (Mountford, 1997; Stark *et al*, 1997, 1998; Vidal, 1998; Stark and Wang, 2002 and Stark, 2004). Hence, under certain conditions, initial human capital losses might be compensated by the subsequent incentive to obtain more education, and as a consequence, brain drain might result in a brain gain. This argument has received little attention from an empirical perspective, which seems quite surprising given the relevance of the phenomenon. The only published exception is Beine, Docquier and Rapoport (2007) (BDR hereinafter), who find support for the incentive effect using a cross-country setting.

According to our view, the results provided by BDR are not robust enough to conclude that migration probabilities have a positive impact on *ex-ante* human capital decisions in developing countries. We

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reach this conclusion by examining the vulnerability of their results to small changes in the conditioning information set.

## 2 Searching for the incentive-effect

The empirical approach taken by BDR to evaluate the incentive effect is a regression of the growth rate of the stock of *ex-ante* human capital (i.e. including emigrants) between 1990 and 2000. This is done using a set of explanatory variables that include initial *ex-ante* human capital, brain drain rate as a proxy of skilled workers' probability to migrate, and a set of control variables. The empirical model is the following:

$$\ln H_{a,00} - \ln H_{a,90} = \alpha + \beta \ln H_{a,90} + \gamma \ln p_{90} + \delta'Z + \epsilon \quad (1)$$

Setting the dependent variable to  $\Delta \ln H_{a,00}$ ,  $\ln H_{a,90}$  aims to capture possible convergence in human capital and  $\ln p_{90}$ , the migration incentives faced by educated individuals.

BDR note that the identification of the incentive effect has to take into account the fact that the migration rate is likely to be endogenous. It is argued that the fraction of educated population is likely to affect the rate of skilled migration in several ways, hence reversing the causality direction. The estimation strategy they propose consists of the search for instruments related to the migration rate which are orthogonal to the error term of equation (1). However, once they test endogeneity they conclude that OLS and IV produce the same results.

Using the same data sources and country sample, we re-ran their preferred specification and reported the results in Table 1 (Column 1)<sup>1</sup>. The coefficient of the variable of interest (which is positive and significantly different from zero) seems to support the hypothesis of the incentive effect. In addition, the human capital coefficient suggests convergence, and the Sub-Saharan African dummy (SSA) is also negative and significant. Next, we tested these findings with several robustness checks, changing the specification, introducing variations in the country sample, allowing for non-linearities and assessing the validity of the instruments.

First, we are interested in the suitability of the introduction of the dynamic component in the equation (initial human capital). If one is not interested in restricting the correlation structure of the error term (as is the case in this paper), initial level of *ex-ante* human capital is likely to be endogenous in the model, therefore it probably biases the results. Moreover, since the availability of data restricts the estimation method for cross-sectional estimates, there is no easy way to eliminate this bias. Therefore, our first step is to eliminate this term in the regression. Once we drop that variable from the model, the coefficient of the brain drain rate is no longer significant and the R-square falls dramatically (Column 2) (in other unreported specifications we consider the inclusion of other exogenous explanatory variables obtaining the same results).

Secondly, as the theory seems to suggest and the results provided by BDR confirm, the relationship between human capital and brain drain has an inverted-U shape. We introduce a quadratic brain drain rate term in the equation (1) and display the results in Columns 3 and 4: results provide a non-inverted-U shape, contrary to theoretical expectations. Moreover, when we drop the initial level of human capital from the model, neither the linear nor the quadratic brain drain rate are significant.

Our third check concerns the sample. BDR consider emigration incentives as confined a priori to non-high income economies; for that reason, they exclude from the total 170 country sample all high income countries. We relax that assumption, widening the original 127 country sample to 146 countries, simply excluding 24 high income OECD economies. Table 1 (Columns 5 to 8) reproduces the former specifications. As we see, the significance of the linear and quadratic coefficients disappears when we exclude the endogenous variable as it happens with the smaller sample.

All these results lead us to conclude that BDR's evidence in support of the incentive effect in OLS estimates is only conditioned to the inclusion of the initial level of human capital, i.e. it is a result of the bias introduced by an endogenous variable. As we explained above, this result is reinforced by

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<sup>1</sup>However, we were not able to replicate exactly their numerical results; we tried to obtain BDR's database from the authors without success

the inclusion of other exogenous determinants correlated with the initial level of human capital<sup>2</sup>, again leading to a non-significant effect.

Another concern lies on the validity of the IV estimation approach followed by BDR. The instruments that they use for the migration rate are total population (*POP*) and the number of emigrants from the country living in the OECD area (*MT*), both at the beginning of the period. The Sargan statistic and its p-value are far below the values BDR report and widely reject the null of exogeneity for the instruments (see Table 2, column 1). Therefore, instruments are not valid and their results are biased.

Column 2 in Table 2 displays the specification without the initial human capital level, and, surprisingly, the brain drain rate is now negative and significant. Nevertheless, the Sargan statistics fail to reject the hypothesis of exogeneity in the instruments. Columns 3 through 8 present IV estimates for other specifications and country samples considered in Table 1. Only two out of eight specifications (Columns 4 and 8) pass the Sargan test using the same instruments as BDR<sup>3</sup>, and both reinforce our result that incentive effect is no longer significant. Therefore, we extended the list of instrumental variables (surface area, power purchasing parity index and population density) and ran a horse race among instruments, specifications and changes in the sample to obtain consistent and unbiased estimates checking instruments exogeneity. Results once instruments are exogenous (not reported) do not lend support to the incentive effect.

A completely different empirical approach to test the incentive effect would be the use of enrollment rates instead of the fraction of population with some tertiary education; the higher the probability of migration for skilled individuals the higher the enrollment rate at the tertiary level should be. This approach has two important advantages: it is closer to the theoretical incentive effect and, although it contains a measurement error, the use of migration stock as an instrument would overcome this important drawback<sup>4</sup>. We run multiple regressions for BDR and extended samples, using as a dependent variable gross school enrollment at tertiary level for the 1990s. Results are represented in Table 3. As we can see, all the incentive effects disappear and a negative sign is predominate, even though instruments are not exogenous; in the last column, however, we find an inverted U-profile with valid instruments.

These results are quite puzzling and require further examination of data at lower levels of enrollment. We repeat the regressions of Table 3 looking for the incentive effect in enrollment at the secondary level (Table 4). Our search finds that the higher skilled workers' migration rate, the greater is enrollment in secondary level either in OLS or IV. A possible explanation for these results lies in the fact that skilled migration figures also include those individuals who acquired higher education abroad. An increase in skilled migration probabilities would generate incentives for individuals to enroll in lower levels of schooling in the home country and then to migrate in order to complete their tertiary education abroad. This would explain the negative (positive) correlation of brain drain with tertiary (secondary) enrollment rates.

### 3 Conclusion

In this paper, we revisit BDR's empirical evidence of an incentive effect of brain drain on *ex-ante* human capital formation. Results suggest that their finding of a significantly positive impact is driven by the inclusion of a "convergence term" in the regressions, which is likely to be endogenous. Moreover, the inclusion of a quadratic term shows that the inverted U-shape suggested by their theoretical model does not seem to hold in data. Furthermore, their instruments do not seem to be exogenous even with their own specification. Therefore, we can conclude that their results are not robust.

Additionally, we introduce an alternative approach to test whether an incentive effect exists, using enrollment at tertiary level as an alternative measure of human capital formation. Surprisingly, results

<sup>2</sup>The variables considered are: the proportion of Muslims in the population, that capture different propensities across societies to invest in education, and the total number of compulsory hours of schooling during primary education, as a measure of opportunity cost of investing in education.

<sup>3</sup>Curiously, the two specifications are the ones that exclude the initial level of human capital and, in addition, allow for a quadratic non-linearity (using also as instruments  $MT^2$ ,  $POP^2$  and  $MT * POP$ ).

<sup>4</sup>In order to construct human capital *ex-ante*, BDR use the migration rate of skilled workers. This variable is probably measured with error, and this error is transferred to total migration figures. Hence, the use of *MT* as an instrument in Table 2 is likely to bias results. In this case, however, with enrollment instead human capital as a dependent variable, it is presumably a valid instrument allowing to correct the bias.

suggest a negative impact of brain drain on enrollment at a tertiary level. A possible interpretation of this fact is that most open countries lose their talented workers before the end of their formation (and they complete their education abroad). This is in accordance with the positive effect we find that brain drain has on secondary enrollment. As a consequence, theoretical models of brain drain should consider that individuals' migration decisions are also motivated by prospects of acquiring a better education abroad, which, at the end of the day, determines individuals' labor market location. Further research should include this possibility in a theoretical model.

As a result, all these checks suggest that there is no evidence of an incentive effect of brain drain on *ex-ante* human capital formation (looking at aggregated data at a country level). Therefore, the case of country 'winners' from skilled migration is not supported.

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Table 1: OLS: Benchmark, convergence, sample and quadratic term (Dep. var.:  $\Delta \ln H_{a,00}$  )

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
$\ln m_{90}$	0.039*	0.035	0.166***	0.094	0.034*	0.033	0.149***	0.098
	(0.021)	(0.025)	(0.056)	(0.065)	(0.018)	(0.022)	(0.051)	(0.061)
$\ln H_{a,90}$	-0.237***		-0.249***		-0.238***		-0.246***	
	(0.036)		(0.037)		(0.035)		(0.035)	
<i>SSA</i>	-0.351***	-0.004	-0.348***	0.006	-0.351***	0.024	-0.346***	0.033
	(0.085)	(0.059)	(0.082)	(0.056)	(0.084)	(0.055)	(0.081)	(0.053)
$\ln m_{90}^2$			0.026**	0.012			0.023**	0.013
			(0.011)	(0.013)			(0.010)	(0.012)
<i>Constant</i>	-0.136*	0.497***	-0.067	0.544***	-0.151**	0.466***	-0.077	0.519***
	(0.072)	(0.070)	(0.072)	(0.090)	(0.070)	(0.062)	(0.069)	(0.083)
$R^2$	0.361	0.004	0.391	0.004	0.377	0.007	0.402	0.009
$N$	127	127	127	127	146	146	146	146

Robust standard errors in parentheses. Significance levels \* 10%\*\* 5% \*\*\* 1%.

Table 2: IV: Benchmark, convergence, sample and quadratic term (Dep. var.:  $\Delta \ln H_{a,00}$  )

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
$\ln m_{90}$	0.028	-0.039*	0.138**	0.042	0.023	-0.037*	0.103*	0.019
	(0.019)	(0.021)	(0.062)	(0.064)	(0.017)	(0.020)	(0.059)	(0.063)
$\ln H_{a,90}$	-0.169***		-0.188***		-0.174***		-0.183***	
	(0.029)		(0.030)		(0.028)		(0.028)	
<i>SSA</i>	-0.189***	0.035	-0.214***	0.061	-0.205***	0.038	-0.210***	0.063
	(0.067)	(0.059)	(0.067)	(0.060)	(0.069)	(0.058)	(0.066)	(0.059)
$\ln m_{90}^2$			0.024*	0.019			0.018	0.013
			(0.013)	(0.016)			(0.012)	(0.015)
<i>Constant</i>	-0.027	0.281***	-0.004	0.328***	-0.042	0.283***	-0.015	0.312***
	(0.067)	(0.043)	(0.070)	(0.049)	(0.066)	(0.040)	(0.067)	(0.046)
$N$	127	127	127	127	134	134	134	134
<i>Sargan</i>	0.00	0.02	0.05	0.13	0.00	0.04	0.04	0.15

Robust standard errors in parentheses. Significance levels \* 10%\*\* 5% \*\*\* 1%.

Table 3: OLS and IV: School enrollment at tertiary level (Dep. var.:  $\ln enr_{t,90s}$ )

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
$\ln m_{90}$	-0.140** (0.055)	-0.149** (0.058)	-0.165*** (0.060)	-0.628*** (0.134)	-0.333* (0.188)	-0.414** (0.194)	-0.046 (0.069)	0.087 (0.092)	0.076 (0.085)	-0.939*** (0.246)	-0.585* (0.320)	-0.654** (0.320)
$\ln enr_{s,90s}$	1.142*** (0.136)			1.225*** (0.135)			1.054*** (0.126)			1.253*** (0.130)		
<i>SSA</i>	-0.547*** (0.189)	-1.661*** (0.177)	-1.613*** (0.182)	-0.511*** (0.188)	-1.679*** (0.179)	-1.638*** (0.185)	-0.704*** (0.170)	-1.699*** (0.176)	-1.640*** (0.179)	-0.526*** (0.207)	-1.727*** (0.188)	-1.640*** (0.190)
<i>muslim</i>			-0.675* (0.345)			-0.746** (0.347)			-0.334 (0.312)			-0.599* (0.335)
<i>sch time</i>			-0.001 (0.001)			-0.001 (0.001)			-0.001 (0.001)			-0.001** (0.001)
$\ln m_{90}^2$				-0.095*** (0.023)	-0.036 (0.032)	-0.048 (0.032)				-0.176*** (0.053)	-0.156** (0.070)	-0.160** (0.069)
<i>Constant</i>	-1.831*** (0.174)	-2.622*** (0.182)	-1.859*** (0.685)	-2.224*** (0.200)	-2.791*** (0.243)	-2.147*** (0.757)	-1.591*** (0.204)	-2.032*** (0.238)	-1.031 (0.772)	-2.311*** (0.248)	-2.542*** (0.321)	-1.093 (0.820)
$R^2$	0.699	0.428	0.442	0.730	0.428	0.445						
<i>N</i>	112	113	113	112	113	113	112	113	113	112	113	113
<i>Sargan</i>							0.02	0.16	0.17	0.09	0.07	0.17

Robust standard errors in parentheses. Significance levels \* 10% \*\* 5% \*\*\* 1%.

Table 4: OLS and IV: School enrollment at secondary level (Dep. var.:  $\ln enr_{s,90s}$ )

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
$\ln m_{90}$	0.015 (0.032)	0.025 (0.040)	0.005 (0.041)	0.211*** (0.076)	0.326*** (0.092)	0.276*** (0.097)	0.142*** (0.040)	0.213*** (0.046)	0.181*** (0.044)	0.202* (0.120)	0.260* (0.143)	0.220 (0.140)
$\ln enr_{p,90s}$	1.094*** (0.160)			1.057*** (0.157)			1.089*** (0.150)			1.097*** (0.145)		
<i>SSA</i>	-0.600*** (0.103)	-0.944*** (0.123)	-0.896*** (0.125)	-0.589*** (0.101)	-0.903*** (0.120)	-0.856*** (0.123)	-0.573*** (0.106)	-0.890*** (0.132)	-0.833*** (0.129)	-0.609*** (0.096)	-0.960*** (0.122)	-0.893*** (0.122)
<i>muslim</i>			-0.645*** (0.192)			-0.556*** (0.189)			-0.445*** (0.204)			-0.365* (0.195)
<i>sch time</i>			-0.001 (0.000)			-0.001* (0.000)			-0.001** (0.001)			-0.001** (0.000)
$\ln m_{90}^2$				0.039*** (0.011)	0.061*** (0.015)	0.054*** (0.017)				0.019 (0.026)	0.019 (0.033)	0.015 (0.031)
<i>Constant</i>	-0.626*** (0.090)	-0.606*** (0.104)	0.208 (0.515)	-0.459*** (0.111)	-0.363*** (0.116)	0.507 (0.484)	-0.357*** (0.092)	-0.229** (0.096)	0.870* (0.528)	-0.317*** (0.116)	-0.220** (0.109)	0.863* (0.492)
$R^2$	0.630	0.374	0.426	0.643	0.410	0.453						
<i>N</i>	119	122	122	119	122	122	119	122	122	119	122	122
<i>Sargan</i>							0.91	0.63	0.42	0.39	0.03	0.02

Robust standard errors in parentheses. Significance levels \* 10%\*\* 5% \*\*\* 1%.