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SKILLED MIGRATION, FDI AND HUMAN CAPITAL INVESTMENT*

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Abstract

It is commonly believed that accumulation of human capital (HC) and availability of physical and financial capitals are among the major determinants of economic growth. In a globalised world, where factors of production are increasingly mobile, the process of domestic accumulation of HC might be affected in several ways through migration and capital inflows. Furthermore, endowment of skilled labour and foreign direct investments (FDI) may reinforce each other through possible "complementary effects". Our paper aims to advance the existing empirical literature on the relationship between international factor mobility and domestic accumulation of HC in developing countries. We provide new evidence on how the presence of foreign firms in the domestic economy and the emigration of skilled workers impact the domestic school enrolment . We also investigate whether existing supply of skilled labour is a significant determinant of inward flows of foreign capital. The interdependence between factor mobility and HC accumulation supports some simple *back-of-the-envelop* calculations aiming to investigate the presence of a virtuous (vicious) circle between HC accumulation and FDI inflows.

Keywords: Human Capital Investment, Factor Mobility, FDI, Brain Drain/Gain, Complementarity Effects, Developing Countries

JEL Classification: F22, F23, O15

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‡ Riccardo Faini left us while we were working at this paper. The paper significantly suffers for his disappearance.

1. Introduction

It is commonly believed that accumulation of human capital (HC) and availability of physical and financial capitals are among the major determinants of economic growth; it is also widely accepted that the lack of these resources (along with the inability to expand them) are potential reasons behind the delay of many poor countries in achieving development.

In a globalised world, where factors of production are increasingly mobile, the process of domestic accumulation of HC might be affected in several ways. In fact, while in principle the availability of foreign capital in the form of inward foreign direct investments (FDI) and an elastic supply of skilled (educated) workers may individually enhance growth prospects, they can also reinforce each other through possible "complementary effects". The presence of foreign investors in the home economy can provide incentives to invest in education for both people and governments: people may want to attain higher level of education in order to access better job opportunities offered by foreign firms, and governments may want to support the accumulation of HC in order to benefit from possible spillovers of FDI (technology and knowledge transfer). In addition, a good HC endowment makes the investment climate more attractive for foreign investors, offering an educated workforce which is also likely to be associated to socio-political stability.

Ideally, a virtuous circle of HC and FDI can be attained whenever «host countries experience continuous inflow of FDI over time by increasingly attracting higher value-added MNEs, while at the same time upgrading the skill contents of pre-existing MNEs and domestic enterprises» [Miyamoto (2003), p.9]. Symmetrically, a Pareto inferior equilibrium is also possible: inadequate supply of skills discourages FDI and the lack of FDI depresses the demand for skills.

But factor mobility does not concern financial and physical capitals only. Domestic workforce is also mobile, and when international migration is considered, the domestic accumulation of HC needs further qualification. Even if migration flows have grown less than trade and FDI flows over the last decades [see Sapir (2000), Faini (2006)], the ongoing "brain drain", enhanced by selective immigration policies[1] in developed economies, is one of the suspect among the forces negatively affecting the economic performance of developing countries. According to an established view, skilled migration causes the flee of the most talented and entrepreneurial individuals from the countries of origin, and severely hampers its growth prospects. Thus the outflow of educated workers is expected to negatively impact onto the domestic stock of cumulated HC.

[1] In response to the growing shortage of skilled workers, most receiving countries have tried to shift the focus of their immigration policy, favouring the recruitment of highly skilled workers. This new twist in the policy stance toward immigration has become a source of considerable concern in traditionally sending countries, which fear the loss of their most skilled and entrepreneurial workers.

In sharp contrast with this expectation, a recent but rapidly developing literature emphasizes a possible positive effect of skilled migration on the origin country. The brain drain becomes, in this view, a "brain gain". Among others, three different channels can be distinguished for a *beneficial brain drain* to operate: a) skilled migrants raise economic welfare at home thanks to a relatively large flow of remittances[2]; b) selective immigration policies in host countries may raise the attractiveness of migration for high skilled individuals, which in turn raises private returns to education (due to reduced supply) and induces additional investment in education at home; c) skilled migration may favour growth-enhancing technology transfer, trade and foreign direct investments between the source and the host country (*network effects*).

Points b) and c) provides further qualifications about possible complementarities between HC and FDI in the wake of international migration. Mountford (1997) was the first to suggest the possibility that migration prospects create incentives to invest more in education: since not all of those who invest in education can (or will choose to) migrate, the post-migration level of human capital can increase. Similar results were found by Stark et al. (1998). Stark et al. (1997) add to this literature by showing that the possibility of a brain gain might stem from the imperfect information of destination country's employers on the skills of the migrants and the impact of return migration. The wage adjustment taking place once the true ability of immigrants is revealed to foreign employers may induce a subset of individuals to return home. Under certain conditions the post-return average level of human capital is higher than that of a closed economy. The literature on this issue is rapidly growing, but the empirical evidence is mixed. In a cross-country regression with 50 developing countries, Beine et al. (2001), using data from Carrington and Detragiache (1998), find a positive effect of skilled migration on human capital investment in the source country and a positive relation between growth and the proportion of highly educated individuals at home. Applying a different empirical approach to the same dataset, Faini (2002) found that the rate of migration among educated individuals was weakly and negatively correlated with tertiary enrolment at home. Using a new dataset on migration stocks and rates by country of origin and educational attainment, developed by Docquier and Marfouk (2005), Mariani (2004) estimates a cross-country growth regression on a large number of developing countries and finds that the relation between brain drain and growth is non linear and high skilled migration affects positively the growth rate only if a large proportion of individuals at home is enrolled in (or have completed) at most the secondary school; according to the author, this result indicates that larger countries are more likely to enjoy positive

[2] The underlining argument proceeds as follows: skilled migrants typically earn relatively more and, ceteris paribus, will therefore save more and remit to relatives remaining inland. However, skilled migrants are also likely to spend a longer span of time abroad and also are more likely to reunite with their close family in the host country. Both factors should be associated with a relatively smaller rather than larger flow of remittances from skilled migrants. Faini (2006) provides evidence supporting this counter-argument.

feedbacks from high skilled migrations. Thus, if the focus is on the accumulation of human capital, the role of skilled migration cannot be neglected and it still represents an unsettled empirical issue.

For what concerns implications of point c), namely technology transfer through networking, it is worth noticing that since developing countries typically lack resources to develop new technologies on their own, what matters for growth is their ability to appropriate and adopt advanced technologies developed elsewhere. The literature on technology diffusion/transfer has focused on trade and foreign direct investments as the two main channels in this respect, provided that the host country is endowed with a sufficient level of competences to make this absorption viable. Migrants may personally be involved in trading and investing in their home country, thus boosting trade and foreign capital inflows, thanks to their inside knowledge or their social ties. Network effects with people still living in their country of origin can also be exploited by their foreign employers to enter their home market (Lucas, 2004).

Our paper aims to address empirically some of these open questions guided by theoretical considerations at the basis of a simple conceptual framework (see Appendix B). In Section 2 we provide further evidence on the relationships between international factor mobility (FDI and migration) and domestic accumulation of HC in developing countries. In Section 3 we explore potential complementarities between FDI and HC by investigating whether existing supply of skilled labour is a significant determinant of inward flows of foreign capital. The interdependence between factor mobility and HC accumulation supports some *back-of-the-envelop* calculations on the impact of migration on domestic HC accumulation in Section 4. Section 5 concludes.

2. Do migration and inward FDI impact enrolments?

We start by focussing on the consequences of factor mobility onto educational choices in developing countries. A simple equation (which corresponds to equation (5) in Appendix B) relates enrolment rate e_{it}^{j} in educational level j (j = secondary, tertiary) in country i and year t to the presence of foreign firms (proxied by the cumulated stock of *FDI*) in the domestic economy and to migration trends of educated workers (*MIG*)

$$e_{it}^{j} = \mu_i^j + \beta_1 \cdot \log FDI_{it} + \beta_2 \cdot MIG_{it} + \delta_i \cdot C_{it} + \tau_t + \varepsilon_{it} \qquad (1)$$

where C_{it} is a set of country specific factors affecting educational choices (control variables), μ_i^j is a country fixed effect, τ_t is a time fixed effect and ε_{it} is an error term.

On the basis of our theoretical considerations (see Appendix B), one would expect the presence of foreign firms providing incentives to enrol in higher education programs ($\beta_1 > 0$). As far as the migration of skilled workers is concerned, a negative impact on domestic enrolment ($\beta_2 < 0$) can be taken as evidence of "brain drain", whereas a positive effect ($\beta_2 > 0$) can be taken as evidence of "brain gain". Relevant control variables for this specification are related to the stage of development of the economy (presence of liquidity constraint / endemic poverty), to the quality of the educational system and to other supply side factors[3].

2.1 Dataset and variables definition

Our dependent variables are extracted by data on educational enrolment on quinquennial base collected by Barro and Lee (2000) integrated by data on emigration rates by educational level collected in Doquier and Marfouk (2005). The intersection of these two datasets containing non missing information in at least one of the two points in time (1990 and 2000) is non empty for 147 developing countries. When we consider a balanced panel version of this sample of countries, their number reduces significantly.

We expand this dataset with information on existing stock of foreign direct investment (referred to the two relevant years or in their proximity), quality of the education, and additional control variables (like GDP per capita, mortality rates, credit availability to the private sector, population density). More specifically, we have considered alternative measures of education quality[4], including public spending on education as % of GDP, the pupil-teacher ratio at primary school (the corresponding measure for secondary school is available only for later years) and the repetition rate at primary school, but the only variable showing weak statistical significance in some regression is the one surviving in the text (pupil/teacher ratio). Among the control variables[5] we have considered alternative measures for the stage of development: in addition to GDP per capita and population density, we have considered urban/rural population (to account for the supply side of educational resources), fuel exports (to account for technology development) as well as measures of local inequality (Gini inequality index). Unfortunately, endemic missing data prevent us to use income inequality measures (like the Gini inequality index or income shares by quintiles) as

[3] Theory would suggest to include also a variable accounting for remittances among regressors. This would capture a possible poverty relief feedback effect of migration. But an improvement in financial conditions of a family could enhance both investment in education and further migration (i.e. migration cost becoming affordable, family reunion, etc.). Hence, the impact of such a variable is not conceptually univocal. Unfortunately, coverage of series on international remittances is not complete for many countries in our sample. Furthermore, since not all financial flows due to migration follow official channels, data on remittances are not fully reliable and they might be an inappropriate proxy for what is called "diaspora exernality". For these reasons we decided to exclude remittances from our regression.

[4] Indicators concerning the quality of the educational system in single countries are extracted from the EdStat on-line service provided by the World Bank.

[5] Control variables are drawn from the World Bank's World Development Indicators database.

indicators of life conditions in the country of origin and possible *poverty constraints*.[6] In order to overcome this limitation, we complemented the GDP per capita with both credit to the private sector (from Beck et al. 2000) and infant mortality rate series. The choice for the latter variable is suggested by two orders of considerations: in the first place, mortality is usually highly correlated with endemic poverty, in the second place, it might be also correlated with educational decisions since "a reduction in mortality increases the number of periods over which the returns from investments in knowledge can be collected" [Grossman (2005), p.18]. The private credit by (deposit money) banks over GDP accounts for financial market imperfections that render liquidity constraints more stringent for poor families. We have also considered other geographical variables (population, distances, former colonial status) but at the end we have only retained macro-regional dummies.[7]

2.2 Results

We have selected gross enrolment rates by educational level (secondary and tertiary – primary enrolment is compulsory everywhere, and attendance rates tend to reach 100%) over almost two decades (1985-2000). Taking into account missing information on regressors, in its largest version we have 195 observations covering 112 countries for secondary enrolment, and 181 observations for 108 countries in case of tertiary enrolment; when we restrict ourselves to the balanced panel version we can rely on 57 countries only. Results are quite stable across different samples, so we report here those obtained relying on the larger unbalanced panel set of observations and countries. Descriptive statistics are reported in table A1 in the Appendix A; similarly, tables referring to results obtained in the balanced panel are reported in Tables A2 and A3 in the same Appendix A.

In Table 1 we report our estimates for secondary enrolment, while Table 2 contains the corresponding estimates for tertiary enrolment. The first column of both tables reports simple OLS correlations, while columns 2 to 4 use a fixed effects estimator; column 5 deals with the problem of potential endogeneity with a IV fixed effects estimator, and finally column 6 adopts a Hausman-Taylor estimator.

We start with secondary enrolment in Table 1. The strongest correlation we obtain is with the GDP per capita and with previous enrolment in primary education, to be interpreted as evidence of schooling being a vertically integrated process. This suggests that (secondary) educational

[6] We experimented with data from World Bank (Deininger and Squire) dataset as well as with Wider dataset, but in both cases the sample size was almost halved and the variable was always non significant. Checchi (2003) finds a significant negative correlation between Gini index and secondary educational attainment, in a larger dataset of low-middle income countries.

[7] They include: East Asia and Pacific, Europe and Central Asia, Latin America and the Caribbean, Middle East and North Africa, South Asia and Sub-Saharan Africa.

attainment is associated with the stage of development of a country, possibly reflecting the availability of resources to families which are necessary to undertake educational investments. Points estimates for the credit to private sector and the infant mortality rate bear the expected correct sign (positive for the former and negative for the latter), but standard errors are large enough to make them non significant.

The migration rate of people with tertiary educational attainment exhibits negative correlation with secondary school enrolment under all specifications but simple OLS, but the impact is not statistically significant.[8] In order to account for the potential endogeneity of migration rates, we have also considered an instrumental variable estimator, where instruments are the (log of) stocks of national migrants in major destination areas (US and EU) ten years before[9]. Under the estimation with IV, the coefficients on migration rate at tertiary level increases in size but does not show any increased statistical significance.

When we look at the presence of foreign investors in the domestic economy (measured by the log of inward FDI stock) we observe a negative correlation with secondary enrolment. This might look rather counter-intuitive. But it is necessary to bear in mind that our measure of stocks of inward FDI's does not allow a distinction among types of investments and/or sectors. FDI motives (whether market-seeking, efficiency-seeking, resources-seeking or a combination among them) may differ across countries and thus be more differentiated at the sectoral-country level[10]. Different types of FDI can provide different incentives to invest in education since they require different types of skills according to their main activity (extraction of mineral resources, production of manufactures, provision of services). Thus the negative sign associated with the log of inward FDI stock might hinder a compositional effect. When we interact this variable with regional dummies (in column 4), we notice that this effect is mainly driven by the poorest countries in the region (Africa and South Asia, corresponding to 33 out of 57 countries in the balanced sample). Despite

[8] Ideally, when considering the impact of migration trends onto enrolment at secondary school one would include among regressors not only the migration rate at the corresponding educational level, but also at the tertiary level. In fact, emigration of graduates workers could affect the decision to invest in HC also at the previous level. The high correlation between the migration rates at secondary and tertiary level (0.74) poses serious collinearity problems on such a specification. So we restrict ourselves to one rate only. For the sake of comparability we present here results obtained by employing the "rate of migration at tertiary level" as independent variable for both (secondary and tertiary) enrolment rates.

[9] See Javorcik et al. (2006). One may reasonably argue that the stock of previous migration may attract additional migrants, without necessarily affect educational choices at home. We have tested for possible overidentifying restrictions in every regression with IV techniques (both under FE and HT methodologies). Results point to the direction of a correct choice of instruments.

[10] Miyamoto (2003) shows that FDI sectoral differentiation at regional level changes over time. African region appears to go against the overall developing country trends with the share of primary goods remaining high and constant and the share of services diminishing. This is due to the fact that a large number of MNEs operating in Africa are still attracted by the abundance of natural resources rather than by the market or by the host-country investment climate. The Latin American and the Caribbean regions show a large drop in the share of the manufacturing sector with a corresponding increase in the share of the services sector. The Asian region exhibits a large and stable share of the manufacturing sector.

unavailability of more detailed information about the type of FDI in each country, this regional effect could be interpreted as evidence of investment more projected to the exploitation of natural resources (which do not require highly educated local labour force) than to the acquisition of existing activities and/or to the start-up of new companies.[11]

Table 1 – Gross enrolment rate – Secondary Education (1990-2000) – Unbalanced Panel

	1 OLS	2 FE	3 FE	4 FE	5 FE IV	6 HT
log gdp per capita	0.094	0.171	0.171	0.205	0.166	0.17
	[5.66]***	[2.73]***	[1.88]*	[2.22]**	[1.89]*	[2.56]**
infant mortality rate 1000 live birth	-0.003	-0.001	-0.001	-0.001	-0.001	-0.001
	[5.52]***	[0.74]	[0.87]	[0.86]	[0.86]	[0.77]
Private Credit by Deposit Money Banks / GDP	0.03	0.123	0.12	0.126	0.119	0.124
	[0.43]	[1.06]	[0.91]	[0.86]	[1.18]	[1.50]
log stock of inward FDI	-0.006	-0.009	-0.028		-0.027	-0.024
	[0.74]	[1.12]	[3.29]***		[2.26]**	[2.52]**
Migration rate tertiary educ	0.006	-0.131	-0.248	-0.219	-0.569	-0.257
	[0.09]	[0.73]	[1.27]	[1.13]	[1.04]	[1.30]
enrolment rate primary 5 years before	0.133	0.187	0.193	0.185	0.183	0.19
	[2.64]***	[1.71]*	[1.67]	[1.62]	[1.55]	[1.96]**
log pupil/teacher primary			-0.034	-0.018	-0.03	-0.039
			[0.42]	[0.18]	[0.35]	[0.55]
log Population density (people per sq. km)			-0.519	-0.358	-0.526	-0.413
			[2.40]**	[1.55]	[2.88]***	[3.11]***
migcountry (countries with mig.ter.>0.1 or mig.sec.>0.05)						2.626
						[2.35]**
log inflow FDI×East Asia and Pacific				-0.024		
				[1.35]		
log inflow FDI×European and Central Asia				-0.017		
				[1.62]		
log inflow FDI×Latin America and Caribbean				-0.02		
				[0.56]		
log inflow FDI×Middle East and North Africa				-0.07		
				[3.99]***		
log inflow FDI×South Asia				-0.098		
				[4.96]***		
log inflow FDI×Sub-Saharan Africa				-0.041		
				[2.24]**		
Observations	195	195	174	174	172	172
R^2	0.72	0.55	0.6	0.65		
Number of countries	112	112	109	109	108	108

Robust t statistics in brackets - * significant at 10%; ** significant at 5%; *** significant at 1%
Year dummy included - regional controls included in HT
IV for FE: log of stock of own migrants in US and in EU (10 years before)

The additional control provided by the pupil/teacher ratio at primary level (as a proxy the quality of education received) is statistically insignificant. The log of population density might be interpreted as a complement to the pupil/teacher ratio in capturing availability of school resources. In principle one would expect that a highly concentrated population decreases the cost of providing

[11] This interpretation is however at odds with the higher impact observed for the interaction of FDI with the South Asia dummy (which include India and Nepal), where natural resources are not in general abundant.

schooling services. Thus, a negative sign, as the one found in our estimates, advocates for saturation effect and/or lack of school resources, which points in the direction of possible supply-side constraints.

Leaving aside for a while the final column of Table 1 (to be commented below), we now consider tertiary enrolment, as reported in Table 2. Most of stage-of-development controls seem not work in this case: GDP per capita, credit to the private sector and mortality rates are all non significant (except in the OLS version). This is not surprising, since people attending university in developing countries are typically self-selected from the upper tail of the income distribution, and they are relatively unaffected by what happen in the lower tail of the income distribution.[12] The same line of argument would induce us to expect a positive contribution of enrolment rates at the previous stage, but this variable has a significant correlation at the 20% confidence interval.

When considering migration, we find that migration rate at tertiary level has a negative statistical significance under fixed effect (column 2), but this effect is lost once we introduce further controls. In this case we find that the presence of foreign firms in the domestic market (stock of inward FDI) exerts a significant positive impact[13]. We interpret this as evidence that inward FDI creates job opportunities for skilled workers, thus providing an incentive to enrol in a higher education program. Looking at compositional effects (column 4) we observe that it is mostly driven by formerly planned economies (Bulgaria, Hungary, Poland and Romania in our sample). The overall effect of factor mobility onto higher education would be positive in our sample: despite weak evidence of brain drain from people migration, the incentives created by capital mobility would more than offset the disincentive to enrol tertiary education.

2.3 One step further

Given the way it is structured, our panel dataset does not offer large *within-panel* variation over the sample, both across countries and over time. This implies that when we try to account for unobserved individual heterogeneity at the country level by estimating a specific parameter μ_i (fixed effect), we might end up capturing too much of it, with the estimated individual intercept washing out part of the effects that are supposed to be explained by the regressors. Thus one would think that it would be better not to consider the unobserved component as a parameter to be estimated and to look at it as a random variable (random effect) instead. By means of the

[12] One additional control that has been introduced in previous literature is the share of fuel and raw materials exports in total exports. The rational is that if a country is natural resource abundant, its population has less incentives to get educated. We tried to include this indicator in our regressions for both secondary and tertiary enrolment and it generally got a minor negative impact, as expected; but because of many missing data in the series, it also causes a considerable drop in the number of observation we can rely on. So we decided to take it off from our specification.

[13] The impact of capital inflows onto higher educational attainment has been studied by Hegger et al. (2005), finding positive correlation in the Barro-Lee dataset.

instrumental variables approach, we are tackling the possible simultaneous determination of the enrolment rates and migration rates under the assumption that all of our independents are uncorrelated with the unobserved component (random effect) of our model. This is a very strict assumption since it is hard to exclude that something we do not observe affects migrating decisions as captured by migration rates.

Table 2 – Gross enrolment rate – Tertiary Education (1990-2000) – Unbalanced Panel

	1 OLS	2 FE	3 FE	4 FE	5 FE IV	6 HT
log gdp per capita	0.005	0.024	0.03	0.033	0.031	0.027
	[0.46]	[0.76]	[0.61]	[0.67]	[0.67]	[0.84]
Infant mortality rate 1000 live birth	-0.001	0	-0.001	0	-0.001	0
	[1.98]**	[0.23]	[0.73]	[0.47]	[0.86]	[1.01]
Private Credit by Deposit Money Banks / GDP	-0.022	0.065	0.024	0.044	0.011	0.023
	[0.47]	[1.02]	[0.42]	[0.65]	[0.21]	[0.59]
log stock of inward FDI	0.008	0.022	0.015		0.016	0.017
	[2.10]**	[2.91]***	[1.98]*		[2.47]**	[3.82]***
migration rate tertiary educ	-0.175	-0.217	-0.174	-0.113	0.206	-0.17
	[5.62]***	[2.33]**	[1.43]	[0.98]	[0.59]	[1.68]*
enrolment rate secondary 5 years before	0.288	0.099	0.079	0.102	0.151	0.093
	[7.44]***	[0.95]	[0.72]	[0.94]	[1.41]	[1.42]
log pupil/teacher primary			-0.043	0.008	-0.03	-0.046
			[0.72]	[0.14]	[0.61]	[1.30]
log Population density (people per sq. km)			-0.278	-0.173	-0.286	-0.207
			[2.55]**	[1.55]	[2.92]***	[3.32]***
migcountry (countries with mig.ter.>0.1 or mig.sec.>0.05)						1.215
						[2.32]**
log inflow FDI×East Asia and Pacific				0.019		
				[1.13]		
log inflow FDI×European and Central Asia				0.023		
				[2.04]**		
log inflow FDI×Latin America and Caribbean				0.01		
				[0.53]		
log inflow FDI×Middle East and North Africa				0.004		
				[0.25]		
log inflow FDI×South Asia				-0.014		
				[0.80]		
log inflow FDI×Sub-Saharan Africa				-0.006		
				[0.81]		
Observations	181	181	162	162	162	162
R-squared	0.68	0.55	0.63	0.69		
Number of id	108	108	103	103	103	103

Robust t statistics in brackets - * significant at 10%; ** significant at 5%; *** significant at 1%
Year dummy included - regional controls included in HT
IV for FE: log of stock of own migrants in US and in EU (10 years before)

A way to partially relax this assumption and to allow our independent variables to be correlated with the individual random effect (μ_i) is to proceed with the estimator proposed by Hausman and Taylor. Their original idea is that the set of regressors can be divided in four groups:

a) a vector of exogenous, time-varying variables ($\mathbf{X}_{1i}$) assumed to be uncorrelated with both random effect (μ_i) and idiosyncratic disturbance (u_i);
b) a vector of endogenous, time-varying variables ($\mathbf{X}_{2i}$) assumed to be possibly correlated with random effect (μ_i) but orthogonal to idiosyncratic disturbance (u_i);
c) a vector of exogenous, time-invariant variables ($\mathbf{Z}_{1i}$) assumed to be uncorrelated with both random effect (μ_i) and idiosyncratic disturbance (u_i);
d) a vector of endogenous, time-invariant variables ($\mathbf{Z}_{2i}$) assumed to be possibly correlated with random effect (μ_i) but orthogonal to idiosyncratic disturbance (u_i).

The Hausman-Taylor estimator allows us to employ the regressors in groups $\mathbf{X}_{1i}$ and $\mathbf{Z}_{1i}$ as instruments for the independent variables in groups $\mathbf{X}_{2i}$ and $\mathbf{Z}_{2i}$, obtaining consistent estimates for the corresponding coefficients. We assume that migration rates are included in group $\mathbf{X}_{2i}$. All other time-varying regressors are assumed to be part of group $\mathbf{X}_{1i}$, thus implying that among others the (log of) population density will act also as an instrumental variable for migration rates [as in Beine et al. (2001)]. We also created a time-invariant variable, *migcountry*, intended to capture the unobservables that make one country more likely than another to be net exporter of migrants. This variable assumes value 1 if a country is a typical source of migrants over time (migration rates greater than the sample average in both years) and 0 in the opposite case; it is supposedly endogenous and is therefore included in $\mathbf{Z}_{2i}$. Docquier and Sekkat (2006) collect a series of stylised facts about trends in brain drain showing that highest migration rates of skilled workers are associated with countries presenting specific characteristics (middle-income countries, small in population size) and that are either islands or located in specific areas (Sub Sahara, Central America). Our *migcountry* variable is supposed to capture this higher propensity to migrate of people born in these countries. We introduce 6 regional controls for sub areas (according to the World Bank classification), thus getting closer to the fixed effects specification. These geographical dummies are assumed to be part of group $\mathbf{Z}_{2i}$ as well. We report results obtained by means of the H-T estimator for both secondary and tertiary enrolments in column 6 of both Table 1 and Table 2.

In Table 1 we observe that results under H-T estimator are similar to what we obtained using fixed effect estimator. Focusing on factor mobility, migration rates of tertiary educated workers has no impact on secondary school enrolment, whereas the negative sign on the (log of) inward stock of FDI's coefficient persists. On the contrary, in Table 2 we find an opposite result: migration rate of skilled workers discourages enrolments (*brain drain*), but the presence of foreign firms on domestic market provides positive incentives to enrol in higher education programs. Thus, we would be in the

presence of a peculiar form of *brain waste*. Natives would be attracted into tertiary education by existing job opportunity created by foreign firms in the local economy (stock of inward FDI), but the outflow of tertiary graduates through migration would offset this tendency. In fact, the relevant elasticities are rather different at sample averages: by considering an estimated coefficient between -0.15 and -0.20, the migration elasticity lies in a interval comprised between 0.22 and 0.29, while the elasticity of the inward FDI stock (using an estimated coefficient of 0.02) is equal to 0.18. Thus, if any, the former effect should dominate the latter, and the overall impact would be a reduction in human capital accumulation of a country exporting skilled labour. This conclusion would be reinforced if we add the result that inward FDI discourage secondary enrolment, which produce the intake for tertiary enrolment.

Our results are in line with those obtained by Groizard and Llull (2006) but we model the stock-flow relationship in a more consistent way. In fact, they study the impact of skilled migration on the cumulated stock of human capital in the country, which almost by construction yields a negative impact (since there is a one-to-one correspondence between a migration of a graduate worker and a (marginal) decline in the average years of education in the working population of the source country). On the contrary, if there are disincentive effects of migration, these should work through the accumulation of new human capital, namely the enrolment (and, if available, completion) rates, as we have done in our regressions. In addition, they neglect other factors that may affect the educational attainment in the country, out of the initial level, while we have provided a richer picture of the process.

Thus our overall conclusion of this section casts doubt on the presumed beneficial effect of factor mobility onto domestic accumulation of human capital. On one side there is some evidence that skilled labour migration plays a disincentive effect on enrolment decision at the corresponding level of education. On the other side there is a more robust evidence that inward FDI modify the relative incentives to acquire education (possibly through the adjustment of relative returns to educational attainment). Using the final column estimates of Tables 1 and 2, a 10% increase in the stock of FDI reduces the enrolment rate at secondary level of 0.24 percent points (corresponding to a reduction of –0.13%) while increasing the enrolment rate at tertiary level by 0.17 (corresponding to an increase of +0.02%). If we include also the negative impact associated to the reduction in the intake from secondary education, the beneficial effect of FDI on tertiary enrolment would be equivalent to a negligible 0.01 percentage point increase.

3. Are FDI attracted by the availability of human capital?

It has been argued that foreign firms determine the choice of location looking at the availability of high level of HC. Thus, along with other possible determinants, relative endowment of HC should affect the attractiveness of certain locations. Related questions concern the type of human capital (education and skills) that foreign investors are seeking for, and whether different types of firms seek different sets of skills.

Our second equation aims to model the dynamics of physical capital accumulation through domestic inflow of foreign capitals. A linear version of equation (6) in Appendix B describes the determinants of FDI inflows, including the domestic endowment of human capital

$$FDI_{it} = \gamma_i + \theta_1 \cdot \log\left(\sum_{k=i}^{T} FDI_{i,t-k}\right) + \theta_2 \cdot HC_{it}^{j} + \phi_i \cdot Z_{it} + \tau_t + \lambda_{it} \qquad (2)$$

where the cumulated sum of past FDI proxies the current stock of foreign capitals, Z is a set of country specific factors affecting investment decision choices (control variables), γ_i is a country (area) fixed effect, τ_t is a time fixed effect and λ_{it} is an error term.

In order to fully account for possible feedback effects due to factor mobility, it would be desirable to include in this specification the impact of return migration on the inflows of FDI. Unfortunately comparable cross-country series on return migration rates are not available. Including alternative measures of the stock of national migrants living abroad in the investing countries is a method adopted in recent contributions to account for possible *network effects*[14]. This approach requires a strict bilateral setting, otherwise it would be impossible to ascertain whether largest flows of FDI to the domestic economy actually come from countries hosting larger share of own migrants. Unfortunately, data on FDI flows available for developing countries are rarely collected on a bilateral basis, and to maintain the cross-country dimension of our analysis we are forced to employ data on total inflows and stocks of FDI regardless of the country of origin.

3.1 Dataset and variables definition

We have created a second dataset integrating series on average net inflows of FDI (as percentage of GDP) computed on a four-year basis (1990-1993, 1995-1998, 2000-2003) from UNCTAD database with series on alternative proxies for human capital stocks obtained from Barro and Lee (2000). We also add some controls usually introduced in the literature studying the

[14] See Docquier and Lodigiani (2006) and Javorcik et al. (2006).

determinants of foreign direct investment (market-seeking, efficiency-seeking): *i*) (log of) inward stock of FDI, to take into account the effects of reinvested profits and scale economies; *ii*) (log of) GDP per capita, to proxy the stage of development; *iii*) (log of) population, to capture "market size" effects; *iv*) price inflation, measured by consumer price index annual percent changes, averaged over 5-year intervals (1988-1992, 1993-1997, 1998-2002), to account for economic stability; *v*) to account for political stability and other determinants of institutional quality we rely on six different indicators collected by Kaufmann et al. (2004): Voice and Accountability, Political Stability, Government Effectiveness, Regulatory Quality, Rule of law, Control of Corruption. Since all these measures (which are obtained by aggregating different opinion surveys worldwide) are highly correlated among them , we summarise them by extracting a common factor from the series using factor analysis (principal component method). The first common factor obtained, which is used in our analysis, summarizes up to the 78% of original series variations[15]; *vi*) we also include trade openness (proxied by the (Import + Export) share in GDP) to consider the exposure to globalisation forces in a country; *vii*) following our previous work (Faini 2004), we finally include telephone mainlines (per 1000 people), to account for the endowment of infrastructures at country level.

This set of control variables includes what current empirical literature recognizes as major determinants. Nevertheless, the focus of our analysis is the identification of a potential role of the HC endowment in attracting FDI; given the fact that we try to capture possible fixed-effect (group/country specific) with appropriate estimation techniques, the possible risk of omitted variables does not seem to be a major impediment. As far as our measure of the stock of domestic human capital is concerned, we have considered alternative measures, either based on the average years of education in the population or on the distribution of the educational attainment in the same population. We have selected the second alternative, because it allows us to distinguish between different levels of skill (associated to different level of educational attainments).

Descriptive statistics of this dataset are reported in table A4. Since in this equation we do not rely on migration-related information, our dataset is not anymore restricted to two points in time: when considering the unbalanced version we have 198 observations from 67 countries, whereas the balanced panel is composed of 153 observations for 51 countries, referred to 1990, 1995 and 2000. There is only a partial overlap with the dataset used in the previous section (31 countries when considering both balanced versions), because some countries (typically the poorest among

[15] Data collected in Kaufmann et al. (2004) go back to mid-1990s only. We use the first available observation for 1990 and the proper one for 2000. An average of the two is assumed to be the corresponding value for 1995.

developing countries)[16] report information on migration, but do not give account of FDI inflows, while some other countries (mostly low-to-middle income countries)[17] attract funds from abroad, but seem not sending migrants out of the country.

3.2 Results

Our results for the unbalanced panel using alternative measure for HC are reported in Table 3 and 4 (respectively secondary and tertiary attainment). Results for the balanced panel are in Tables A5 (secondary education) and A6 (tertiary education) in the Appendix A. Here again we start with OLS estimator (column 1), then we add regional controls (columns 2 to 5), and finally we pass to country fixed effect estimator (column 6). While we have experimented with alternative measures of human capital stock (the percentage of population attaining primary, secondary and tertiary education, and any possible combination of them), we find that only the population share with secondary school attainment is statistically significant (see Table 3). This measure of human capital stock is positively correlated with FDI inflow, as long as we do not include country fixed effect. We have already highlighted that country fixed effect clean away excessive variability in the data.

Political stability seems to impact positively on FDI inflows, as opposed to economic instability (here proxied by the average inflation rate) which exerts a negative impact. A substantial part of inflows is due to reinvested profits or expansion of existing investments. Infrastructures (poorly proxied by telephone lines availability) seem not to play any significant role. Apparently, FDI look attracted by larger countries (in terms of population), while it is impossible to ascertain the role of the level of development, given the alternating sign on GDP per capita coefficient.[18] This is partly due to multicollinearity existing between the GDP per capita and the government factor (correlation in the unbalanced sample is equal to 0.65). Since more developed countries experience more stable governments (the executives are more effective, the rule of law is more frequently enforced, the level of corruption is lower, the regulatory quality is more valuable), the effect of

[16] Countries included in the enrolment model of section 3 and not in the FDI model of section 4 are Bahrain, Benin, Botswana, Bulgaria, Burkina Faso, Cameroon, Chad, Cote d'Ivoire, Ethiopia, Indonesia, Laos, Lesotho, Malawi, Mali, Mauritania, Mongolia, Morocco, Mozambique, Nepal, Nigeria, Oman, Romania, Rwanda, Swaziland, Tanzania, Vietnam (average GDP per capita in 2000 equivalent to 1354 US dollars).

[17] Countries included in the FDI model of section 4 and not in the migration model of section 3 are Argentina, Bangladesh, China, Dominican Republic, Ecuador, El Salvador, Gambia, Honduras, Jordan, Kenya, Niger, Pakistan, Panama, Paraguay, Sri Lanka, Syria, Turkey, Venezuela, Zambia (average GDP per capita in 2000 equivalent to 1800 US dollars).

[18] However, one has to remember that our dependent variable is the log of the ratio between FDI inflow and GDP. Therefore the actual sign of (log of) GDP is (1-coefficient reported in Table 3), which is positive up to column 5. For the same reason the coefficient on (log of) population is the difference between its coefficient and the coefficient on GDP per capita, thus attaining an overall positive sign.

GDP per capita that we measure once we introduce this factor (from column 4 onward) is the net effect of the stage of development.

Table 3 – 4-years Average Inflows of FDI – 1990-1995-2000 – Unbalanced Sample
human capital = secondary education attainment

	1 OLS	2 OLS+RC	3 OLS+RC	4 OLS+RC	5 OLS+RC	6 FE
population with secondary completed	1.99	2.696	2.585	2.171	1.381	-0.314
	[2.64]***	[3.48]***	[3.28]***	[2.76]***	[2.04]**	[0.09]
Log gdp per capita	0.225	0.106	0.088	-0.27	-0.774	-1.553
	[2.41]**	[0.77]	[0.60]	[1.78]*	[4.03]***	[2.03]*
Log stock of inward FDI			0.072	0.123	0.532	0.159
			[1.05]	[1.92]*	[4.43]***	[1.95]
factor extracted from political variables				0.401	0.214	1.177
				[2.27]**	[1.45]	[2.70]**
Trade (% GDP)					0.002	-0.006
					[0.80]	[1.65]
Inflation, consumer prices (annual %)					-0.03	-0.023
					[1.85]*	[2.39]*
Log population					-0.477	0.774
					[4.22]***	[0.50]
Log telephone mainlines x 1000 inhabitants					0.129	-0.267
					[0.94]	[1.10]
Observations	198	198	192	180	175	175
R-squared	0.18	0.34	0.35	0.4	0.55	0.54
Number of id	71	71	70	68	67	67

Robust t statistics in brackets - * significant at 10%; ** significant at 5%; *** significant at 1%
Year dummy included - RC (regional controls) included in OLS

Table 4 – 4-years Average Inflows of FDI – 1990-1995-2000 – Unbalanced Sample
human capital = tertiary education attainment

	1 OLS	2 OLS+RC	3 OLS+RC	4 OLS+RC	5 OLS+RC	6 FE
population with tertiary completed	1.004	1.398	0.856	0.393	1.584	-7.363
	[0.63]	[0.75]	[0.46]	[0.23]	[1.17]	[1.36]
Log gdp per capita	0.305	0.262	0.263	-0.15	-0.727	-1.365
	[2.93]***	[2.11]**	[2.03]**	[0.94]	[3.51]***	[1.70]
Log stock of inward FDI			0.058	0.116	0.53	0.168
			[0.83]	[1.79]*	[4.26]***	[2.11]*
factor extracted from political variables				0.438	0.227	1.218
				[2.53]**	[1.59]	[2.87]**
Trade (% GDP)					0.003	-0.006
					[1.27]	[1.84]
Inflation, consumer prices (annual %)					-0.029	-0.024
					[1.86]*	[2.34]*
Log population					-0.474	0.602
					[3.95]***	[0.38]
Log telephone mainlines x 1000 inhabitants					0.134	-0.305
					[0.95]	[1.24]
Observations	198	198	192	180	175	175
R-squared	0.16	0.31	0.32	0.38	0.55	0.55
Number of id	71	71	70	68	67	67

Robust t statistics in brackets - * significant at 10%; ** significant at 5%; *** significant at 1%

Year dummy included - RC (regional controls) included in OLS

When analysing the relationship between an elastic supply of HC and the inflows of capital from abroad, it is crucial to discuss the nature of foreign investment. If FDI is aimed to the exploitation of natural resources, the local availability of educated people might be less relevant than in the case of investments in manufacturing or services. Furthermore, FDI trends reveal a significant geographical concentration pattern by type of investment[19]. For both the African and the Middle-East regions the share of FDI inflows in the primary sector has remained high and constant over time, since a large number of MNEs operating in Africa are still attracted by the abundance of natural resources rather than by the market size or by host-country investment climate. The Latin American and the Caribbean regions show a large drop in the share of the manufacturing sector investment, associated with a corresponding increase in the share of the services sector. The Asian as well as the Central Eastern European region exhibit a large and stable share in the manufacturing sector.

These considerations provide a possible explanation to the fact that, by and large, specifications with OLS and regional controls perform better than those with country fixed effects. Since we do not have country-level information on the type of FDI, we are forced to adopt an overall measure of capital inflows; this may explain why regional controls provide better fit, because they may capture this compositional effect in FDI inflows.

4. Policy implications

Is there any evidence of a virtuous circle of human capital formation and increased inflow of FDI? What are the implications of our estimates? In order to adapt our estimates to our theoretical framework (see Appendix B), we need to clarify the relationship between human capital and enrolment rates. If we approximate the total human capital stock H by the average years of education in the population, it is defined as $H = l_p \cdot P + l_s \cdot S + l_t \cdot T$ where l_p, l_s, l_t are respectively the school length of primary, secondary and tertiary education, while P, S, T are the corresponding population shares. Taking l_p, l_s, l_t as fixed, we have that $\dot{H} = l_p \cdot \dot{P} + l_s \cdot \dot{S} + l_t \cdot \dot{T}$. If we consider that educational attainment affects differently life expectancy, the share of population with a given educational attainment increases whenever the corresponding enrolment rate is greater than the existing share. For example the variation of the population share with secondary education can be

[19] See Myamoto (2003).

described by the following expression $\dot{S} = \frac{enrolment_S - S}{life_S}$. Thus the variation of human capital stock is given by

$$\dot{H} = \frac{l_P}{life_P} \cdot (enrolment_P - P) + \frac{l_S}{life_S} \cdot (enrolment_S - S) + \frac{l_T}{life_T} \cdot (enrolment_T - T) \qquad (3)$$

Thus equation (3) implies that the overall effect of FDI on the accumulation of human capital is given by $\frac{\partial \dot{H}}{\partial K} = \frac{l_P}{life_P} \cdot \frac{\partial enrolment_P}{\partial K} + \frac{l_S}{life_S} \cdot \frac{\partial enrolment_S}{\partial K} + \frac{l_T}{life_T} \cdot \frac{\partial enrolment_T}{\partial K}$. If we neglect the impact of FDI on primary enrolment, where it is statistically insignificant in any specification, and we take the estimates reported in the Hausman-Taylor column of Table 1 and 2, we obtain that $\frac{\partial \dot{H}}{\partial K} = \frac{l_S}{life_S} \cdot \frac{\partial enrolment_S}{\partial K} + \frac{l_T}{life_T} \cdot \frac{\partial enrolment_T}{\partial K} \cong \frac{5}{60} \cdot (-0.024 + 0.017) = -0.00058$ which is negative but rather small. Since K is measured in logs, it implies that doubling the stock of FDI ($\Delta K = +1$) would (dynamically) decrease the human capital stock by 0.00058 years, while changing the skill composition in the labour force in favour of tertiary educated workers.

If we take the migration decision as exogenous, the Jacobian corresponding to system (8) in Appendix B is therefore given by[20]

$$\begin{bmatrix} \dot{H} \\ \dot{K} \end{bmatrix} = \begin{bmatrix} -0.016 & -0.00058 \\ 0.158 & 0.138 \end{bmatrix} \times \begin{bmatrix} H \\ K \end{bmatrix} \qquad (4)$$

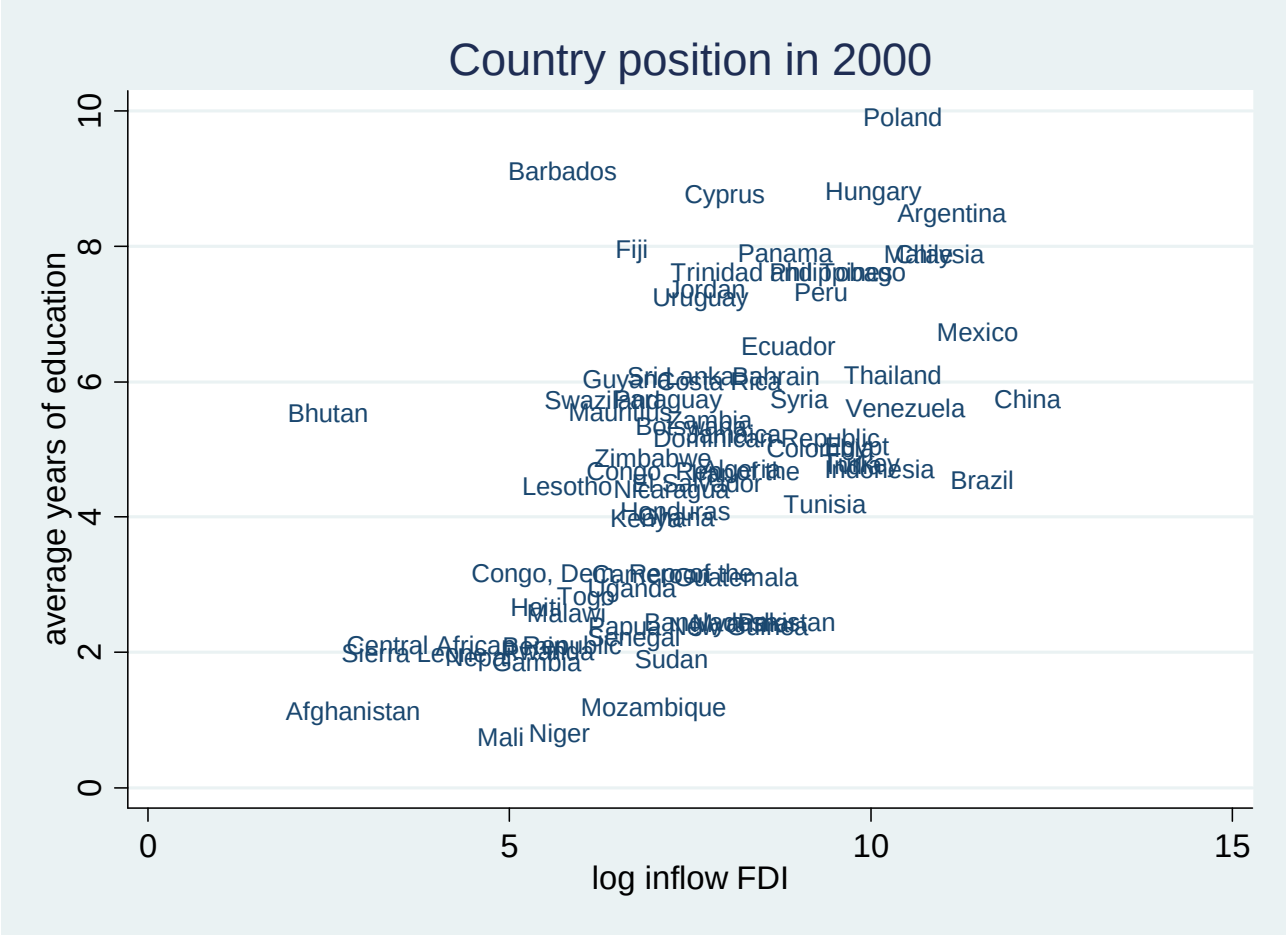
which is saddle-path stable.

Going to the debate over brain gain/drain, let us consider an exogenous increase in migration of skilled (tertiary educated) workers, in the order of 100%. At sample mean of the balanced panel, this implies a passage from 0.145 to 0.290. Looking at Tables 1 and 2 (last column) this implies a reduction in secondary enrolment of 3.7 (corresponding to an impact of –0.257×+0.145) and in tertiary enrolment of 2.4 (corresponding to an impact of –0.17×+0.145). If we are available to

[20] The figures reported in the second row of the Jacobian (4) are obtained by OLS regression of average FDI flow onto FDI stock and average years of education in the population, which replaces the population shares with different educational attainment (primary, secondary and tertiary). The estimated coefficient for average years of education on the unbalanced sample is $\underset{[2.67]}{0.158}$, while for log of FDI inflow is $\underset{[2.24]}{0.138}$. Finally, the coefficient of $\partial \dot{H} / \partial H$ is derived under the assumption of identical life expectancy for any educational attainment, equal to 60 years ($-\frac{1}{60} = -0.016$).

assume that the average school length at secondary and tertiary level is approximately 5 years, we obtain a reduction in the average years of education of 0.30, approximately one third of one year of schooling in the population. We now know from previous results, that this produces a reduction in capital inflow: since our dependent variable in the estimation of Table 3 is the log of the ratio between capital inflow and GDP, a variation of –0.19 (corresponding to +0.647×–0.306) implies a significant drop of capital inflows, in the order of pre-existing flows (equal to 0.18 at sample mean of the balanced panel). In the long run, this reduction cumulates in lower stock, yielding lower enrolment and lower human capital.

Figure 1



When we graph the country position according to these state variables (human capital stock H, proxied by the average years of education in the population, and physical capital stock, K, proxied by the log of foreign investment) we observe that countries are aligned along a ray exiting from the origin (see figure 1). Qualitative analysis of the dynamic properties of dynamical system described by equation (4) indicates that the stable branch of the saddle path will exhibit a negative slope comprised between $-\frac{0.00058}{0.016} \cong -0.036$ and $-\frac{0.138}{0.158} \cong -0.873$, while the unstable branch can be

either positively or strongly negatively sloped. Thus, according to our model, most of the countries would be positioned on unstable paths, that lead either to infinite values in both H and K, or to a poverty trap where both variable tend to zero value. In both cases, along the unstable braches, both human capital and physical capital move together, exhibiting a complementary nature. On the contrary, on the stable branches, the two types of capital do exhibit negative correlation, coherently with our empirical finding of an overall negative feedback of FDI onto the accumulation of HC.

5. Concluding remarks

Two main results are obtained in this paper, and can be summarized as follows:

1. we do not find strong evidence of the existence of a virtuous cycle between human capital accumulation and foreign direct investment. In our estimates, FDI discourages secondary enrolment while favouring tertiary enrolment, but the overall effect is negative. On the other side, in our data FDI seem to be attracted by existing endowment of human capital, but only at the secondary level. Thus, as in any saddle-path stable system, there is a unique combination of stocks of human capital and foreign capital leading to a stable equilibrium, but all other combinations lead to unstable path;
2. in addition to direct reduction of domestic human capital, we find evidence of a sort of brain drain through skilled (tertiary educated) worker migration. We interpret this result as disincentive effect: when the domestic population observes that a large share of university graduate migrates, it takes this as evidence of lack of adequate local job opportunities, and reduces the corresponding investment in higher education.

On both grounds, less developed countries are not benefited by factor mobility: they loose domestic human capital under both foreign capital inflow and domestic human capital outflow. Unfortunately we do not possess data on the type of FDI involved in this analysis. Looking at their geographical distribution, we suspect that our story involves natural resource exploitation (like mining and oil extraction) rather than Greenfield investment. In such a case the local endowment of human capital is less relevant, as well as the incentive to further human capital accumulation.

APPENDIX A – Additional tables

Table A1 – Descriptive statistics (1990-2000)

Variable	Obs	Mean	Std. Dev.	Min	Max	Obs	Mean	Std. Dev.	Min	Max
	unbalanced panel					balanced panel				
gross enrolment rate secondary	283	0.55	0.30	0.05	1.15	114	0.48	0.28	0.05	1.05
gross enrolment rate tertiary	255	0.15	0.14	0.00	0.59	114	0.12	0.12	0.00	0.51
Enrolment rate primary 5 years before	254	0.91	0.25	0.10	1.47	114	0.92	0.23	0.25	1.47
Enrolment rate secondary 5 years before	254	0.49	0.30	0.03	1.19	114	0.43	0.26	0.03	1.02
log GDP per capita	277	6.95	1.18	4.45	9.69	114	6.77	1.21	4.45	9.38
log stock of inward FDI	267	6.40	2.34	0.00	12.17	114	7.05	2.20	0.00	11.54
infant mortality rate 1000 live birth	298	56.80	40.80	4.10	191.00	114	62.64	38.83	8.10	158.00
Private Credit by Deposit Money Banks / GDP	250	0.23	0.19	0.00	1.04	114	0.23	0.18	0.00	0.94
log pupil/teacher primary	249	7.94	0.41	6.97	8.95	114	8.08	0.40	6.97	8.84
Migration rate secondary educ	281	0.08	0.14	0.00	0.70	114	0.04	0.06	0.00	0.30
Migration rate tertiary educ	281	0.21	0.23	0.00	0.92	114	0.15	0.16	0.00	0.84
log Population density (people per sq. km)	295	3.87	1.31	0.30	6.90	114	3.81	1.32	0.30	6.85

Table A2 – Gross enrolment rate – Secondary Education (1990-2000) – Balanced Panel

	1	2	3	4	5	6
	OLS	FE	FE	FE	FE IV	HT
log gdp per capita	0.087	0.193	0.177	0.204	0.174	0.194
	[4.91]***	[2.55]**	[2.05]**	[2.37]**	[1.86]*	[2.82]***
Infant mortality rate 1000 live birth	-0.003	-0.001	-0.001	-0.001	-0.001	-0.001
	[4.95]***	[0.66]	[1.17]	[1.15]	[0.99]	[0.98]
Private Credit by Deposit Money Banks / GDP	0.059	0.126	0.136	0.121	0.133	0.128
	[0.64]	[0.91]	[1.16]	[0.93]	[1.26]	[1.56]
log stock of inward FDI	-0.012	-0.012	-0.028		-0.027	-0.02
	[1.28]	[1.72]*	[3.62]***		[2.15]**	[2.22]**
migration rate tertiary educ	-0.088	-0.244	-0.167	-0.162	-0.445	-0.183
	[1.26]	[1.26]	[1.03]	[0.93]	[0.70]	[0.87]
enrolment rate primary 5 years before	0.239	0.172	0.157	0.169	0.153	0.165
	[3.92]***	[1.51]	[1.53]	[1.65]	[1.24]	[1.71]*
log pupil/teacher primary			-0.049	-0.045	-0.049	-0.08
			[0.64]	[0.50]	[0.54]	[1.15]
log Population density (people per sq. km)			-0.58	-0.43	-0.562	-0.31
			[2.86]***	[1.94]*	[2.76]***	[2.76]***
migcountry (countries with mig.ter.>0.1 or mig.sec.>0.05)						1.323
						[1.63]
log inflow FDI×East Asia and Pacific				-0.025		
				[1.53]		
log inflow FDI×European and Central Asia				-0.02		
				[1.97]*		
log inflow FDI×Latin America and Caribbean				0.002		
				[0.04]		
log inflow FDI×Middle East and North Africa				-0.068		
				[2.48]**		
log inflow FDI×South Asia				-0.096		
				[5.75]***		
log inflow FDI×Sub-Saharan Africa				-0.037		
				[2.18]**		
Observations	114	114	114	114	114	114
R-squared	0.78	0.53	0.61	0.66		
Number of id	57	57	57	57	57	57

Robust t statistics in brackets - * significant at 10%; ** significant at 5%; *** significant at 1%
Year dummy included - regional controls included in HT - IV for FE: log of stock of own migrants in US and in EU (10 years before)

Countries included: Algeria, Bahrain, Benin, Bolivia, Botswana, Brazil, Bulgaria, Burkina Faso, Cameroon, Chad, Chile, Colombia, Congo, Dem. Rep. of the, Congo, Rep. of the, Costa Rica, Cote d'Ivoire, Egypt, Ethiopia, Ghana, Guatemala, Hungary, India, Indonesia, Iran, Jamaica, Laos, Lesotho, Malawi, Malaysia, Mali, Mauritania, Mauritius, Mexico, Mongolia, Morocco, Mozambique, Nepal, Nicaragua, Nigeria, Oman, Papua New Guinea, Peru, Philippines, Poland, Romania, Rwanda, Senegal, Swaziland, Tanzania, Thailand, Togo, Trinidad and Tobago, Tunisia, Uganda, Uruguay, Vietnam, Zimbabwe.

Table A3 – Gross enrolment rate – Tertiary Education (1990-2000) – Balanced Panel

	1 OLS	2 FE	3 FE	4 FE	5 FE IV	6 HT
log gdp per capita	-0.018	0.027	0.028	0.032	0.017	0.033
	[1.36]	[0.76]	[0.61]	[0.69]	[0.34]	[1.01]
Infant mortality rate 1000 live birth	-0.001	0	-0.001	0	-0.001	0
	[2.06]**	[0.48]	[0.86]	[0.56]	[0.80]	[1.03]
Private Credit by Deposit Money Banks / GDP	0.048	0.01	0.022	0.042	0.012	0.017
	[0.93]	[0.18]	[0.43]	[0.72]	[0.22]	[0.45]
log stock of inward FDI	0.012	0.024	0.015		0.015	0.019
	[3.38]***	[3.26]***	[2.30]**		[2.29]**	[4.47]***
migration rate tertiary educ	-0.168	-0.177	-0.16	-0.106	0.312	-0.16
	[4.71]***	[1.31]	[1.36]	[0.98]	[0.74]	[1.58]
enrolment rate secondary 5 years before	0.246	0.136	0.09	0.111	0.181	0.1
	[5.84]***	[1.34]	[0.91]	[1.13]	[1.48]	[1.56]
log pupil/teacher primary			-0.039	0.011	-0.023	-0.052
			[0.75]	[0.22]	[0.43]	[1.54]
log Population density (people per sq. km)			-0.287	-0.184	-0.315	-0.139
			[2.92]***	[1.75]*	[2.93]***	[2.84]***
migcountry (countries with mig.ter.>0.1						0.448
or mig.sec.>0.05)						[1.38]
log inflow FDI×East Asia and Pacific				0.019		
				[1.33]		
log inflow FDI×European and Central Asia				0.023		
				[2.35]**		
log inflow FDI×Latin America and Caribbean				0.009		
				[0.51]		
log inflow FDI×Middle East and North Africa				0.004		
				[0.33]		
log inflow FDI×South Asia				-0.014		
				[0.92]		
log inflow FDI×Sub-Saharan Africa				-0.005		
				[0.90]		
Observations	114	114	114	114	114	114
R-squared	0.68	0.54	0.63	0.69		
Number of id	57	57	57	57	57	57

Robust t statistics in brackets - * significant at 10%; ** significant at 5%; *** significant at 1%
Year dummy included - regional controls included in HT
IV for FE: log of stock of own migrants in US and in EU (10 years before)

Countries included: Algeria, Bahrain, Benin, Bolivia, Botswana, Brazil, Bulgaria, Burkina Faso, Cameroon, Chad, Chile, Colombia, Congo, Dem. Rep. of the, Congo, Rep. of the, Costa Rica, Cote d'Ivoire, Egypt, Ethiopia, Ghana, Guatemala, Hungary, India, Indonesia, Iran, Jamaica, Laos, Lesotho, Malawi, Malaysia, Mali, Mauritania, Mauritius, Mexico, Mongolia, Morocco, Mozambique, Nepal, Nicaragua, Nigeria, Oman, Papua New Guinea, Peru, Philippines, Poland, Romania, Rwanda, Senegal, Swaziland, Tanzania, Thailand, Togo, Trinidad and Tobago, Tunisia, Uganda, Uruguay, Vietnam, Zimbabwe.

Table A4 – Descriptive statistics – 1990-1995-2000

Variable	Obs	Mean	Std. Dev.	Min	Max	Obs	Mean	Std. Dev.	Min	Max
	unbalanced panel					balanced panel				
log of inflow over GDP - average over 3 years	384	0.46	1.42	-4.68	4.31	153	0.36	1.33	-4.68	3.37
population share with secondary	224	0.18	0.12	0.01	0.50	153	0.20	0.11	0.01	0.50
population share with tertiary completed	224	0.06	0.06	0.00	0.22	153	0.07	0.06	0.00	0.22
log gdp per capita	418	6.92	1.18	4.03	9.69	153	7.05	1.05	4.45	8.95
log stock of inward FDI	390	6.50	2.27	-0.69	12.17	153	7.75	1.78	1.79	12.17
factor extracted from political variables	362	0.00	1.00	-2.57	3.06	153	0.23	0.92	-2.45	3.06
Trade (% GDP)	411	80.96	40.34	3.15	228.88	153	70.22	38.90	14.99	228.88
Inflation, consumer prices (annual %)	373	0.88	4.44	-0.03	53.99	153	1.32	6.47	-0.03	53.99
log population	448	15.38	2.01	10.62	20.96	153	16.48	1.56	13.55	20.96
log telephone mainlines x 1000 inhabitants	453	87.97	107.87	0.20	559.67	153	67.33	72.06	0.20	371.98

Table A5 – 3-years Average Inflows of FDI – 1990-2000 – Balanced Panel – human capital = secondary attainment

	1	2	3	4	5	6
	OLS	OLS+RC	OLS+RC	OLS+RC	OLS+RC	FE
population with secondary completed	1.381	1.912	1.906	1.602	1.798	-0.146
	[1.95]*	[2.57]**	[2.54]**	[2.11]**	[2.81]***	[0.04]
log gdp per capita	0.266	0.163	0.144	-0.192	-0.819	-1.659
	[2.62]***	[1.11]	[0.86]	[1.18]	[3.94]***	[2.18]*
log stock of inward FDI			0.031	0.089	0.503	0.193
			[0.42]	[1.34]	[3.90]***	[2.29]*
factor extracted from political variables				0.329	0.167	1.141
				[1.71]*	[1.11]	[2.44]*
Trade (% GDP)					-0.031	-0.023
					[2.01]**	[2.39]*
Inflation, consumer prices (annual %)					0.003	-0.006
					[1.17]	[1.71]
log population					-0.515	0.858
					[4.57]***	[0.54]
log telephone mainlines x 1000 inhabitants					0.115	-0.239
					[0.83]	[0.96]
Observations	153	153	153	147	147	147
R-squared	0.2	0.37	0.37	0.42	0.59	0.56
Number of id	51	51	51	51	51	51

Robust t statistics in brackets - * significant at 10%; ** significant at 5%; *** significant at 1%
Year dummies included – RC (regional controls) included in OLS .

Countries included: Algeria, Argentina, Bangladesh, Bolivia, Brazil, Chile, China, Colombia, Congo, Dem. Rep. of the, Congo, Rep. of the, Costa Rica, Dominican Republic, Ecuador, Egypt, El Salvador, Gambia, Ghana, Guatemala, Honduras, Hungary, India, Iran, Jamaica, Jordan, Kenya, Malaysia, Mauritius, Mexico, Nicaragua, Niger, Pakistan, Panama, Papua New Guinea, Paraguay, Peru, Philippines, Poland, Senegal, Sri Lanka, Syria, Thailand, Togo, Trinidad and Tobago, Tunisia, Turkey, Uganda, Uruguay, Venezuela, Zambia, Zimbabwe.

Table A6 – 3-years Average Inflows of FDI – 1990-1995-2000 – Balanced Panel
human capital = tertiary attainment

	1 OLS	2 OLS+RC	3 OLS+RC	4 OLS+RC	5 OLS+RC	6 FE
population with tertiary completed	0.049	0.304	0.259	-0.36	1.101	-6.31
	[0.03]	[0.16]	[0.14]	[0.20]	[0.75]	[1.15]
log gdp per capita	0.331	0.309	0.288	-0.094	-0.716	-1.497
	[2.94]***	[2.30]**	[1.86]*	[0.54]	[3.26]***	[1.90]
log stock of inward FDI			0.033	0.094	0.502	0.2
			[0.43]	[1.40]	[3.66]***	[2.40]*
factor extracted from political variables				0.365	0.206	1.181
				[1.94]*	[1.40]	[2.58]*
Trade (% GDP)					0.004	-0.007
					[1.52]	[1.85]
Inflation, consumer prices (annual %)					-0.029	-0.024
					[1.97]*	[2.35]*
log population					-0.502	0.737
					[4.02]***	[0.47]
log telephone mainlines x 1000 inhabitants					0.107	-0.277
					[0.73]	[1.09]
Observations	153	153	153	147	147	147
R-squared	0.19	0.35	0.35	0.41	0.58	0.57
Number of id	51	51	51	51	51	51

Robust t statistics in brackets - * significant at 10%; ** significant at 5%; *** significant at 1%
Year dummies included – RC (regional controls) included in OLS

Countries included: Algeria, Argentina, Bangladesh, Bolivia, Brazil, Chile, China, Colombia, Congo, Dem. Rep. of the, Congo, Rep. of the, Costa Rica, Dominican Republic, Ecuador, Egypt, El Salvador, Gambia, Ghana, Guatemala, Honduras, Hungary, India, Iran, Jamaica, Jordan, Kenya, Malaysia, Mauritius, Mexico, Nicaragua, Niger, Pakistan, Panama, Papua New Guinea, Paraguay, Peru, Philippines, Poland, Senegal, Sri Lanka, Syria, Thailand, Togo, Trinidad and Tobago, Tunisia, Turkey, Uganda, Uruguay, Venezuela, Zambia, Zimbabwe.

APPENDIX B – Theoretical considerations

We are interested in analysing the long run consequences of factor mobility on human capital investment in developing countries, when feedbacks from capitals and workers mobility onto educational choices of the population are taken into account. While in the empirical analysis we will distinguish between different types of educational attainment (as proxy for different degrees of skill in the workforce), here let us define M as the migration rate (defined as the fraction of nationals leaving the domestic country, which is assumed to take the role of "less developed" economy), H as the domestic human capital stock and K as the domestic physical capital stock.

While in principle an economy could be either exporter or importer of both workers and capital, developing countries are typically net exporter of workers and net importer of (foreign) capital in the form of foreign direct investment. In addition, the low level of domestic production and/or the high level of domestic absorption make it rather difficult to obtain domestic accumulation of physical capital. For this reason we assume that immigration of foreign workers and domestic investment are set to zero.

Domestic human capital can be augmented through (domestic) school attendance and decreased through migration of educated workers (the so-called "brain drain"). However, some recent literature has drawn attention on the potential existence of a sort of "brain gain" through which the educational achievement, by favouring the chance to emigrate, would represent a sort of incentive to acquire education, yielding an overall positive balance of migration onto domestic human capital accumulation.

Since both possibility are equally likely, and we are agnostic on this issue, we leave the data speak. Therefore our first equation is given by

$$\dot{H} = e\left(\underset{+}{K}, \underset{\pm}{M}, X_e\right) - M \tag{5}$$

where $\dot{H} = dH/dt$ (the Newtonian derivative), $e(K, M, X_e)$ summarises school enrolment (with a supposedly positive impact of foreign investment K in the domestic economy, an ambiguous effect of migration M and country specific factors X_e affecting educational choices – like income inequality, poverty, school resources and so on). Equation (5) indicates that domestic human capital stock is increased by school attendance and decreased by migration of educated workers (even if in the long run the incentive created by migration may rise enrolment and therefore its long run stock).. The sign of $de/dM > 0$ is taken as indicator of the occurrence of "brain gain", whereas $de/dM < 0$ is interpreted as evidence of "brain drain".

Our second equation aims to model the dynamics of physical capital accumulation through domestic inflow of foreign capitals. We know from the literature that FDI tend to be attracted by the

existence of local favourable conditions[21] (like infrastructure, political stability) as well as by the local availability of skilled labour [Lucas (1990), Zhang and Markusen (1999)], which is positively correlated with the educational attainment in the population. In addition, we also consider the possibility of economies of scale and/or of technology/knowledge linkages: both make a new investment more likely in countries where other investments have already taken place. We also consider the possibility of a decline in the relative profitability of domestic investment (due to decreasing marginal productivity, exhaustion of raw materials, shortage of adequate skill): in such a case, the impact of current stock on new investment would be obviously negative. Thus our second equation takes the form

$$\dot{K} = k\left(\underset{\pm}{K}, \underset{+}{H}, X_h\right) \tag{6}$$

where X_h indicates country specific factors affecting FDI inflows (i.e. infrastructures, degree of openness, country size, political stability, etc.).

Finally, our third equation takes into account the determinants of outward migration. Here again the literature is quite substantial. We do consider two aspects: the first one is the impact of the availability of skilled jobs on the decision to migrate, which is correlated with the technological level prevailing in the country; if the technological progress is embodied in the newly invested physical capital, then migration should report a negative correlation with foreign direct investment. The second aspect is the internal competition for skilled jobs, since the greater is the unemployment in the educated labour force, the longer will be the unemployment spell, and the more likely becomes the migration. Our assumptions are then summarised in the following

$$M = m\left(\underset{-}{K}, \underset{\pm}{H}, X_m\right) \tag{7}$$

where X_m include the identifying restrictions for this equation, like language facilities, distance, the former colony status, and so on.

Equations (5)-(6)-(7) describe a dynamical system in R^2. In facts, by replacing equation (7) into (5) we obtain the following system

$$\begin{cases} \dot{H} = h\left(\underset{\pm}{H}, \underset{\pm}{K}, X_m, X_e\right) \\ \dot{K} = k\left(\underset{+}{H}, \underset{\pm}{K}, X_h\right) \end{cases} \tag{8}$$

[21] See Blonigen (2005) for a comprehensive review of the literature on FDI determinants. Faini (2004) provides evidence of a positive effect of domestic human capital stock (proxied by average years of education in the population) as well as domestic infrastructure (proxied by telephone lines) onto FDI.

In the case of “brain gain” the Jacobian associated to the system (8) takes the form $\begin{bmatrix} \pm & - \\ + & \pm \end{bmatrix}$, while under the case of “brain drain” it exhibits the following signs $\begin{bmatrix} \mp & + \\ + & \pm \end{bmatrix}$. The system incorporates a feed-back mechanism that contributes to its stabilisation. In facts, when capital stock increases, it tends to reduce (skilled) workers migration, thus favouring domestic accumulation of human capital (through the reduced outflow of skilled migrants as well as through an incentive effect on enrolled students to proceed further on in education). In its turn, an increase in human capital stock makes additional inflows of new capitals more likely. In both cases, global stability can be assessed only when the sign and the size of the elements on the Jacobian main diagonal are known.

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