On the Effects of FDI on Local Human Capital Formation

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August 22, 2011

ABSTRACT

This paper lends both theoretical and econometric support to the notion of optimal FDI levels. It does so by uncovering an inverted-U-shaped relationship between FDI and educational effort. The optimality of a particular FDI inflow depends on the educational incentives induced by FDI on the local, heterogeneous population. Those incentives are formed in the face of uncertainty and asymmetric information between the multinational and its potential workers. Our estimates confirm the significance of a positive (linear) and a negative (non-linear) impact of FDI per capita on tertiary schooling, both in developed and developing countries.

Keywords: Asymmetric Information; FDI; Human Capital; Skills; Tournaments.

JEL Classification: F23, H52, J24.

RESUMEN

El presente paper presta tanto argumentos teóricos como soporte econométrico a la idea de un nivel óptimo de FDI. Lo hace descubriendo una relación con forma de U invertida entre FDI y esfuerzo educativo. La optimalidad de un flujo limitado de FDI depende de la formación de incentivos para educarse entre la población local, que es a su vez heterogénea en términos de destreza o habilidad. Estos incentivos se forman en presencia de incertidumbre e información asimétrica entre la multinacional y sus potenciales empleados. Nuestras estimaciones revelan la existencia (y significatividad) de un impacto positivo (lineal) y otro negativo (no lineal) de la inversión extranjera directa sobre la escolarización terciaria, tanto en países desarrollados como en vías de desarrollo.

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Keywords: Información Asimétrica; FDI; Capital Humano; Habilidad; Competición.
Clasificación JEL: F23, H52, J24.

1. INTRODUCTION

It has been widely reported by the literature on multinational corporations (henceforth MNCs) the role played by the latter in the expansion of formal education in the host countries. As emphasized by Blomström and Kokko (2001), "MNCs provide attractive employment opportunities to highly skilled graduates in natural sciences, engineering and business sciences, which may be an incentive for gifted students to complete tertiary training"[3]. According to this idea, in order to access the staff of reputed multinationals, potential workers need to qualify as educated labor force. Therefore, even when not all of them will effectively work for such multinationals, this reality will induce on these workers an effort of human-capital formation with significant spillovers for the rest of their countries.

In principle, it is straightforward that more FDI, meaning better conditions of employability at higher wages, should stimulate human-capital formation to be selected by multinationals. That is, the relation between FDI inflows and educational investment is monotonically increasing when the local population is homogeneous. However, once we introduce some ability-heterogeneity among native workers, such relation becomes non-monotonic: a very large MNC staff implies a high likelihood to be employed for the high-ability natives, which will tend to reduce their effort then; and the lower effort exerted by the most capable will be accompanied (as a reaction) by more laziness by all others. Therefore, under certain conditions we suggest that the above-mentioned relation between FDI per capita and schooling in recipient countries shows approximately an inverted-U shape.[4]

There is in principle no reason why the MNCs will tend to maximize the aggregate efficiency units of the local human capital, because there are many other strategic priorities for them. Therefore, it may be in the interest of the local government to use some instruments in order to internalize the external effects, which will spill over most

[3] Abundant empirical studies also suggest that multinational corporations tend to raise the demand for education in developing countries, as their plants are often more skilled-labor-intensive than the rest of the economy (see, for instance, Feenstra and Hanson (1997)).

[4] Unlike Hoffmann (2003), who used a general-equilibrium model to explore the mechanics of the complementarity (and two-way causality) between human-capital accumulation and FDI, we considered a partial-equilibrium framework.

of the productive sectors. Furthermore, human-capital accumulation is not the only priority to be considered by the host-country government. Productive linkages with local sectors, multiple forms of technology transfer, or just the value added generated by FDI may be even more significant (e.g. Markusen and Venables (1999)). Nevertheless, we tried to emphasize the potential non-monotonicity of the previous relation, together with some causal explanations for such phenomenon, whose relevance will be confirmed in the empirical sections of our paper.

Indeed, our empirical estimates confirm the significance of both a positive, linear impact of FDI on tertiary schooling, and of a negative impact of FDI^2, both in developed and developing countries. To the best of our knowledge, this is the first paper to incorporate a non-linear effect of FDI in the analysis of human-capital accumulation. Zhuang (2008) used a difference-in-differences approach in which the reverse-causality problem was addressed using dummies of policy changes as independent variables, instead of FDI measured in dollars. On the other hand, Checchi et al. (2007) used explicitly an FDI variable as a regressor, but only captured its positive linear effect on human-capital formation.

The rest of the paper is organized as follows: section 2 describes an illustrative model; sections 3 and 4 present the data and the estimation procedure; section 5 contains the results and section 6 an appendix listing the countries in our sample.

2. AN ILLUSTRATIVE MODEL

In our model there must be a chance for all potential workers (skilled and unskilled) to be eligible for a job in MNCs. Otherwise the gains would be circumscribed to the high-skilled workers. Therefore, some noise in the educational and/or the political system of the host country must play a role, by preventing the MNCs from using a fully-informed recruiting policy. That same noise is also responsible for some uncertainty on the part of the applicants, who will select their optimal education effort as a function of the probability to be selected by the MNCs.

2.1. Education as an instrument to be hired by multinationals

Our theoretical framework is a variation of Lazear and Rosen (1981)'s model of tournaments. In this particular setting there are l local workers competing for h jobs offered by the MNCs. The total size of the population (l) is divided into a proportion ½ of high-ability types (let us call them type-2) and a proportion ½ of low-ability types

(type-1). The former types own θ efficiency units of labor (θ>1), whereas the latter own just one efficiency unit. However, the type of each individual is not observable to the employer. He needs to use a selection process in order to choose the (presumably) best employees for the MNC, though such selection depends on an imperfect test.

We assume that, in this model, more formal education improves the chance to be selected by the MNC, that is, it plays the role of a signaling device. However, schooling also helps the MNC to improve the quality of its pool of employees, since the most capable individuals will be more educated. Given that the most capable workers are also more productive, this implies that schooling will channel disproportionally the skilled workers to the MNC, raising the aggregate productivity (and value added) of the economy. From that point of view, it can be said that schooling also has an aggregate productivity effect.

Let the personal outcome of any individual *i* in the test depend on his own training effort (e_i) and an element of randomness (η_i), where the random variable η_i follows an uniform distribution over the interval [-*a*,*a*], *a*>0 for all *i*. More specifically, let us denote by g_i the test score of individual *i* and assume that

$$g_i = e_i + \eta_i \qquad (1)$$

That randomness (η_i) obscures the true type of the individual to the eyes of the employer, given that a good (or a bad) result in the test could be obtained (under different circumstances) by any of the two types. We can interpret the variance of η_i as an inverse measure of the quality of the educational system in the host country. The magnitude of such variance is measured by the parameter *a*.

Despite the imperfections in the test, the multinational firm decides to recruit the best *h* scores, where *h* stands for the size of the local staff in the multinational corporation. That variable (*h*) will also determine the relative incentives of both types to get educated and, subsequently, the ex-post quality of the hired staff.

The way to be selected in the test is beating at least *l*-*h* competitors, where *l* is the total number of candidates involved in the selection process. That is, all workers will be interested in applying for a job in the multinationals, given that the MNC offers a higher wage than the one available locally (w_F - w_H=Δw>0, where *F* and *H* stand for foreign and home, respectively).

First of all, it is intuitive that – given identical preferences (in the form of disutility) with respect to effort – the high-ability types will tend to exhibit a higher incentive to

acquire education, since they will enjoy from the same wage gap, but applied to a higher number of efficiency units of labor. We will show this fact by obtaining the probability that any worker (of type *i*) gets a higher score than any other worker (of type *j*; *i*,j Є(1,2)), as follows:

$$P(g_i > g_j) = P\left(\eta_i - \eta_j > e_j - e_i\right) = \int_{e_j - e_i}^{2a} \frac{d\left(\eta_i - \eta_j\right)}{4a} = \left(\frac{1}{2} - \frac{\left(e_j - e_i\right)}{4a}\right) \quad (2)$$

where we have considered an uniform, independent probability distribution for the random variables η_i and η_j, and assumed that *a* is big enough to ensure that probabilities are always positive and lower than one. Let us denote by γ the parameter measuring the intensity of the effort disutility by both types of individuals. Now we are ready to present the maximization problem faced by the workers of both types:

$$Welfare_2 = Max_{e_2}\left\{p_2\left(e_1, e_2\right)^{l-h}\theta\,\Delta w - \frac{1}{2}\gamma\, e^2{}_2\ \right\}$$

$$Welfare_1 = Max_{e_1}\left\{p_1\left(e_1, e_2\right)^{l-h}\Delta w - \frac{1}{2}\gamma\, e^2{}_1\ \right\} \quad (3)$$

where

$$p_2 = \frac{1}{4} + \frac{1}{2}\left(\frac{1}{2} + \frac{\left(e_2 - e_1\right)}{8a}\right) = \frac{1}{2} + \frac{\left(e_2 - e_1\right)}{8a}$$

$$p_1 = 1 - p_2 = \frac{1}{2} - \frac{\left(e_2 - e_1\right)}{8a} \quad (4)$$

We have denoted by p_i the probability that an agent shows a higher score than another one, conditional on the type (i=1,2) of the former. In (3) we are incorporating the fact that, in order to be hired by a multinational, any candidate must defeat other (*l*-*h*) potential workers. Let us denote by z=e_2-e_1 the difference between the education efforts of both types, so that $p_2 = p_1 + \frac{z}{4a}$ .Then, by plugging the equations in (4) into the maximands given by (3) and taking the corresponding first-order conditions, we come up with the following reaction functions:

$$e_2 = \left(l - h\right)\frac{\Delta w}{8\gamma a}\theta\left(\frac{1}{2} + \frac{z}{8a}\right)^{l-h-1}$$

$$e_1 = \left(l - h\right)\frac{\Delta w}{8\gamma a}\left(\frac{1}{2} - \frac{z}{8a}\right)^{l-h-1} \quad (5)$$

If we now subtract both terms in (5), we can characterize the distance between the optimal efforts made by both types as follows:

$$z = (l-h)\frac{\Delta w}{8\gamma a}\left[\theta\left(\frac{1}{2}+\frac{z}{8a}\right)^{l-h-1} - \left(\frac{1}{2}-\frac{z}{8a}\right)^{l-h-1}\right] \quad (6)$$

Furthermore, we can close the system by imposing a consistency requirement, which guarantees that the workers` expectations are rational: the effective size of the MNC staff must be equal to the sum of the probabilities to be hired.[5] Such requirement can be expressed as follows:

$$h = \frac{l}{2}\left[p_1^{l-h} + p_2^{l-h}\right] = \frac{l}{2}\left[\left(\frac{1}{2}+\frac{z}{8a}\right)^{l-h} + \left(\frac{1}{2}-\frac{z}{8a}\right)^{l-h}\right] \quad (7)$$

Therefore, our whole economic system can be characterized by the equations (6) and (7) in the two endogenous variables *h* and *z*.

If we examine carefully both equations above, it is straightforward that both expressions will hold if *h* is close enough to *l* ($h \rightarrow l-$), and if *z* is close enough to zero ($z \rightarrow 0+$).[6] However, we believe that nothing substantial hinges on that proximity to the 'corner solutions', since we will be still able to plot the shape of the (admittedly small) individual efforts with respect to the FDI inflow.

Our exercise will consist in taking comparative statics (on the effort levels) with respect to the wage gap; obtaining (and plotting) the labor income generated by FDI[7] that corresponds to such values of the gap; and also plotting the relationship between FDI and the aggregate training effort of the local population. We consider two possible objective functions (or criteria) to be maximized by the government in the host country: either the labor income generated by FDI, or the aggregate educational effort also induced by FDI. In the latter case, since our proposed objective will be promoting FDI up to the point where aggregate educational effort is maximized, we will derive some conclusions concerning the available policy instruments for the government.

In other words, the wage gap is exogenous for us, whereas FDI (understood here as the local labor income generated by the MNC) and the effort levels are our endogenous variables.

2.2. Calibration and diagrammatic results

Since the system of non-linear equations expressed by (6) and (7) has no analytical solution, we need to solve it numerically for some plausible values of the parameters. In particular, we have followed Ghosh and Whalley (2007) ´s parameterization with

[5] In other words, condition (7) means that the MNC can exactly fulfill its promise to hire the best *h* scores.
[6] Those two conditions are also a guarantee that the maximization problems specified in (3) are concave.
[7] We assume that the potential profits generated by the MNC will be repatriated to the home country. Therefore, the host country will be interested exclusively in the labor income stemming from FDI.

respect to the units-term in the disutility of effort function (γ=1). Goldin and Katz (1999) suggest an average return to each year of college in the USA of 0.13, which amounts to a lower bound for θ=1.52. We will discuss later the implications of changing our parameter a, which for the moment will take a value a=830, while l=1.7.

A useful definition will be for us

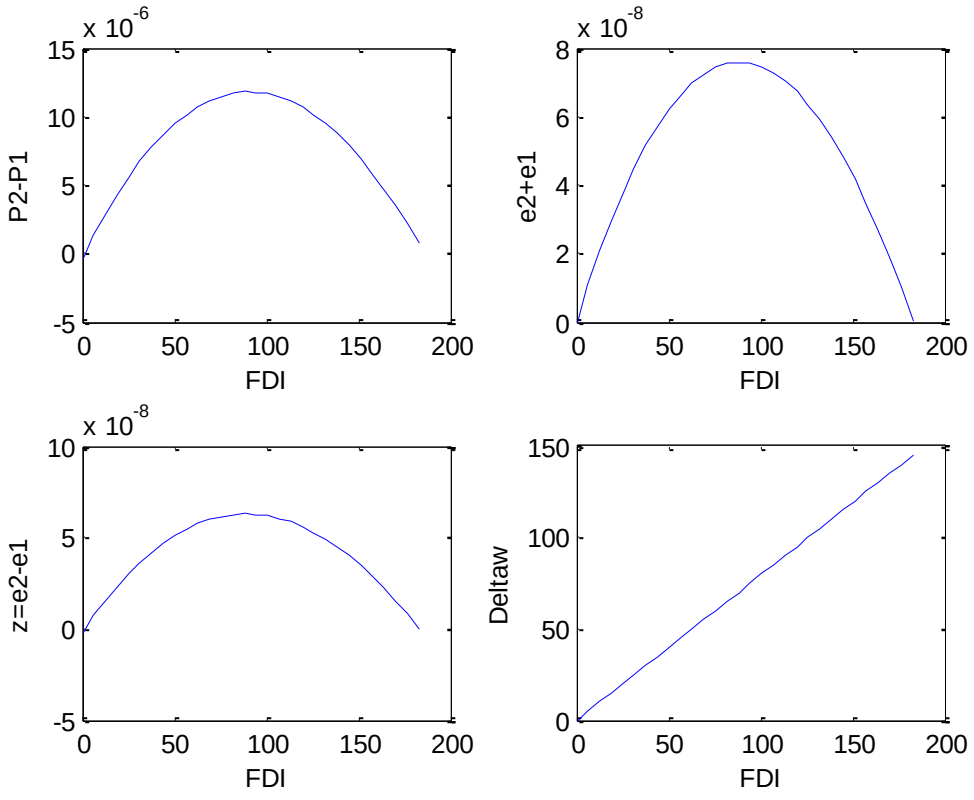
$$HC \equiv \frac{l}{2}\left[\left(\frac{1}{2}+\frac{z}{8a}\right)^{l-h}\theta+\left(\frac{1}{2}-\frac{z}{8a}\right)^{l-h}\right] \tag{8}$$

That is, the variable HC captures the aggregate units of effective labor used in the MNC. Moreover, we have normalized (without loss of generality) the domestic wage w_H to zero. Therefore, the labor income distributed by the MNC among the domestic workers (that is, the value added that remains in the host country) is

$$FDI \equiv HC(\Delta w) \tag{9}$$

Since we are interested in the empirical implications of our numerical results, we have included in every horizontal axis of Figure 1 the variable FDI, as defined in equation (9). We can clearly observe (in the last panel) that FDI and Δw are positively correlated, which conforms well with Feenstra and Hanson (1997) ´s findings with Mexican data.

Figure 1 (a=830)



2.3. Interpretation of the figures

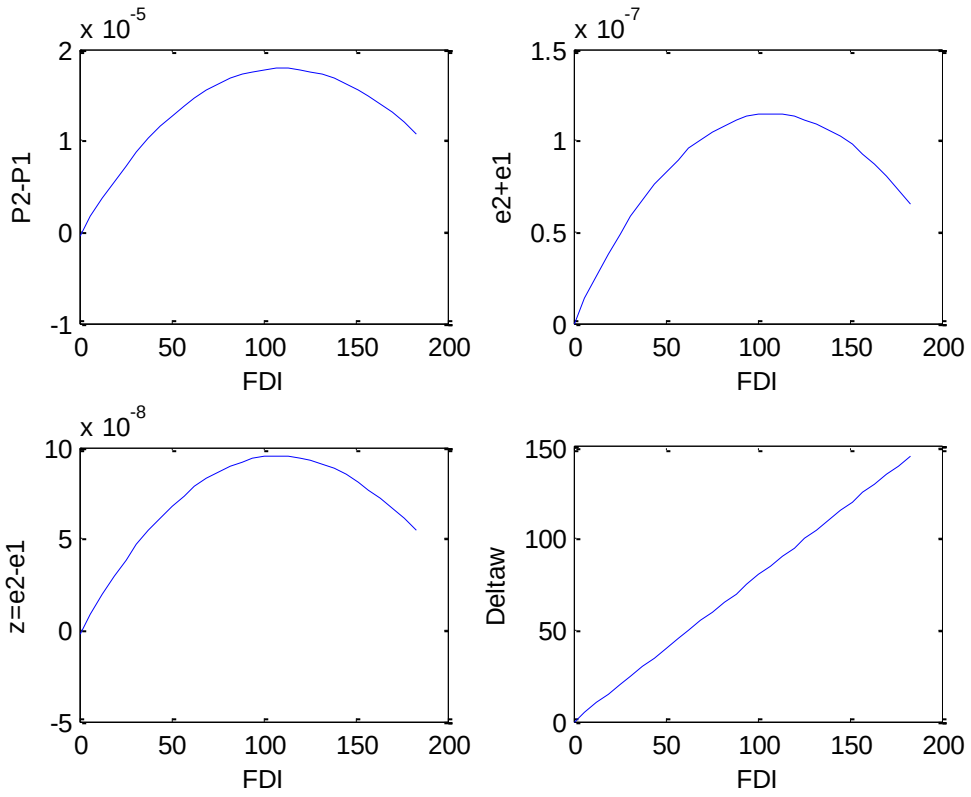
Higher wage gaps and FDI inflows are likely to induce additional training on the part of both high-ability and low-ability workers. However, the incentives are in principle stronger for the most capable people, given their extra units of effective labor, which translates into higher wages per hour worked. That is the reason why, as FDI starts to reach very significant values, the aggregate effective units of labor grow substantially and skilled workers increase their training effort at a faster rate.

But that situation will only last up to a certain point. When both FDI and the wage gap are quite high and MNCs hire a significant fraction of the population, skilled types will start to feel that the relative gains from additional effort are lower than their disutility. When they eventually decide to relax, everybody will also decide to do so, as we can observe in the panel that shows the aggregate effort levels. Under such circumstances, it makes sense for the government in the host country to wonder: "Should we really promote FDI so much, when that is (locally) reducing the educational achievement of our workers, and the MNCs will end up releasing many uneducated, unskilled employees for the rest of the economy?"

In other words, in terms of Figure 1 the government may wonder whether *FDI*=50 is better for the local economy than *FDI*=100, although in the latter case the wage gap is still higher (see the lower panel on the right).

What could the government do to enhance the exertion of educational effort, while allowing for more FDI? Interestingly, a good answer would be increasing the levels of corruption in the administration/educational system. If we raised the value of *a* from 830 to 835, lowering therefore the precision of the tests in the host country, then type-2´s would have to work harder to differentiate themselves, which would also push type-1´s,…as we can observe in figure 2. However, this process could not persist forever, since eventually an extremely corrupted system would completely abort any effort by both types. Finally, we would obtain again an optimal level of FDI in terms of educational effort; though such effort would be higher this time (compare the second panels on figures 1 and 2).

Figure 2 (a=835)



Just to conclude with the section, let us emphasize the following idea: if the single priority of the government were maximizing a weighted average of the local welfare levels in (3), then there would be no upper bound for the local FDI target.

Nevertheless, if the government anticipated future layoffs by the multinational and appreciated the adaptability and redeployment capacity of the workers, probably they could limit FDI to enhance the aggregate educational effort.

An instrument that seems to reconcile both criteria is a high corruption level in the educational sector, although that is particularly likely to be damaging in other respects.

3. DATA

We use data from the World Bank's World Development Indicators.[8] The data cover 167 countries, for the years 2000 and 2005. Based on the IMF country classification there are 28 developed and 139 developing countries in the data. Table TableMeans reports summary statistics of our main variables of interest, for the year 2005.

Table 1: Summary Statistics 2005

	All		Developed		Developing	
	Mean	Std. Error	Mean	Std. Error	Mean	Std. Error
Literacy rate	82.0	20.00	98.1	1.91	78.8	20.43
Schooling years	12.2	3.19	16.2	1.50	11.4	2.81
Secondary education	61.6	27.74	89.8	6.49	55.9	26.89
Tertiary education	27.7	24.9	61.9	17.32	20.8	20.13
FDI (Bill. USD)	10.2	31.99	36.3	64.72	5.07	16.04
FDI per capita (1000' USD)	0.730	1.4241	1.859	2.4399	0.506	0.9898
GDP (per capita)	8354.2	12527.32	31745	13235	3709.2	4835.14
Expenditure on education	15.2	5.11	12.9	3.16	15.7	5.31
Pupil-Teacher ratio	27.0	14.88	14.7	4.01	29.5	15.04
Mortality rate	35.7	33.38	4.2	1.11	42.0	33.15
Land (1000 sq. km)	740.2	1961.00	1072.9	268.58	674.2	1787.99
Observations	167		28		139	

Source: Authors' calculation, WDI data.

The variables secondary and tertiary education represent the gross enrollment ratio, which is the ratio of total enrollment regardless of age to the whole age group which officially corresponds to the relevant education level. These, as well as the literacy rate, are expressed in percentage points. For example, about 90% of the population aged 16-18 in developed countries are enrolled in some sort of high school.

FDI is the net flow of Foreign Direct Investment in billions of current USD. We also define FDI-PC which is FDI (in billions of USD) divided by the population (in millions); therefore, the FDI per capita, FDI-PC, is defined in thousands of current USD.

[8] <http://data.worldbank.org/data-catalog/world-development-indicators> accessed March/25/2011.

GDP per capita is also expressed in current USD. It is evident from the table that GDP per capita in developed countries is almost nine-fold that in developing countries. Mortality rate is expressed in percentage points; and it is worth noting that in developing countries this is ten times higher than in developed countries. Finally, Land is the country's total area excluding water bodies, i.e., lakes and major rivers. This is expressed in thousands of squared-Km.

4. ESTIMATION

One of the main testable hypotheses suggested by our theoretical analysis is that the increase in foreign direct investment in a country induces an increase in the human capital of the country, exemplified by higher participation rates in higher education, but at a decreasing rate. Eventually, exceeding some (high) level of FDI, this will start inducing a decline in schooling attainment. To test this hypothesis we run the following regression by OLS

$$HC_i = \alpha + \beta_1 FDI_i + \beta_2 FDI_i^2 + \gamma X_i + \varepsilon_i \qquad (10)$$

where HC_i , signifying human capital, is either the enrollment rate in tertiary education or the enrollment rate in secondary school in country i. We also consider the overall average years of schooling as a measure of human capital; this, however, is not the best measure of human capital because of its inability to distinguish between primary or advanced levels of schooling. Besides, we do not have previous (for the year 2000) levels of average schooling, which does not facilitate a comprehensive estimation of the relationship regarding this variable.[9] FDI_i represents the *per capita* FDI in country i, in thousands of USD. ε_i is the error term.

Other control variables are included in the vector X_i for country i . These control for macro variables in the economy, like GDP per capita, which is probably correlated with education outcomes as we expect richer countries to have more resources allocated to education; also they control for education input variables, like the log of public expenditure on education (per capita), the pupil-teacher ratio, the mortality rate, and a dummy variable which takes on the value 1 if country i is a developed country.

[9]This simply means that we will not be able to carry out the proxy-variable estimation for this variable as it will become clear shortly.

In the education literature, researchers generally include variables about education inputs. Two major measures of education inputs are the pupil-teacher ratio and the public expenditure on education. The pupil-teacher ratio is the number of pupils enrolled in primary school divided by the number of primary school teachers. The public expenditure on education is the government spending on educational institutions (private and public) and educational activities (administration, subsidies, students, etc...). As all these are believed to affect education outcomes in a country, it is necessary to control for them in the regression analyses in order not to confound their effect with that of the *FDI* levels in the country.

Mortality rate is included in the regression because it conveys some information about poverty (as mortality rate is higher in poorer countries), but also this may affect educational choices: educational attainment is an investment decision, the return of which depends on the life-span [see Egger et al. (2005), Checchi, De Simone, and Faini (2007)].

4.1 Endogenous *FDI*

Although we believe that changes in the levels of *FDI* in some country affect the levels of education in that country, it is also equally convincing that the current levels of education affect *FDI*. Foreign companies might be attracted to invest in countries with higher potential, exemplified by a more skilled (educated) labor force. There also exist theoretical models that confirm this intuition of reverse causality between *FDI* and human capital (see Hoffmann 2003). Therefore, *FDI* is suspected to be an endogenous variable in our main equation of interest. To show this, assume that

$$\varepsilon_i = z_i + \nu_i \qquad (11)$$

where ν_i is a white noise (homoskedastic, serially uncorrelated error term) that is independent of variables included in the model, particularly *FDI* and FDI^2. And z_i stands for possible variables that are omitted from the regression, because they are either not available or unobservable, that might be correlated with our variable of interest, namely *FDI*. If that is the case, then our OLS estimates of equation (10) will be biased and inconsistent.

To address this concern we use two different methods. First, to control for z_i, the unobservable variables in the error term that may be correlated with *FDI*, we include a proxy variable. This variable, if not exactly z_i, has to be related to it. We choose the lag of the dependent variable as a proxy variable in our analyses. For example, in the

case of tertiary enrollment, we include in the regression an additional variable which is tertiary enrollment in the year 2000, recalling that our analyses focus on the year 2005. The inclusion of such a variable controls for differences between the countries in our cross-sectional data that could not otherwise be captured by our included variables. The same idea applies for the other measure of human capital, secondary enrollment.

The second approach that we use is the instrumental variables approach (two stage least squares, 2SLS). The idea is to capture the part of *FDI* that is orthogonal to z_i, and measure its effect on the human capital measure. To do that, we use the overall population density, defined as the number of residents per one square kilometer, as an instrument for *FDI.* In our sample we find that the correlation coefficient between *FDI* per capita and population density is about 0.45, confirming its relevance here. On the other hand, it is not very likely that land area has an effect on the level of education in a country, or an effect on the individual choice of investment in education, lending support to the exclusion restriction, which simply means that the population density is not part of, or is not correlated with, the variables included in z_i. The use of a valid instrument allows us to estimate $\overline{FDI}$ (the predicted value of *FDI*) by running the following (first stage) regression by OLS:

$$FDI_i = \lambda_0 + \lambda_1 X_i + \lambda_2 Density_i + \omega_i \qquad (12)$$

where $Density_i$ is the population density in country *i*. We then use the predicted $\overline{FDI}$ in the main regression instead of *FDI* (the second stage).

One final point worth emphasizing is that we have in our main regression the variable FDI^2 also. If *FDI* is deemed endogenous as discussed above, then it follows that FDI^2 is also endogenous (being a function of an endogenous variable). One will be tempted to use $\overline{FDI}^2$ instead of FDI^2 in the second stage estimation. However, this is not correct, from a methodological view.[10] Therefore, to get an instrument for FDI^2 we use a nonlinear form of the variables included in the first stage, and calculate $\overline{FDI^2}$ as follows:

$$FDI_i^2 = \mu_0 + \mu_1 X_i + \mu_2 Density_i + \mu_3 \overline{FDI}^2 + \kappa_i \qquad (13)$$

[10]Actually, this approach is referred to as the forbidden regression, in the econometric literature. See Wooldridge (2002) for more details.

Where $\overline{FDI}^2$ is simply the square of the predicted values in regression (12). The regression in (13) will give us the predicted value of FDI^2, namely $\overline{FDI^2}$, which we will use instead of FDI^2 in our main regression.[11]

5. RESULTS

We carry out the analyses for three individual measures of schooling: secondary enrollment, tertiary enrollment, and average years of schooling; then we define a "general" measure of schooling based on a weighted combination of secondary and tertiary enrollment.

Table 2 shows the main results of our analyses for the secondary enrollment ratio. It shows results from the naive OLS estimation, the proxy-variable estimation, and the instrumental-variables estimation. The dependent variable in all regressions is the secondary enrollment ratio.

Table 2: The Effect of FDI on Secondary Enrollment

	OLS	Proxy	IV
FDI per capita	4.899^{**} (2.08)	3.492^{**} (2.07)	-1.600 (−.15)
(FDI per capita) ^{2}	$-.573^{**}$ (−2.13)	$-.492$ (−2.56)	0.037 (.03)
$\ln(GDP \text{ per capita})$	3.003^{*} (1.95)	0.192 (.17)	5.059 (1.49)
$\ln(\text{Public Expenditure})$	$-.777$ (−1.40)	$-.748^{*}$ (−1.88)	$-.237$ (−.25)
Pupil-Teacher Ratio	$-.512^{***}$ (−4.40)	$-.238^{***}$ (−2.75)	$-.513^{***}$ (−4.40)
Mortality Rate	$-.367^{***}$ (−5.80)	$-.185^{***}$ (−3.83)	$-.350^{***}$ (−5.17)
Developed Country	1.567 (.40)	-3.046 (−1.08)	0.867 (.20)
Secondary enrollment 2000		0.514^{***} (11.39)	
R^2	0.81	0.90	0.79
Observations	164	161	164

NOTE: t-statistics in parentheses. (*) is significant at the 10% level, (**) at the 5%, and (***) at the 1%. "Developed Country" is a dummy variable that takes on the value 1 if the country is developed and zero otherwise. See text for details.

[11]Note that, for symmetry, we use the same variables in the first stage of both *FDI* and FDI^2, namely, *X*, *Density*, and $\overline{FDI}^2$.

The first column reports the simple OLS regression of secondary enrollment against the relevant variables. It is evident from the table that GDP has a positive and significant effect on school enrollment. As expected, the pupil-teacher ratio and the mortality rate have a negative and very significant effect on school enrollment. The sign of the coefficient of public expenditures on education is counterintuitive, nonetheless it is not statistically different from zero in this regression.

The most interesting finding in this table is that *FDI* has the quadratic effect on secondary school enrollment, confirming our theoretical model. A positive β_1 and a negative β_2, point to the fact that the schooling-FDI relationship can be described by an inverted U-shape graph.

The second column is an OLS regression that uses a lagged dependent variable, namely secondary enrollment in 2000, as a proxy for the unobservable variables in the error term that affect current enrollment and maybe related to *FDI*. Results from this regression are similar to these from the OLS regression, and also confirm the inverted U-shape relationship between schooling and *FDI*.

The last column reports the two-stage-least-squares regression output for secondary enrollment. Although the expected, positive effect of GDP and negative effect of mortality rate and pupil-teacher ratio is once again confirmed, the *FDI* coefficients are not statistically significant anymore (and their signs are counterintuitive).

Table 3 reports the analog results for tertiary enrollment. All estimation results point to the important observation that an inverted-U shape captures the relationship between *FDI* and tertiary enrollment.

Table 3: The Effect of FDI on Tertiary Enrollment

	OLS	Proxy	IV
FDI per capita	3.940 (1.37)	2.027 (1.59)	34.527** (2.08)
(FDI per capita) ^{2}	−.448 (−1.38)	−.154 (−1.07)	−3.997** (−2.15)
$\ln(GDP \text{ per capita})$	4.506** (2.49)	.189 (.23)	−3.703 (−.73)
$\ln(\text{Public Expenditure})$	−3.172*** (−5.02)	−.239 (−.77)	−4.966*** (−3.86)
Pupil-Teacher Ratio	−.261* (−1.92)	−.050 (−.84)	−.259 (−1.47)
Mortality Rate	−.168** (−2.27)	−.018 (−.54)	−.223** (−2.21)
Developed Country	13.403*** (2.96)	−.448 (−.22)	19.196*** (2.92)
Tertiary enrollment 2000		1.100*** (24.70)	
R^2	0.68	0.94	0.42
Observations	164	156	164

NOTE: t-statistics in parentheses. (*) is significant at the 10% level, (**) at the 5%, and (***) at the 1%. "Developed Country" is a dummy variable that takes on the value 1 if the country is developed and zero otherwise. See text for details.

Other variables, excluding public expenditure on education, also receive coefficients with the right intuitive sign, and are statistically significant. The instrumental variables estimation results (column 3) are now very statistically significant with the right signs. Table 4 reports results for the case of average years of schooling. As discussed earlier, this variable is more problematic measure of human capital, and a significant relationship is not expected in this case.

Table 4: The Effect of FDI on Average Years of Schooling

	OLS	IV
FDI per capita	−.101 (−.33)	.900 (.63)
(FDI per capita) ^{2}	−.004 (−.10)	−.135 (−.86)
$\ln(GDP \text{ per capita})$	.572*** (2.82)	.322 (.71)
$\ln(\text{Public Expenditure})$	−.011 (−.15)	−.071 (−.57)
Pupil-Teacher Ratio	−.021 (−1.39)	−.020 (−1.31)
Mortality Rate	−.044*** (−5.22)	−.045*** (−5.01)
Developed Country	1.399*** (2.75)	1.683*** (2.87)
R^2	0.75	0.73
Observations	164	164

NOTE: t-statistics in parentheses. (*) is significant at the 10% level, (**) at the 5%, and (***) at the 1%. "Developed Country" is a dummy variable that takes on the value 1 if the country is developed and zero otherwise. See text for details.

Both OLS and IV estimates of the effect of *FDI* on the average years of schooling are not statistically significant, although the sign of the IV estimates is in line of our previous results. Also, as mentioned earlier, since we do not have the lagged value of schooling (in 2000) we could not carry out a proxy variable estimation for this variable.

5.1 A General Measure of Schooling

In this section we define a general measure of schooling, equivalent in nature to the average years of schooling used earlier, but is different in the sense that it gives higher weight to tertiary education—in line with our theoretical predictions. In particular, we define the general schooling measure *GS*, as the follows:

$$GS = \%Secondary \times 12 + \%Tertiary \times (12 + 3 \times 1.13)$$

This measure translates high-school into 12 years of schooling, and tertiary education into 15.39 years of schooling. The idea here is to capture the increased gain in

productivity associated with higher education.

We then use this measure of schooling to estimate the effect of *FDI* using similar functional forms as were used in previous sections. Main results are summarized in Table 5.

Table 5: The Effect of FDI on Schooling, a General Measure of Schooling

	OLS	Proxy	IV
FDI per capita	0.969^{*} (1.63)	0.656^{*} (1.94)	5.253^{*} (1.75)
(FDI per capita) ^{2}	$-.115^{*}$ (–1.72)	-0.085^{**} (–2.23)	-0.620^{*} (–1.84)
$\ln(GDP \text{ per capita})$	1.037^{***} (2.80)	0.042 (0.19)	-0.080 (–0.09)
$\ln(\text{Public Expenditure})$	-0.650^{***} (–4.88)	-0.209^{**} (–2.50)	-0.890^{***} (–3.86)
Pupil-Teacher Ratio	-0.106^{***} (–3.79)	-0.028^{*} (–1.73)	-0.105^{***} (–3.28)
Mortality Rate	-0.070^{***} (–4.64)	-0.018^{**} (–2.01)	-0.078^{***} (–4.29)
Developed Country	2.315^{**} (2.49)	-0.143 (–0.26)	3.100^{***} (2.65)
SCL2000		0.807^{***} (17.84)	
R^2	0.81	0.94	0.74
Observations	162	153	162

NOTE: t-statistics in parentheses. (*) is significant at the 10% level, (**) at the 5%, and (***) at the 1%. "Developed Country" is a dummy variable that takes on the value 1 if the country is developed and zero otherwise. The dependent variable is *GS*—a general measure of schooling based on a linear combination of tertiary and secondary education. See text for details.

The table reveals significant and consistent estimates of the FDI-schooling relationships. The positive coefficient of FDI and the negative coefficient of FDI-squared, valid and significant under all three estimation methods, confirm the inverted-U shape of the education-FDI found so far. A relationship of this shape allows us to calculate an "optimal level" of *FDI* at which the human capital in the country, summarized by this general measure of schooling (*GS*), is maximized. We carry out this exercise in the following section.

5.2 Optimal FDI

Given that the relationship between human capital and *FDI* is described by the following quadratic equation:

$$HC = \alpha + \hat{\beta}_1 FDI + \hat{\beta}_2 FDI^2 + \hat{\gamma} X$$

it is possible to find the optimal *FDI*, that is, the level of *FDI* at which the human capital (i.e., schooling) is maximized.[12] The maximum *HC* is attained at FDI^* which satisfies:

$$FDI^* = \frac{-\hat{\beta}_1}{2\hat{\beta}_2}$$

Using our general measure of schooling, and substituting our significant estimates of $\hat{\beta}_1$ and $\hat{\beta}_2$ from Table 5 in the above equation, we find optimal FDI^* levels under each scenario. Strikingly, despite the different methods employed, our analyses seem to point to an optimal *FDI* level around 4 (thousand USD per capita). In particular, using OLS estimation, the optimal *FDI* is found to be 4.21; using proxy-variables estimation, the optimal *FDI* is 3.86; and using instrumental variables estimation, the optimal *FDI* is 4.24.[13]

Our data reveal a striking fact. It is that many countries cluster at much lower levels of *FDI* per capita than the optimal calculated levels. Moreover, these lower *FDI* levels are associated with lower education levels. Specifically, calculating the simple average human-capital variables, for countries with *FDI* per capita above and below *any arbitrary* level, shows that high-FDI countries attain much higher schooling levels than low-FDI countries. For example, we choose a cutoff point of *FDI=2,* and report our findings in Table 6 below.

Table 6: Average Human Capital, by FDI Levels

[12] In particular, we know the critical point found is a maximum and not a minimum given that the coefficient of *FDI* is positive and the coefficient of FDI^2 is negative, rendering a concave function of schooling with respect to *FDI*.

[13] One can do this exercise for the other measures of human capital, say tertiary education, to find that optimal *FDI* levels are similar to the above reported estimates, and generally hover around 4.3.

	Low *FDI*		High *FDI*	
	Mean	Std. Deviation	Mean	Std. Deviation
Secondary Enrollment (%)	58.8	27.86	84.2	9.00
Tertiary Enrollment (%)	26.1	24.75	45.9	23.13
Average Schooling Years	12.0	3.21	14.5	2.50
General Measure, *GS*	11.1	6.71	16.9	4.20

NOTE: Low-*FDI* defines countries (150-151) for whom the *FDI* per capita is below 2 (i.e., 2000 USD), and High-*FDI* defines (12-13) countries above that level. The 'general measure' is a weighted average of schooling based on high-school and college enrollment rates; see text for details.

Table 6 draws a clear fact: countries with high (above $2,000 per capita) *FDI* attain higher levels of schooling under any and every measure of human capital used. On the one hand, this proves the existence of the optimal *FDI* point, at least in regards to human capital in the host country. On the other hand, however, this may point to the possibility that many countries are caught with a low-human-capital-trap, where the *FDI* level is not sufficiently large to mobilize them to the maximum potential human capital.

6. CONCLUDING REMARKS

As a conclusion, we should emphasize the concave, inverted-U shape of the relation between FDI per capita and human-capital formation. This relationship is clearer in the case of tertiary education, which may reveal that FDI tends to be skill-biased and raise inequality in most LDCs. There is also a clustering of many countries around a lower-than-optimal level of FDI. We conjecture that some of these countries may be affected by a low-human-capital trap, as suggested by some of our simulations. Proving the effective existence (or inexistence) of those traps is an interesting avenue for future research.

7. APPENDIX

Countries included in our samples are:

Afghanistan, Albania, Algeria, Angola, Antigua and Barbuda, Argentina, Armenia, Aruba, Australia, Austria, Azerbaijan, The Bahamas, Bahrain, Bangladesh, Barbados, Belarus, Belgium, Belize, Benin, Bhutan, Bolivia, Bosnia and Herzegovina, Botswana, Brazil, Brunei Darussalam, Bulgaria, Burkina Faso, Burundi, Cambodia, Canada, Cape Verde, Central African Republic, Chad, Chile, China, Colombia, Comoros, Dem. Rep. of Congo, Congo Rep., Costa Rica, Cote d'Ivoire, Croatia, Cyprus, Czech Republic, Denmark, Djibouti, Dominica, Dominican Republic, Ecuador, Egypt, El Salvador, Estonia, Ethiopia, Fiji, France, Gabon, The Gambia, Georgia, Germany, Ghana, Greece, Grenada, Guatemala, Guinea, Guinea-Bissau, Guyana, Haiti, Honduras, Hong Kong (SAR China), Hungary, Iceland, India, Indonesia, Islamic Rep. of Iran, Iraq, Israel, Italy, Jamaica, Japan, Jordan, Kazakhstan, Kenya, Kiribati, Rep. of Korea, Kyrgyz Republic, Lao P.D.R., Latvia, Lebanon, Lesotho, Liberia, Libya, Lithuania, Macao SAR, Macedonia FYR, Madagascar, Malawi, Malaysia, Maldives, Mali, Malta, Mauritania, Mauritius, Mexico, Moldova, Mongolia, Morocco, Mozambique, Myanmar, Namibia, Nepal, Netherlands Antilles, The Netherlands, New Zealand, Nicaragua, Niger, Nigeria, Norway, Oman, Pakistan, Panama, Paraguay, Peru, Philippines, Poland, Portugal, Romania, Russian Federation, Rwanda, Samoa, Sao, Tome and Principe, Saudi Arabia, Senegal, Serbia, Seychelles, Sierra Leone, Slovak Republic, Slovenia, Solomon Islands, Spain, Sri Lanka, St. Kitts and Nevis, St. Lucia, St. Vincent and the Grenadines, Sudan, Swaziland, Sweden, Switzerland, Syrian Arab Republic, Tajikistan, Tanzania, Thailand, Togo, Tonga, Trinidad and Tobago, Tunisia, Turkey, Turkmenistan, Uganda, Ukraine, United Kingdom, United States, Uruguay, Uzbekistan, Vanuatu, R.B. de Venezuela, West Bank and Gaza, Rep. of Yemen, Zambia, Zimbabwe.

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