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Higher education and economic development: can public funding restrain the returns from tertiary education?

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Abstract

This paper examines whether the contribution of tertiary education to economic growth and income per capita depends on the structure of public education budgets. The analysis resorts to a panel of 41 countries over the period 1970-2010. The empirical approach is based on system GMM regressions and Hierarchical Linear Models, which allow dealing with endogeneity concerns and parameter heterogeneity. The estimates show that budget imbalances against basic schooling seem to undermine the achievement of productivity gains from higher education.

Keywords: tertiary education, public spending, economic growth, income per capita

JEL Codes: H52, I25, I26, O40, O50

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Introduction

A wide literature emphasizes the positive effects of human capital accumulation on income per capita and economic growth (Aghion and Howitt, 1998; Benhabib and Spiegel, 2005; Nelson and Phelps, 1966; Romer, 1990). The mechanism works either directly because the skilled labour force innovates and facilitates technology adoption or indirectly because it is an essential input into a research sector which generates new knowledge. In this framework, the role of higher education can hardly be disputed.

Today, the main channels of knowledge creation, absorption and dissemination crucial to obtain positive economic results are associated to skills acquired through tertiary education. At first sight, these effects would bring out good reasons for its public funding. However, how much governments should spend on upper education levels has been subject to a lively debate (Oketch, 2016).

One of the main issues in the debate on tertiary public funding stems from the divergence between individual and macroeconomic gains from higher schooling. While microeconomic returns from human capital accumulation have been widely documented (Psacharopoulos 1994; Psacharopoulos and Patrinos 2004), its effect on aggregate income has produced mixed evidence. Indeed, the studies focused on the productivity impacts of tertiary education are not unanimous about its positive results (Wolff, 2001; Canton, 2007; Bloom et al., 2013; Pereira and St. Aubynb, 2009; Holmes, 2013).[1] Among them, some find growth effects limited to the technologically advanced economies (Papageoriou, 2003; Self and Grabowski, 2004; Keller, 2006). This result has been associated to their proximity to the technological frontier (Vandenbussche et al., 2006; Aghion et al., 2009). However, Gyimah-Brempong et al. (2006) or Castelló and Mudrokaphy (2013) show that higher education is also relevant in less developed economies. Moreover, Ang et al. (2011) and Hanushek (2013) provide evidence about a positive effect in middle income countries, further from the technological frontier.

Another strand of literature has underlined the distributive implications of a completely tax-based funded tertiary system. The elitist bias in access to higher education combined with the private benefits it yields would make of these public investments a regressive mechanism which reinforces extant inequalities (Datt and Ravallion, 2002; Lindert, 2009). The situation gets worse in the presence of a tertiary tilt in education budgets as observed for developing countries (Lindert, 2009; Frankema, 2010). Whenever the limited fiscal resources favor higher education, government would be strengthening the advantages of the wealthiest families at the

[1] Sianesi and van Reenen (2003) and Kimeny (2011) provide a detailed revision of the literature.

expense of mass education with important consequences for poverty fighting (Datt and Ravallion, 2002) and income inequality (Birdsall et al., 1997; Gruber and Kosak, 2014).

Interestingly, scholars have not paid much attention to the role of the education budget composition. This paper points out that, beyond total amounts, an important policy issue lays in the distribution of public funds between education levels. It argues that how much countries tilt their public resources on tertiary students at the expense of basic levels might undermine the macroeconomic returns from higher education. The rationale behind the proposition hinges upon the links between education budgets, human capital distribution and labour market results. If growth is to be sustained, not only the fraction of those higher educated but the whole labour force should be prepared to deal with the new or more efficient production methods (Jones, 2011, 2014). A low funding at mass education stages may harm the knowledge acquisition and accumulation of students entering the following education stages. Moreover, it may affect the ability of the low skilled segment of labour force to develop productive skills and/or rapidly adopting cutting-edge technologies. As a result, the productivity effect of a relatively low budget allocation to early ages might not be made up for by more tertiary spending.

The empirical approach builds on a panel of 22 high-income and 19 upper middle-income countries (HICs and UMICs, respectively) at 5-year intervals from 1970 to 2010. The sample comprises countries which have largely surpassed minimum education standards: their education attainments are among the world highest (Barro and Lee, 2013). However, they differ in their capacities of technology generation and application, which might influence the relationship between skills and growth and income per capita.

The estimations follow system GMM regressions and Hierarchical Linear Models (HLM). They allow dealing with different methodological issues. System GMM tackles endogeneity concerns, while the HLMs also take into account parameter heterogeneity in cross-country regressions by modeling tertiary tilts as a persisting country feature.

The econometric results provide new evidence on the relevance of tertiary education in HICs and UMICs and on the growth-enhancing impacts of the education resource structure. Particularly, we find that the average macroeconomic gains from higher education decreases as the tertiary tilts in public education spending are higher. Therefore, beyond the non-negligible budget constraints, the composition of public education outlays becomes an important issue. The results are robust to the inclusion of several controls. Among them, the role of students at science and technological fields is particularly significant.

The remainder of the paper is organized as follows. Section 2 presents the data and Section 3 describes the empirical methodology. Section 4 shows the results as well as some robustness checks and Section 5 concludes.

2. Data and sources

The analysis is based on measures of GDP per capita, tertiary education attainment and public education spending for 41 countries, including 22 HICs and 19 UMICs from Latin America (LACs) and Asia (Table A.1 in the Appendix). The classification follows the World Bank with modifications, because some countries which are contemporaneously taken as HICs have not been under this category during most of the period (such the cases of Chile, South Korea, Poland or Turkey).

The stock of higher educated people is measured as the share of those aged 25 or more with tertiary education as highest attainment. The age group aims to account for people actively participating in the labour force. The information comes from Barro and Lee (2013), who compile data at 5-year intervals. This implies that the empirical estimations in the present study are also restricted to 5-year spans. The tertiary skill level includes people who have been trained at universities, teacher's colleges and higher professional schools, either if they completed the level or not. It provides a better picture than the measure "years of tertiary education" as it is not affected by the fraction of illiterates (Castelló and Mukhopadhyay, 2013).[2]

Cross-country data on public education spending by level has been assembled from several sources: ECLAC (ECLAC.stats), IMF, OECD (OECD.stats), UNESCO (UNESCO Institute of Statistics-UIS) and World Bank (World Development Indicators-WDI), together with statistical information from each particular country. Enrolment data from the same institutions allowed computing spending per student at the different education levels. For the case of tertiary education, UNESCO and WDI provide information for the whole system (private and public), so the fraction of students at public institutions has been obtained from country-information at UNESCO Yearbooks, as well as secondary literature at the country level.

The "tertiary tilt" stands for the relative concentration of educational resources at the tertiary level. Following Gruber and Kosak (2014), it is computed as the ratio of tertiary over pre-primary and primary public spending per student. The figures are expressed as a share of GDP per capita to better represent the cost per student relative to the standard living in each country. The variable is taken in logarithms to minimize the impact of countries with very high

[2]Average years of tertiary education will also be used to check the robustness of the estimates.

tilts (Gruber and Kosak, 2014: 257). Secondary education has not been considered in order to emphasize the unbalanced distribution of resources between two extremes: one totally compulsory and the other totally non-mandatory. It must be noted that while the fraction of tertiary educated people does not distinguish if they have been qualified at private or public institutions, the main hypothesis of the analysis is related to the effect of public budgets. The apparent discrepancy is alleviated by the weight of the public sub-system and its spill-over effects on the whole educational system. Among the countries in the sample, public enrolment has been more than 80% for the primary, secondary and tertiary levels, respectively, during most of the period (UIS-UNESCO). Moreover, the level of public schooling investment is likely to shape the social demand for higher education, no matter if it is later realized at the private or public sub-systems.

Table 1 shows that the skill composition in UMICs by the end of the period almost resembles the one prevailing in HICs at its onset. Despite this disparity, both country groups have seen an increasing relevance of tertiary education attainments compared to the records for the secondary level. The change has been particularly accelerated for UMICs, where the share of tertiary education has grown 307% to reach 14% of the population. Consider that for developing countries as a whole, in 2010 this share still stays below 10% (Barro and Lee, 2013). In contrast, the drop in the fraction of people with just primary education has been far more dynamic for the HICs, where people equipped with the most basic skills are half than in UMICs (40.24% vs 19.93%, respectively).

Hence, the stronger presence of high skilled people at HICs and UMICs can be expected to have a role to speed up productivity gains in both country-groups, independently of their position at the processes of international innovation, technology generation or adaptation. Still, the strategy at UMICs seems to have been more tied to widen tertiary education access than to raise the average education level by also broadening the acquisition of basic skills.

Table 1. Education level by period and country-group

Countries	Level of education (% share over pop. aged 25+)		
	Primary(*)	Secondary(*)	Tertiary(*)
	Whole period		
All countries	42.3	33.1	13.1
HICs	37.1	40.4	16.6
UMICs	48.7	24.6	8.7
	1970s		
All countries	52.9	23.7	6.7
HICs	47.2	35.2	11.7
UMICs	53.9	14.4	3.5
	2000s		
All countries	30.3	41.8	19.9
HICs	19.9	48.5	26.7
UMICs	40.2	34.9	14.2
	% change 1970s-2000s		
All countries	-42.7	75.9	200.1
HICs	-57.7	37.6	123.6
UMICs	-25.4	143.2	306.9

Note: (*) highest level attained. The share of people with no school is not included.
Source: own computation based on Barro and Lee (2013).

Table 2 contains public education spending and GDP per capita figures. Data on income per capita at constant PPP dollars are drawn from the Penn World Tables-PWT, 8.0 (Feenstra et al., 2013). Measured as share of GDP per capita, per pupil primary education spending in HICs has been 20% while the ratio for the tertiary level has reached 64%. The gap is wider in UMICs: the percentages have been, respectively, 11% and 85%. However, distances have narrowed during the period in both country groups as a result of the shrinkage in the resource concentration at the upper tail of the spending distribution.

Table 2. GDP per capita and public education spending per student

Countries	GDP pc (US PPP)	Public education spending per student (% GDP per capita, by level)			Tertiary tilt (ln)
		Primary	Secondary	Tertiary	
	Wholeperiod				
Allcountries	14,956	15.5	27.3	73.8	1.4
HICs	21,883	19.4	33.2	64.1	1.1
UMICs	7,443	10.9	20.1	85.3	1.8
	1970s				
Allcountries	9,677	14.2	29.9	98.1	1.8
HICs	14,968	17.9	33.6	83.9	1.4
UMICs	5,343	9.2	24.7	114.1	2.2
	2000s				
Allcountries	21,911	16.5	29.1	54.4	1.1
HICs	33,257	18.8	36.7	53.4	0.9
UMICs	11,228	12.7	19.1	54.8	1.3

Source: own computation based on Barro and Lee (2013); IMF; ECLAC; UNESCO Yearbooks; UIS; WDI.

It is remarkable that the primary education outlay as a share of GDP has virtually remained the same in HICs, while by the end of the period UMICs are still far from that benchmark. This relative underinvestment becomes more significant considering that primary education is the highest education attainment for 40% of people at UMICs (Table 1). The last column in Table 2 shows that the tertiary tilt has decreased over time, though the gaps between country groups remain. Accordingly, this bias in public investment could be a good indicator of persisting trends at the country-level.

A set of covariates are used to control for omitted variable biases when estimating the role of budget tertiary tilts in the relationship between GDP per capita and tertiary education. The percentage of areas in the tropics accounts for the geographical location, as warm and humid climates near the equator have been negatively associated to income per capita (Sachs and Warner, 1997). The variable is taken from the Center for International Development (CID). A measure of voting turnout controls for the effect of democracy, under the assumption that well-functioning political and legal institutions help to sustain economic performance (Barro and Sala-i-Martin, 2004).[3] The negative growth impact of the size of government, deemed to distort private decisions (Barro, 1991), is captured by an index which ranges from 0 to 10 (large and small government, respectively). Both indicators are provided by the Quality of Government Database (Teorell et al., 2015). The share of people aged 25- 64 over total population aims to capture the size of the active labour force. It has been taken from the WDI.

Data on domestic investment rate, stock of capital and trade openness (ratio of exports plus imports over GDP) which might also shape economic performance are drawn from PWT-8.0. Finally, we use information about the fraction of people trained at tertiary scientific and technological (ST) fields (e.g. mathematics, statistics, computing, physics and other life sciences) collected from several UNESCO Yearbooks and the UIS-database. The variable is chosen because of its correlation to productivity growth when compared to other majors (Murphy et al., 1991; Cantoni and Yachtman, 2012). According to the series, the share of S&T students for the country-sample has been on average 9% of the total and has only expanded in UMICs. By contrast, social sciences have gathered more than 1/3 of tertiary students and humanities and education more than 20%. A caution is required because the lack of reliable information about the share of engineering students in LACs at the beginning of the period has precluded its consideration in the analysis. This limits the scope of the effect being captured. A summary of the descriptive statistics for all variables is presented in Table A.2.

[3] Under non democratic rules, the degree of participation drops to 0.

3. Methodological approach

3.1. Empirical models

This paper aims to assess whether the varying levels of the tertiary tilt in government education spending alter the contribution of high skilled human capital to economic growth and income per capita. Two different approaches are used to test this proposition. The first one is based on a standard "level growth" model, following Barro (1991) and Mankiw et al. (1992):

$$g_{it} = \beta_0 + \beta_1 \ln y_{i0} + \beta_2 share\ tertiary\ educated_{it-1} + \beta_3\ tertiary\ tilt_{it} + \\ + \beta_4 s.terteduc_{it}\ x\ \ tert.tilt_{it} + \ \delta\ Z_{it} + c_i + t_t + \mu_{it} \quad (1)$$

where g_{it} is the growth rate of real GDP per capita for country *i* in period *t*; $\ln y_{i0}$ is the initial level of real GDP per capita (accounting for the convergence property); Z_{it} is a vector with factors other than tertiary education affecting growth; c_i captures country time-invariant fixed effects; *t* denotes time effects and μ_{it} is a stochastic term, normally distributed.

This specification allows exploring if countries grow faster as a larger fraction of its population attains tertiary education and how much this effect changes depending on the tertiary tilt. The hypothesis is that β_4 (the coefficient of the interaction term) is negative, implying that the net contribution of the higher skilled human capital to economic growth gets reduced as tertiary tilts are higher.

The second approach explores the role of tertiary education on income per capita by adjusting a "meta-production function". This specification assumes that all countries are part of a common underlying production function, so that they have potential access to the same technology, but may produce on different parts of it depending on particular country features (Hayami and Ruttan, 1970; Boskin and Lau, 2000). From an empirical perspective, the assumption has two advantages: first, it justifies the estimation by pooling data from different economies. Second, it allows considering country-specific coefficients for certain equation parameters (Lau and Yotopoulos, 1989). In this way, the formulation recognizes that the impact of education (as well as of other relevant variables) is not homogenous across countries. The expression takes the following form:

$$lny_{it} = \beta_{oi} + \beta_{1i} stertiary_{it} + \beta_{2i} time + \beta_3 lnk_{it} + \beta_4 lnworkingpop_{it} + \varepsilon_{it} \quad (2)$$

where lny_{it} is the logarithm of the real GDP per capita in country *i* at time *t*; *time* is a trend that takes the difference between the current and the initial time period; lnk_{it} is physical capital per capita(in logarithms); *lnworkingpop* stands for the share of population between 25 and 64 years (in logarithms) and ε_{it} is the unexplained residual error, unique for each country-time observation and normally distributed. $\beta_{0i,}\beta_{1i}, \beta_{2i}$ are country-varying coefficients.

This model assumes that only the most productive or skilled labour endowment enters the production function ($stertiary$). The variable is not taken in logarithms to reflect the exponential contribution of schooling to the production function (Krueger and Lindhal, 2001). The coefficients of capital stock and labour force are the common link among the aggregate production functions of individual countries.

Under this setting, the hypothesis to be tested is the presence of a significant cross-country variation in the effect of higher educated people on GDP per capita which partly depends on the country-level tertiary tilts. A similar reasoning leads to exploring the effect of the tertiary tilt on the output level (through its effect on the intercept, β_{oi}) and on the rate of technical progress (β_{2i}), as in Jamison et al. (2003, 2007). Together with equation 2, these relationships are modeled as "random coefficient" models of the following form:

$$\beta_{0i} = \gamma_{00} + \gamma_{01}Z_i + \gamma_{02}tertiarytilt_i + v_{0i} \quad (2.1)$$

$$\beta_{1i} = \gamma_{10} + \gamma_{11}tertiarytilt_i + v_{1i} \quad (2.2)$$

$$\beta_{2i} = \gamma_{20} + \gamma_{21}tertiarytilt_i + v_{2i} \quad (2.3)$$

where $\beta_{0i,}\beta_{1i}, \beta_{2i}$ are used at outcome variables; $\gamma$are regression coefficients associated to country-specific determinants (intercepts, Z_i and $tertiarytilt_i$) and $v_{0i}v_{1i}v_{2i}$ are other country-specific (random) effects which account for the unmeasured heterogeneity among countries and represent a country's deviation from the "mean" effect (Skrondal and Rabe-Hesketh, 2004). They are assumed to be normally distributed with mean zero, estimable variance and uncorrelated with ε_{it}.

3.2 Estimation strategy

One important methodological issue for estimations is potential endogeneity. Beyond the set of controls, an omitted variable bias might still appear if cultural, historical or institutional conditions favourable to economic growth (or a higher income per capita) which also promote higher education attainments are not properly captured. In this case, the relation would not reflect causality but other features of the economy that are growth enhancing. Similarly, a reverse causality issue arises if economic growth increases returns to education leading agents to invest more in tertiary education or countries to expand public resources and improve schooling attainment (Castelló and Hidalgo, 2012; Jamison et al., 2007). The empirical strategy must introduce alternatives to alleviate these biases.

In model (1), the dynamic specification for panel data resorts to System GMM estimations (Blundell and Bond, 1998).[4] They account for endogeneity and deals with plausible panel unobserved heterogeneity by using the sample moments of each variable as instruments. Bond et al. (2001) show that this is the preferred approach for estimating dynamic growth models as it provides more efficient estimates than traditional IV estimators. The method has been devised for a sample where *i* is large relative to *t,* as it is the case in the present analysis.
System GMM estimates simultaneously two equations: one in first differences and one in levels, using the lags of the endogenous and predetermined variables as instruments.[5] Accordingly, the present specification treats the share of tertiary educated as the endogenous variable. The tertiary tilt and its interaction with tertiary educated are taken as predetermined. The same treatment is given to the logarithm of initial income per capita, trade openness and the investment ratio. All these variables are taken at the beginning of each of the 5-year period both to reflect their delayed influence and to further alleviate endogeneity concerns. Geographical location, size of government, political participation and working-age population are taken as exogenous and calculated as 5-year averages.

In order to avoid instrument proliferation which biases the estimates, the number of lags has been set at 3 (i.e. up to 3 lags for the difference equation and first difference dated "t"- without lags- for the level equation) and the matrix of instruments collapsed (Roodman, 2009). The regressions consider a small sample correction and a Windmeijer (2005) finite-sample correction to produce unbiased standard errors. The output tables report the Hansen and the ''Difference-in-Hansen'' tests: the first examines whether all instruments are uncorrelated with residuals while the second tests the exogeneity of a subset of instruments. The results also include a test of the absence of second order serial correlation in the error term.

The "meta production function" of model (2) is estimated by Hierarchical Linear Modeling (HLM). The hierarchical structure organizes panel data taking time-varying variables as "level 1" units nested within clusters corresponding to each country ("level 2" units) (Bartels, 2008). In this study the interest lies in evaluating if the relationship between the share of higher educated people and GPD per capita (level 1 units) varies substantially from country to

[4]Note that the dynamic characteristic in model (1) is given by the computation of the dependent variable (average growth rate) as (ln y_{it}- $\ln y_{it-T}$ /*T*) while $\ln y_{it-T}$is one of the explanatory variables at the right hand side of the expression (in this paper *T*= 5-time periods).

[5]Predetermined variables are those not strictly exogenous in the sense that they might be potentially correlated to the lagged values of the structural error (Hayashi, 2005).

country depending on the tertiary tilt and other unobserved factors (both defined as country-varying units).[6] This sort of specification describes a "random coefficient" model shown in equation (3). It is based on the substitution of equations 2.1 and 2.2 into equation (2):

$$lny_{it} = \gamma_{00} + \gamma_{01}Z_i + \gamma_{02}tertiarytilt_i + \gamma_{10}stertiary_{it} + \gamma_{11}(tertiarytilt_i * stertiary_{it}) + $$
$$+\beta_{2i}time + \beta_3 lnk_{it} + \beta_4 lnworkingagepop_{it} + v_{0i} + v_{1i}(stertiary_{it}) + \varepsilon_{it} \quad (3)$$

Instead of treating unmeasured between-country differences as fixed (like in fixed effects models), this formulation includes specific factors accounting for cross-country differences (Z_i and $tertiarytilt_i$) and split the remaining unmeasured heterogeneity into within and between-country errors (εit and $v_{0i}v_{1i}$, respectively). The coefficient of the interaction term(γ_{11}) captures the "causal" heterogeneity variation that is, how the relationship between GDP per capita and tertiary education varies across countries depending on their tertiary tilt (measured at the country level). The same effect can be estimated to assess the effect of the tertiary tilt on the rate of technical progress.

The HLMs are estimated by Maximum Likelihood. The random intercepts and random slopes are predicted by an empirical Bayesian method which provides the "best linear unbiased predictors". Though the method does not directly give a measure of the random effects, it does compute its standard deviations or variances (V(v_{0i})= τ_{00}; V(v_{1i})= τ_{11}; V(v_{2i})=τ_{22}). Whenever these are significantly different from zero, there are factors specific to each country that affect the dependent variable, part of which can potentially be explained.

In order to alleviate any endogeneity bias, the share of tertiary educated and the physical capital are taken with a 10-year lag. The income per capita and the share of working age population are taken as 5 year-averages. The Akaike and Bayesian criteria (AIC or BIC) as well as the Deviance (-2 x log likelihood) are applied to compare the model fit. The smaller results the better the model. Finally, a correction is used to obtain errors robust to heteroskedasticity.

4. Results

4.1. Baseline estimates

Table 3 presents the system GMM estimates of the level-growth model. Columns 1-5 contain a simplified version of equation 1, without interactions. In Columns 2-5, the regressions add alternatively different measures of public expenditure as covariates (total education spending over GDP, tertiary education spending per student, this variable together with primary education spending per student and the ratio between these variables summarized in the

[6]In the present panel, as N=41 and T= 8 five-year periods, there are 328 measurement occasions (level 1 units) nested within 41 countries (level 2 units).

"tertiary tilt"). The results show that there is a positive and significant growth impact of the share of tertiary educated people. Besides, the coefficient increases its statistical significance when controls for education spending are included.

In Column 6 the share of tertiary educated is allowed to depend on the tertiary tilt. Both, the higher education term and its interaction with the tertiary tilt have opposite signs and are statistically significant. This implies that the higher the tertiary tilt (that is, the relative concentration of educational resources at the tertiary level), the lower the contribution of the tertiary educated people to GDP growth. Finally, Column 7 includes the fraction of S&T tertiary students over total. Its coefficient shows a positive and significant effect on economic growth, beyond the direct contribution of the share of tertiary educated. Note that the coefficient denotes the impact of students enrolled at S&T in relation to those belonging to any other field of knowledge. In this specification, the main explanatory variables from Column 6 retain the statistical significance and sign.[7]

Over the period, the average tertiary tilt in UMICs and HICs has been, respectively, 1.8 and 1.1 (Table 2). Taking the coefficients of Column 7 for an average tertiary tilt as high as in UMICs, the impact of tertiary education on economic growth would be 60% of that obtained when the computation takes the value at HICs (the sums of the interaction term and the coefficient for tertiary educated equal 0.14 and 0.24, respectively). Therefore, the extent up to which the countries tilt their public resources on tertiary students at the expense of primary education seems to lead to a considerable variation in the economic returns from higher education.

[7] The fraction of S&T has also been interacted with the impact of the total share of tertiary educated, but the results are not conclusive.

Table 3. Tertiary education and tertiary tilt as determinants of per capita GDP growth

Dep. Var. g_{it}	(1)	(2)	(3)	(4)	(5)	(6)	(7)
s.tertiary$_{t-1}$	0.141*	0.103**	0.146**	0.137**	0.160**	0.269***	0.384***
	(0.076)	(0.039)	(0.068)	(0.066)	(0.061)	(0.077)	(0.132)
public educ. spending/GPD$_{t-1}$		0.001*					
(US$ PPP)		(0.000)					
tertiary public educ. spending			0.003	0.011*			
per student/GDPpc (%)			(0.008)	(0.006)			
primary public educ. spending				-0.067			
per student/GDPpc(%)				(0.081)			
tertilt$_{t-1}$ (logs)					0.013	0.018*	0.029***
					(0.009)	(0.009)	(0.007)
s.tertiary$_{t-1}$ xtertilt$_{t-1}$						-0.109**	-0.135***
						(0.041)	(0.038)
S&T students/total$_t$							0.233***
							(0.052)
ln y $_{i,\,t-1}$	-0.103***	-0.080***	-0.097***	-0.095***	-0.122***	-0.107***	-0.100***
	(0.023)	(0.020)	(0.035)	(0.019)	(0.023)	(0.017)	(0.015)
investment ratio$_{t-1}$	0.162*	0.175**	0.214***	0.228***	0.201***	0.154**	0.241***
	(0.085)	(0.070)	(0.070)	(0.077)	(0.069)	(0.057)	(0.072)
trade openness$_{t-1}$	0.036***	0.029**	0.026*	0.032***	0.022*	0.028***	0.012
	(0.013)	(0.014)	(0.013)	(0.011)	(0.011)	(0.008)	(0.010)
pop. 25-64$_t$	0.362**	0.226*	0.286	0.291**	0.464***	0.378***	0.318**
	(0.155)	(0.119)	(0.229)	(0.143)	(0.147)	(0.131)	(0.122)
size of government$_t$	-0.006**	-0.005**	-0.006**	-0.007**	-0.008***	-0.005***	-0.007***
	(0.002)	(0.002)	(0.003)	(0.003)	(0.002)	(0.002)	(0.002)
Political participation$_t$	0.001*	0.000	0.001***	0.001***	0.001**	0.001**	0.001**
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
tropical areas	-0.054***	-0.040**	-0.040***	-0.049***	-0.058***	-0.061***	-0.047***
	(0.020)	(0.017)	(0.013)	(0.015)	(0.019)	(0.015)	(0.010)
Observations	311	311	301	306	303	303	267
Number of instruments	28	32	32	36	32	30	37
AR(2) test	0.900	0.886	0.881	0.636	0.859	0.655	0.751
Hansen test (p-val)	0.161	0.169	0.396	0.444	0.459	0.709	0.970
Diff in Hansen test (p-val)	0,064	0,176	0,413	0,395	0,280	0,407	0,571

Note: The number of total observations varies due to missing data on public spending and tertiary enrolled in S&T fields. Estimates from two-step difference GMM with 3 lags in endogenous variables and other instruments collapsed; Windmeijer's (2005) finite sample correction and robust standard errors.
*, **, *** measures statistical significance at the 10, 5 and 1% levels respectively. All regressions include a constant (not shown) and period fixed effects.

Across the estimations, the set of control variables have the expected sign and are statistically significant. Hence, the negative coefficient for the initial GDP per capita accounts for the convergence condition among countries. Besides, the investment ratio, openness and political participation (as a proxy of sound institutions) bear positive effects. The same happens with the share of working age population. Finally, a greater size of government and being close to tropical areas seem to discourage economic growth, as has been found in previous studies (Section 2). The estimates satisfy the Hansen and Difference-in-Hansen tests for instrument validity. In both cases, the null hypothesis of exogeneity of instruments is not rejected, though in Column 7 the closeness to 1 might indicate that the model could be over-fitted. The AR (2) check for the absence of second order serial correlation in errors is fulfilled.

Next, we report the HLM estimates where the variance in income per capita is explained by time-varying determinants $(stertiary_{it}, time, lnk_{it}, lnworkinagepop_{it_{it}})$, between-country factors (vector Z_i and $tertiarytilt_i$) and unmeasured, unobserved differences among economies $(v_{0i}v_{1i}v_{2i})$. Table 4 contains the estimates of equations 2 and 2.1 in which the intercept is the only coefficient computed on a country-varying basis. At the bottom of the table, the "random effect" coefficients show the variance of intercepts and of the whole model.

Table 4. Tertiary education and other determinants of income per capita in random intercept models (HLM)

Dep. Var.: *lny*$_{it}$	(1)	(2)	(3)	(4)	(5)
β_{0i}					
Intercept Υ_{00}	3.004***	3.354***	3.235***	3.140***	3.157***
	(0.727)	(0.825)	(0.683)	(0.683)	(0.657)
tropical areas$_i$ Υ_{01}		-0.570***	-0.687***	-0.624***	-0.612***
		(0.123)	(0.117)	(0.111)	(0.123)
trade openness$_i$ Υ_{02}		0.310***	0.312***	0.275***	0.277***
		(0.066)	(0.072)	(0.060)	(0.062)
size of government$_i$$\Upsilon_{03}$		-0.034			
		(0.044)			
political participation$_i$$\Upsilon_{04}$		0.003			
		(0.005)			
S&T students/total$_i$$\Upsilon_{05}$				2.308**	2.306**
				(1.098)	(1.111)
ter.tilt$_i$ Υ_{06}					-0.016
					(0.075)
s.tertiary$_{t-2}$	0.865**	0.766**	0.785**	0.800***	0.797***
	(0.343)	(0.317)	(0.305)	(0.307)	(0.307)
time	0.043**	0.060***	0.058***	0.058***	0.058***
	(0.021)	(0.021)	(0.019)	(0.019)	(0.019)
per capita capital (logs)$_{t-2}$	0.566***	0.509***	0.522***	0.514***	0.514***
	(0.056)	(0.061)	(0.054)	(0.054)	(0.054)
s. population25-64 (logs)$_{t-2}$	-0.350	-0.567	-0.562	-0.540	-0.545
	(0.369)	(0.375)	(0.363)	(0.361)	(0.371)
RandomEffects					
Intercept (τ_{00})	0.112**	0.047**	0.049**	0.045**	0.045**
	(0.036)	(0.017)	(0.019)	(0.018)	(0.018)
Residual (σ^2)	0.020**	0.020**	0.020**	0.020**	0.020**
	(0.005)	(0.004)	(0.004)	(0.004)	(0.004)
Modelfitstatistics					
AIC	-142.20	-175.04	-177.14	-178.56	-176.61
BIC	-116.59	-134.78	-144.21	-147.97	-136.35
Deviance	-156.20	-197.03	-196.14	-198.56	-198.61
Observations	287	287	287	287	287

Note: The number of observations is lower than in the system GMM table because HLM regressions consider 2 period lags in the share of tertiary educated and physical capital. Cluster robust standard errors in parentheses. *, **, *** measures statistical significance at the 10, 5 and 1% levels respectively.

Across the Columns, the share of tertiary educated people, the physical capital and technical progress have been positive and significant determinants of cross-country income levels. The share of working age population has not stood significant. In Column 1, the most interesting feature lies in the variance of the random intercept (τ_{00}), which is significantly different from zero, meaning that it varies from country to country. Therefore, the level of the production function is systematically higher or lower than the overall mean among the countries in the sample. Figure A.1 summarizes the variability in the intercept across countries according to the estimates in Column 1.

Given the significant variance in the intercept, Columns 2-5 explore which factors typical of each country might account for it. Column 2 shows the intercept is highly dependent on geography (with a negative impact of tropical areas) and trade openness, while factors like size of government or political participation do not bear a significant influence. Indeed, just including the two significant determinants seem to improve the fit of the model (AIC and BIC tests show lower values in Column 3 than in Column 2). According to these figures, a further improvement is obtained with the fraction of S&T students (Column 4). Observe that the intercept variance (τ_{00}) gets reduced after this inclusion. Instead, in Column 5, the presence of a tertiary tilt does not seem to improve the results.

In Table 5, the random intercept model from Table 4 is complemented with a random slope approach. In Column 1, the share of tertiary educated is computed on a country-varying basis (a simplified version of equations 2 and 2.1). In line with the expected relevance of cross-country differences, tertiary education and the variance of its random effect (τ_{11}, at the bottom of the table) are significant. Note that here the magnitude of the impact is bigger than in Table 4, where a common slope is considered. This varying slope might be reflecting a wide range of country peculiarities such as the range of tertiary education accomplishments, the degrees at which labour markets could efficiently absorb this high-skilled human capital or how capital markets work to support the accumulation of human capital (Figure A.2 shows the variability across countries).In this study, the aim is to assess whether the tertiary tilt in education budgets has any role.

The estimation of equation 3 is presented in Column 2. Here, the random effects at the tertiary educated slope (τ_{11}) has got reduced in relation to the previous column implying that the tertiary tilt has a role to explain country differences. Furthermore, coefficients $\Upsilon_{10;}$ Υ_{11} are statistically significant and have opposite signs. This means that the tertiary tilt reduces the influence of tertiary education on income per capita. The inclusion of the interaction term in the model makes it fit better according to the criteria reported in the table. Taking the tertiary tilt records as in Table 2 together with these results, the net contribution of tertiary education to income per capita for a tertiary tilt equal to the one in UMICs would be just 26% of the one obtained with the value present in HICs.

Alternatively, Columns3 and 4 consider country-specific variations in the intercept and in the slope associated to the rate of technological progress (estimating at the same time equations 2, 2.1 and 2.3). The results show that the tertiary tilt (according to the sum of Υ_{20} andΥ_{21}) and unobserved country factors (τ_{22}) shape the magnitude of the impact of technological progress on income per capita. Again, the interaction in Column 4 improves the fit of the model in relation to Column 3. All the estimations underpin the importance of geographical location, trade openness, S&T students and other unobserved country factors (τ_{00}) to account for shifts in the output level. The effect of the tertiary tilt taken just at the intercept does not report conclusive results (Column 1 and 3). Physical capital and population age have the expected signs, though only the former is statistically significant.

Table 5. Tertiary education, tertiary tilt and technical progress as determinants of income per capita in random slope models (HLM)

Dep. Var.: *lny_{it}*	(1)	(2)	(3)	(4)
β_{0i}				
Intercept Υ_{00}	4.521***	4.481***	5.728***	5.511***
	(0.577)	(0.560)	(0.607)	(0.578)
tropical areas$_i$ Υ_{01}	-0.693***	-0.711***	-0.654***	-0.633***
	(0.095)	(0.093)	(0.098)	(0.093)
trade openness $_i$ Υ_{02}	0.377***	0.358***	0.331***	0.312***
	(0.070)	(0.068)	(0.053)	(0.050)
S&T students/total$_i$$\Upsilon_{05}$	1.834*	1.778*	2.885**	2.889**
	(0.991)	(0.966)	(1.218)	(1.184)
ter.tilt$_i$ Υ_{06}	-0.072	0.203*	-0.088	0.263**
	(0.062)	(0.104)	(0.073)	(0.118)
s.tertiary$_{t-2}$(averages)			1.118***	1.046***
			(0.281)	(0.279)
β_{1i}				
s.tertiary$_{t-2}$ Υ_{10}	1.437***	4.282***		
	(0.506)	(0.995)		
s.tertiary$_{t-2}$ x ter.tilt$_i$$\Upsilon_{11}$		-2.105***		
		(0.649)		
time (averages)	0.039***	0.037***		
	(0.010)	(0.010)		
β_{2i}				
time Υ_{20}			0.047***	0.104***
			(0.016)	(0.019)
time x ter.tiltΥ_{21}				-0.045***
				(0.012)
capital per cápita (logs)$_{t-2}$	0.436***	0.419***	0.335***	0.331***
	(0.044)	(0.044)	(0.053)	(0.051)
s. population25-64 (logs)$_{t-2}$	0.020	0.183	0.298	0.539
	(0.218)	(0.222)	(0.323)	(0.339)
RandomEffects				
s. tertiary (τ_{11})	5,733**	4,375**		
	(1,701)	(1,332)		
t (τ_{22})			0,003**	0,002**
			(0,001)	(0,001)
Intercept (τ_{00})	0,141**	0,120**	0,190**	0,157**
	(0,037)	(0,030)	(0,089)	(0,068)
Residual (σ^2)	0,011**	0,011**	0,010**	0,001**
	(0,001)	(0,001)	(0,002)	(0,002)
Model fit statistics				
AIC	-254.12	-261.73	-272.74	-281.56
BIC	-206.55	-211.51	-225.17	-230.33
Deviance	-280.12	-289.73	-298.74	-309.56
Observations	287	287	287	287

Note: The number of observations is lower than in the previous table because HLM regressions consider 2 period lags in the share of tertiary educated and physical capital. Cluster robust standard errors in parentheses. The model assumes that random intercepts and slopes are correlated. *, **, *** measures statistical significance at the 10, 5 and 1% levels, respectively.

Overall, the different estimation strategies point to a relevant role of tertiary educated students to accelerate economic growth and to explain cross-country-differences in the level of income. They also suggest that public investment in education matters for this result. It is shown that the extent up to which the countries tilt their public resources on tertiary students at the expense of primary education seems to lead to a considerable variation in economic returns and technical progress. Particularly, the HLM technique underlines that the tertiary tilt in education budgets emerges as important source of cross-country differences to accrue macroeconomic benefits from higher education. Additionally, the fraction of S&T students seems to act as an independent effect, able to accelerate the rate of economic growth. This finding is in line with the idea that individual's decisions to accumulate certain types of human capital may affect the economy's long run potential.

4.2 Robustness checks

A set of robustness checks is performed. Across them, control variables are kept as in the baseline regressions. The first three columns in Table 6 compare different system GMM estimations. Columns 1 and 2 restrict the number of instruments (set one and two lags less than in Table 4 estimates, respectively) and Column 3 includes an additional lag. On the whole, the results are consistent with the baseline specification. Tertiary education enhances growth though it reduces its effect whenever the tertiary tilts in education spending is higher. The diagnostic checks perform quite well, except in Column 2 where they indicate that the model could be over-fitted.

The next regressions consider additional covariates that could affect the joint impact of higher educated people and tertiary tilts on economic growth.[8] Column 4 includes the fraction of tertiary students trained at private institutions. The intuition is that highly privatized tertiary education systems might drive out the influence of the tertiary tilt in public education spending. However, the coefficient is not statistically significant and the interaction term holds. The next column explores whether the link between tertiary education and the tertiary tilt has an effect which exclusively depends on the country's level of income inequality (Column 5). The coefficient of the Gini Index is significant and negative to economic growth, but the variable does not eliminate the impact of the interaction term.

Finally, Column 6 includes a control for the relative GDP per capita between country *i* and US. The variable accounts for the evolution of the productivity gap in relation to one of the world technological leaders. In case the link between tertiary education and public spending would

[8] These estimations exclude the control for the fraction of S&T students in order to enlarge the number of available observations.

only be present in the less developed countries within the sample, the interaction term may become non significant. The proximity to US is significant and positive to economic growth (a relation which stands independently from the convergence condition and from human capital formation), but it does not affect the statistical significance of the relation between tertiary education and tertiary tilt.[9] Note that the estimates of the overall effect of tertiary education in Columns 4-6 are lower than in all the previous specifications. Thus, the included covariates are related to economic growth, but controlling for them the influence of the main explanatory variables discussed in this analysis still remains.

Table 6. Robustness checks for determinants of per capita GDP growth

Dep. Var. g_{it}	(1)	(2)	(3)	(4)	(5)	(6)
s.tertiary$_{t-1}$	0.382***	0.317***	0.367***	0.245***	0.203***	0.180***
	(0.107)	(0.093)	(0.121)	(0.068)	(0.071)	(0.048)
tertilt$_{t-1}$ (logs)	0.034***	0.026***	0.027***	0.017**	0.014	0.012**
	(0.007)	(0.008)	(0.007)	(0.007)	(0.011)	(0.005)
s.tertiary$_{t-1}$ xtertilt$_{t-1}$	-0.149***	-0.120***	-0.135***	-0.073**	-0.097**	-0.085*
	(0.035)	(0.036)	(0.047)	(0.032)	(0.044)	(0.045)
S&T students/total$_t$	0.244***	0.221***	0.212***			
	(0.057)	(0.059)	(0.049)			
s. privatetertiary educated$_{t-1}$				-0.017		
				(0.010)		
Income Gini Index$_{t-1}$					-0.171*	
					(0.103)	
(GDPpc$_i$/GDPpc$_{US}$)$_{t-1}$						0.178***
						(0.041)
Other controls	yes	yes	yes	Yes	yes	yes
Observations	267	267	267	303	265	303
Nº of instruments	31	25	43	37	40	40
AR(2) test	0.766	0.477	0.733	0.512	0.247	0.497
Hansen test (p-val)	0.912	0.981	0.918	0.591	0.357	0.616
Diff in Hansen test (p-val)	0.668	0.981	0.929	0,190	0,376	0,316

Note: Regressions include ln $y_{i,\ t-1}$; investment ratio $_{t-1}$; pop. 25-64$_t$; trade openness; size of government; political participation, tropical areas a constant and period fixed effects. Estimates from two-step difference GMM and other instruments collapsed; Windmeijer's (2005) finite sample correction and robust standard errors. *, **, *** measures statistical significance at the 10, 5 and 1% levels, respectively.

Table 7 provides robustness checks for the HLM regressions. Columns 1 and 2 replicate the random slope models of Table 4, taking the share of tertiary educated people aged 65 to 69 years as the main explanatory variable (*s.tertiary65*).[10] The objective is to further alleviate the possible endogeneity bias in the relationship between income and human capital. The new variable is correlated to the current share of tertiary educated but not necessarily to the

[9]Data for share of private tertiary enrolment are based on UNESCO Yearbooks and UIS; Gini Index is extracted from SoltSWII database (2014) and productivity gaps computed from PWT database.
[10]The variable is taken from Barro and Lee database (2013).

current income (Gennaioli et al., 2013).Alternatively, Columns 3 and 4 take years of tertiary education as the main explanatory variable. In both exercises, the significant variances at the slopes (shown at the random effect analysis) are negatively related to tertiary tilt. Thus, the overall income effects of tertiary education and technological progress are associated to the tertiary tilt in public education spending which has featured the countries over the period. The coefficients for the rest of covariates included in the regressions remain similar to the previous estimates.

Table 7. Robustness checks for determinants of income level in random slope models

Dep. Var.: lny_{it}	(1)	(2)	(3)	(4)
β_{0i}				
InterceptΥ_{00}	3.758***	5.302***	5.836***	5.683***
	(0.557)	(0.604)	(0.733)	(0.520)
tropical areas$_i\Upsilon_{01}$	-0.700***	-0.636***	-0.746***	-0.624***
	(0.117)	(0.104)	(0.115)	(0.100)
tradeopenness $_i\Upsilon_{02}$	0.315***	0.299***	0.346***	0.289***
	(0.058)	(0.053)	(0.047)	(0.049)
S&T students/total$_i\Upsilon_{05}$	1.795*	2.622**	1.541	2.902**
	(1.005)	(1.287)	(1.140)	(1.165)
ter.tilt$_i\Upsilon_{06}$	0.177**	0.261**	0.273**	0.276**
	(0.085)	(0.115)	(0.111)	(0.110)
s.tertiary65-69 (averages)		0.876**		
		(0.358)		
years tertiaryt-2 (averages)				0.347***
				(0.089)
β_{1i}				
s.tertiary65-69Υ_{10}	5.768***			
	(1.023)			
s.tertiary65-69 x ter.tilt$_i\Upsilon_{11}$	-2.796***			
	(0.619)			
years tertiary$_{t-2}$ Υ_{10}			1.470***	
			(0.263)	
years tertiary$_{t-2}$ x ter.tilt$_i\Upsilon_{11}$			-0.824***	
			(0.222)	
time (averages)	0.040**		0.041**	
	(0.016)		(0.017)	
β_{2i}				
time Υ_{20}		0.111***		0.101***
		(0.021)		(0.020)
time x ter.tiltΥ_{21}		-0.045***		-0.046***
		(0.012)		(0.012)
capital per cápita (logs)$_{t-2}$	0.469***	0.352***	0.309***	0.317***
	(0.043)	(0.055)	(0.068)	(0.048)
s. population25-64 (logs)$_{t-2}$	-0.133	0.503	0.562*	0.600**
	(0.340)	(0.347)	(0.340)	(0.296)
RandomEffects				
s. tertiary65-69/years tertiary (τ_{11})	7.171**		0.590**	
	(4.887)		(0.372)	
t (τ_{22})		0.002**		0.002**
		(0.001)		(0.001)
Intercept (τ_{00})	0.110**	0.156**	0.161**	0.152**
	(0.052)	(0.070)	(0.079)	(0.071)
Residual (σ^2)	0.012**	0.001**	0.009**	0.009**
	(0.002)	(0.002)	(0.002)	(0.002)
Model fit statistics				
AIC	-255.55	-278.89	-279.53	-285.58
BIC	-204.32	-227.65	-228.29	-234.35
Deviance (-2*loglikelihood)	-283.55	-306.89	-307.53	-313.58
Observations	287	287	287	287

Note: cluster robust standard errors in parentheses. The model assumes that random intercepts and slopes are correlated. *, **, *** measures statistical significance at the 10, 5 and 1% levels, respectively

5. Discussion and conclusion

It is generally accepted that more schooling enhances income and economic growth. In this context, the role of higher educated people has been subject to debate based on the budgetary resources it captures at the expense of mass schooling; the range of benefits it concentrates on already wealthy students or the role it plays depending on the different development stages. This paper argues that another relevant issue conditioning the economic effects of this skilled human capital is the tertiary tilt in public education budgets. The empirical approach builds on a panel of 41 countries for the period 1970-2010 and on estimates of system GMM and HLMs regressions.

The results show that for HICs and UMICs, the share of tertiary educated people has played a significant role to accelerate economic growth and to account for cross country-differences in the level of income per capita. This is, indeed, a good reason why government should provide higher schooling. However, this study also finds that the gains from higher education hinges upon the structure of the education resource allocation. Countries characterized by relatively high tertiary tilts obtain lower income effects from higher schooling and from technological change. This result holds regardless of differences among the countries in the sample, as shown in HLM regressions.

Indeed, for a tertiary tilt equal to the average of UMICs, the impact of higher education on economic growth is 40% lower than the one computed with the value at HICs. Results are worse in the case of GDP per capita, because using the average for UMICs the effect is almost 70% lower than when applying the figure at HICs. A closer look within the UMIC group reveals the higher levels of the tertiary tilt have corresponded to the LACs. These countries have presented values above the rest of its group-counterparts from the mid 1980s onwards. This result might contribute to explain why their range of productivity gains has remained barely unchanged during the period while it grew threefold in the Asian UMICs (ECLAC, 2014).

It might be claimed that it is the amount spent, not its composition, what matters. In fact, in the 2000s, the HICs of our sample have spent 17,000 constant PPP dollars per tertiary student per year while the figure has been 6,000 in UMICs. However, part of the difference stems from political choices and not from resource constraints typical of developing countries, because by 2010s, education spending ranged 5% of GDP in HICs but just 3.5% in UMICs. In this context, HICs and UMICs spend roughly the same in tertiary education as a share of their GDP per capita (54%), but the percentages for primary schooling are almost 20% in HICs and 13% in UMICs. Then, the argument about the need of a higher priority to education funding together with a more balanced budget distribution across education levels seem to hold.

Additionally, this study finds that the economic contribution of people qualified at S&T appears to be higher compared to other fields. The result is suggestive because this field just comprises around 9% of total students and emerges regardless of each country's quality of higher schooling and capacity to generate or adapt new technologies. Accordingly, the returns from higher education seem to be enhanced by the type of skills it creates, a premise which might ground future research.

Further research is needed to dig into the mechanisms leading the tertiary tilts to hamper macroeconomic returns from tertiary education. However, some arguments can be raised. A relatively low funding at the pre-primary and primary levels implies insufficient infrastructure, equipment and teaching quality, which translates into low educative standards. These, in turn, affect the individuals' capacity to contribute to productivity growth when they decide to enter the labour market. Back to the case of LACs, Hanushek and Woessman (2012) point out that at least half of the regional low-growth performance can be attributed to the low levels of cognitive skills among students. Indeed, the failures in terms of education quality could reach out the tertiary education system itself. At present, the most skill intensive industries are in finance and business services. However, in LACs, these sectors are featured by the lack of technological dynamism and tend to fall behind the world frontier (Timmer et al., 2014).

Even if the share of highly educated people would accrue high-quality records, the fact that children are not properly prepared to make headway in the formal system damages the worker complementarities in the labour market. Provided the productivity of skilled workers depends on the broader human capital context in which they act (Nelson and Phelps, 1996; Jones, 2011 and 2014), by weakening the first and massive links in the chain, a biased education budget also weakens the sources of productivity gains. Overall, the evidence presented so far emphasizes that the spending tilt towards higher education is not only inegalitarian, as claimed by several authors, but it might also be an "anti-growth" policy.

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Appendix

Table A.1 Country sample

High-incomeCountries (HICs)		
Australia	Ireland	Portugal
Austria	Israel	Spain
Belgium	Italy	Sweden
Canada	Japan	Switzerland
Denmark	Luxemburg	UnitedStates
Finland	Netherlands	UnitedKingdom
France	New Zealand	
Greece	Norway	
Upper-middle income countries (UMICs)		
Argentina	Jamaica	Poland
Brazil	Mexico	Singapour
Chile	Panama	South Korea
Colombia	Peru	Thailand
C. Rica	Uruguay	Turkey
Dominican Rep.	Venezuela	
Ecuador	Malaysia	

Source: www.data.worldbank.org/about/country-and-lending-groups

Table A.2 Descriptive statistics

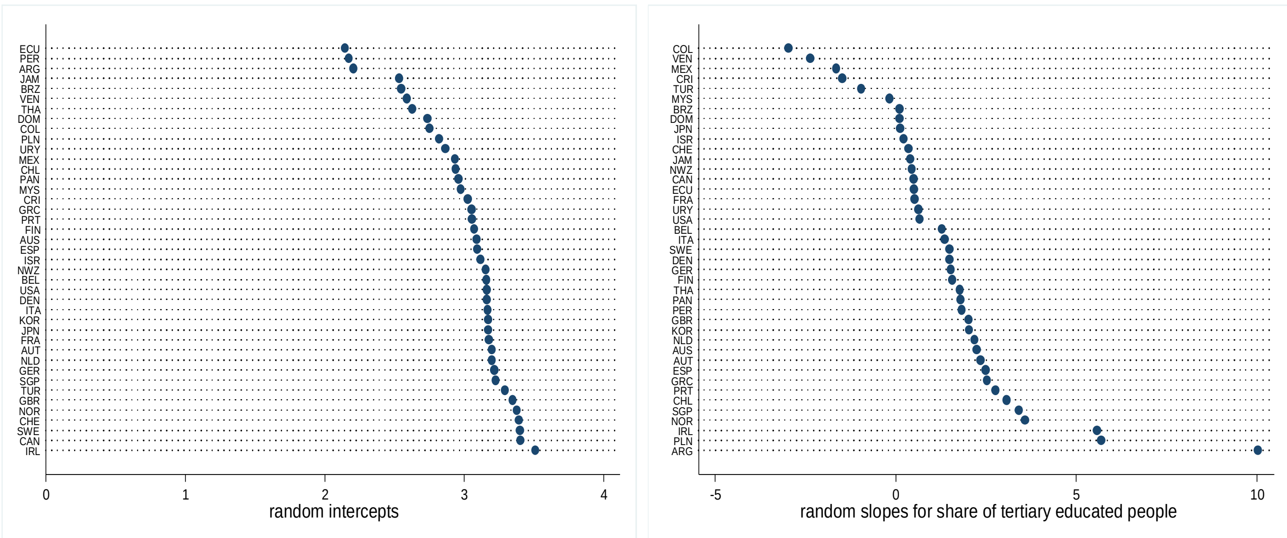
Variable		Mean	Std. Dev.	Min	Max	Observations
lny$_{it}$	overall	9.42	0.72	7.64	11.09	N = 328
	between		0.64	8.31	10.33	n = 41
	within		0.34	8.14	10.43	T = 8
g_{it} (%)	overall	2.6	2.73	-5.98	13.42	N = 328
	between		1.24	-0.42	6.65	n = 41
	within		2.44	-3.36	12.32	T = 8
s.tertiaryaged 25 + (%)	overall	13.05	9.58	1.1	53.05	N = 328
	between		7.7	3.91	39.26	n = 41
	within		5.82	-7.25	32.16	T = 8
tert.tilt (ln)	overall	1.39	0.78	-0.21	3.96	N = 320
	between		0.62	0.43	2.76	n = 41
	within		0.49	0.08	3.01	T-bar = 7.8
S&T students/total (%)	overall	8.73	3.79	1.7	17.42	N = 289
	between		3.14	2.7	14.94	n = 41
	within		2.17	3.35	16.33	T-bar = 7.0
tropical areas	overall	0.32	0.45	0	1	N = 328
	between		0.45	0	1	n = 41
	within		0	0.32	0.32	T = 8
capital per capita (log)	overall	10.5	0.81	8.47	12.01	N = 328
	between		0.73	9.2	11.48	n = 41
	within		0.37	8.94	11.87	T = 8
investment/GDP(%)	overall	24.84	7.36	10.37	62.58	N = 328
	between		6.04	12.33	47.89	n = 41
	within		4.3	6.17	41.94	T = 8
pop. 25-64/total (%)	overall	45.97	7.11	30.27	59.32	N = 328
	between		6.02	35.61	53.73	n = 41
	within		3.88	32.34	57.12	T = 8
politicalparticipation (%)	overall	46.38	15.13	5	70	N = 315
	between		13.28	19.89	66	n = 41
	within		7.41	15.25	67.79	T-bar = 7.7
size of government	overall	5.57	1.58	1.63	9.27	N = 319
	between		1.24	2.59	7.51	n = 41
	within		0.99	1.56	8.62	T-bar = 7.8
tradeopenness (%)	overall	68.17	55.74	12.45	410.25	N = 328
	between		54	19.59	339.75	n = 41
	within		15.9	-7.58	138.67	T = 8
s.tertiaryaged 65-69 (%)	overall	6.54	6.24	0.24	41.79	N = 328
	between		5.05	1.2	25.02	n = 41
	within		3.74	-7.03	24.14	T = 8

Table A.2 Descriptive statistics (cont.)

Variable		Mean	Std. Dev.	Min	Max	Observations
years of tertiaryeducation	overall	0.43	0.31	0.04	1.62	N = 328
	between		0.24	0.15	1.22	n = 41
	within		0.2	-0.14	1.05	T = 8
tertiaryprivateenrolment (%)	overall	25.12	24.76	-21.35	85.92	N = 324
	between		23.49	0.57	77.94	n = 41
	within		8.5	-20.8	60.8	T-bar = 7.9
IncomeGini Index$_{t-1}$	overall	0.36	0.11	0.20	0.66	N = 311
	between		0.10	0.22	0.55	n = 41
	within		0.03	0.24	0.50	T-bar = 8
tertiary public educ. spending per student/GDPpc (%)	overall	73.78	63.24	4.72	411.61	N = 323
	between		52.02	25.36	226.31	n = 41
	within		36.39	-71.34	291.79	T-bar = 8
primary public educ. spending per student/GDPpc(%)	overall	15.53	7.60	3.31	45.46	N = 324
	between		6.82	5.93	41.43	n = 41
	within		3.50	4.61	31.01	T-bar =8
GDP$_i$pc/GDP $_{US}$pc	overall	48.77	27.53	9.53	153.94	N = 328
	between		26.44	13.35	100.00	n = 41
	within		8.59	8.07	109.69	T = 8

Source: Barro and Lee (2013); IMF; ECLAC; UNESCO Yearbooks; UIS; WDI.

Figures A.1 and A.2 Bayes estimations of the random intercept and random slope per country



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