IRJEMS International Research Journal of Economics and Management Studies
Published by Eternal Scientific Publications
ISSN: 2583 – 5238 / Volume 1 Issue 2 November 2022 / Pg. No: 24- 32
Paper Id: IRJEMS- V1I2P104, Doi: 10. 56472/25835238/IRJEMS-V1I2P104

Tertiary Education and Economic Growth: How Much Does Physical Capital Matter?

[1]Boris Aguilera, [2]Carolina San Martín
[1]Budget Office of Chile.
[2]National Statistics Bureau of Chile

Received Date: 22 November 2022 Revised Date: 24 November 2022 Accepted Date: 26 November 2022

Abstract: *This paper addresses the impact of tertiary education on economic growth through physical capital accumulation. Results indicate the presence of a threshold of physical capital development, particularly in regions such as Northern Africa, Western Asia, and Latin America and the Caribbean, where tertiary education becomes in an important factor to the economic growth. This impact is not found in the absence of a physical capital analysis, which could suggest that the impact of tertiary education on economic growth could dilute when estimating the effect with traditional regressions.*

Keywords: *Economic Growth, Education, Human capital, Physical capital, Accumulation of Capital.*

I. INTRODUCTION

Worldwide a fundamental issue for governments is to identify the elements with positive impact in economic growth, particularly from the perspective of factors linked to public expenditure. Due to limited resources in each country, governments must decide how to distribute public investment combining criteria such as public welfare and economic development. In this context, education spending is characterized by impacting on economic growth and on social welfare; being a significant percentage of the national budget in each country. However, this poses a dilemma to governments concerning how to focus resources on the different educational levels. Across OECD countries, the lowest expenditure on educational institutions is concentrated at the tertiary level, being around 30%, on average (OECD, 2019). However, it is worth asking whether tertiary education should receive a higher share. On this, the interrelation between physical and human capital cannot be neglected. Therefore, this note aims to answer the following question: Is physical capital important in the effect of tertiary education on economic growth?.

The important progress in the study of the role of human capital in economic growth was the starting point for the development of neoclassic models of endogenous growth. These started with Mankiw, Romer, and Weil (1992), who proposed an extended neoclassic growth model where countries with faster educational growth rates had bigger incomes. Afterwards, a series of endogenous growth models were developed, which found that human capital matters in the production (Barro & Sala-i Martin, 1997). Regarding empirical studies, an appropriate starting point is Barro (1991), whose research demonstrated that human capital is directly related to economic growth. Later, with the improvement of data quality and estimation techniques, almost all studies have concurred to find a positive and significant effect of education on economic growth (Benos and Zotou (2014)). Particularly, some articles have found a positive relationship between economic growth and tertiary education (Gyimah-Brempong, Paddison, & Mitiku, 2006; Siddiqui & Rehman, 2016).

In this paper, we use a threshold dynamic panel model developed by Caner and Hansen (2004) to identify whether a threshold in physical capital exists generating an effect in the relationship between tertiary education and economic growth. Relevant result to consider is presented by Ahsan and Emranul (2017), who found a positive and statistically significant effect of schooling on economic growth, once economy crosses the physical capital threshold. To the best of our knowledge, without having found another study that follows this approach, hypothesis is that exists a development threshold in physical capital where tertiary education is essential for economic growth. This result suggests that the impact of tertiary education on economic growth could not have been found in absence of a physical capital analysis. This note is organized as follows: section 2 presents the materials and methods, section 3 shows the results, and section 4 concludes.

II. MATERIALS AND METHODS

We built a balanced panel data of 74 countries between 1987 and 2010. We retrieved the real GDP per capita, population, investment as a percentage of the GDP, terms of exchange, and public expenditure as a percentage of the GDP from Penn World Table. Also, we used a Political Index, from Polity IV. To educational attainment, we used Barro and Lee (2013).

Finally, inflation data was retrieved from the World Bank. The countries included in our analyses[1] were being grouped into three regions as follows: Advanced Economies (AE); Central, Eastern, Southern Asia and Sub-Saharan Africa (CSA); and Northern Africa, Western Asia, Latin America and the Caribbean (WANALAC). We followed the specifications used in Siddiqui and Rehman (2016), Gyimah-Brempong et al. (2006) and Ogundari and Awokuse (2018). We considered a enrollment rates at primary, secondary, and tertiary levels as proxies for human capital.

$$y_{i,t} = \alpha_i + \beta_1 y_{i,t-1} + \beta_2 Prim_{i,t} + \beta_3 Sec_{i,t} + \beta_4 Ter_{i,t} + \beta_2 x_{i,t} + \varepsilon_{i,t} \quad (1)$$

Where $y_{i,t}$ represents economic growth of GDP per capita of country i in period t; $Prim_{i,t}$ is educational attainment as completed primary; $Sec_{i,t}$ corresponds to educational attainment as completed secondary; $Ter_{i,t}$ is attainment as completed tertiary; and $x_{i,t}$ correspond to other variables, such as: population growth, investment as a percentage of the GDP, exchange terms, political stability indices, public expenditure as a percentage of GDP and inflation.

To estimate Equation 1, we considered the system-generalized method of moments (GMM). Coefficients were estimated considering the cluster robust standard errors approach, to control reverse causality, and therefore, the endogeneity, using lagged dependent variable as instrumental variable. Also, serial correlation in the error term is evaluated using the AR(1) and AR(2) Arellano-Bond test. Finally, we estimated J test of overidentifying restrictions and C test of valid instruments (exogeneity). As Ahsan and Emranul (2017), we used the threshold dynamic panel model developed by Caner and Hansen (2004), to identify if there is a physical capital threshold generating an effect in the relationship between tertiary education and economic growth:

$$y_{i,t} = \alpha_i + \beta_1 y_{i,t-1} + \beta_2 Prim_{i,t} + \beta_3 Sec_{i,t} + \beta_4 Terc_{i,t} I(k_{i,t} > \gamma) + \beta_5 Terc_{i,t} I(k_{i,t} =< \gamma) + \beta_6 x_{i,t} + \varepsilon_{i,t} \quad (2)$$

Where, k_i is capital threshold that corresponds to the logarithm of capital per capita; and $I(\cdot)$ is the function of the threshold indicator of the variable $k_{i,t}$.

III. RESULTS AND DISCUSSION

Table 1 presents the results obtained for Equation 1 and Equation 2. Results of Equation 1 indicate that there is no positive relationship between tertiary education and economic growth in none of the country groups. In AE group effect is significant and negative. When assessing the AE group in Equation 2, tertiary education presents a negative effect, both below and above the threshold of capital accumulation. This suggest that these economies have already reached a high level of human capital. In the same line, for CSA group, under the threshold of 13.9564 (the lowest threshold reported), the effect of tertiary education is negative. This result is probably explained by the significant shortage of physical capital that makes these countries unable to take advantage of tertiary education expansion. For the case of WANALAC, our estimations show that below a certain physical capital threshold (13.2401) tertiary education does count with a positive impact on economic growth.

In summary, our results show great heterogeneity between country groups regarding the effect of tertiary education on economic growth. Furthermore, in WANALAC tertiary education has a positive impact on economic growth. However, it must be noted that this result is not found in the absence of the physical capital threshold analysis.

We studied robustness of models using two strategies. First, we replaced attainment variable using average years of schooling by level (see table 3 of the Appendix). As a second strategy we study three, six and nine lags of the attainment variable of primary, secondary and tertiary schooling (see table 4 of the Appendix). Regarding the first strategy, to AE and CSA groups the effect of tertiary education on the GDP is negative under the threshold. On the contrary, to WANALAC group the effect is positive. Regarding the second strategy, to AE group with three-lags tertiary education has a negative effect above and below the threshold. In the case of six and nine lags, effect is only significant and negative below the physical capital threshold.

In CSA group, with three lags, tertiary education has a negative effect on GDP under the threshold. In WANALAC group, the effect is positive with nine lags. In summary, under the variable change strategy, to AE and CSA groups the effect is negative under the physical capital threshold, whereas to WANALAC group the effect is positive. In the case of lags, the results are similar. Consequently, results are robust to both strategies implemented.

IV. CONCLUSION

Using a balanced panel of 74 countries, we addressed whether a physical capital threshold exists generating an effect in the relationship between tertiary education and economic growth. Estimations suggest that the effect of tertiary education on the economic growth is highly heterogeneous. On the one hand, there is a physical capital threshold determining whether tertiary education influences economic growth in a positive or negative way; in line with the work of Ahsan and Emranul (2017). For instance, this is the case for WANALAC countries, where this threshold has a positive effect on economic growth. On the other hand, for AE and CSA countries, this threshold has a negative effect.

These results are crucial because highlight the importance of assessing the role of physical capital thresholds in economic growth. In absence of physical capital analysis there is no statistically significant effects, which undermines and underestimates the importance of higher education for economic growth.

V. REFERENCES

[1] Ahsan Humna, and Haque Emranul, Threshold effects of human capital: Schooling and economic growth, *Economics Letters*, *156* (1), (2017) 48-52.

[2] Barro Robert, Economic growth in a cross section of countries, *The Quarterly Journal of Economics*, *106* (2), (1991) 407.

[3] Barro Robert and Lee Jong, A new data set of educational attainment in the world 1950-2010, *Journal of Development Economics*, *104* (1), (2013) 184-198.

[4] Barro Robert and Sala-i Martin Xavier, Technological diffusion, convergence, and growth, *National Bureau of Economic Research*, *2* (1), (1997) 48-52.

[5] Benos Nikos and Zotou Stefania, Education and economic growth: A meta-regression analysis, *World Development*, *64* (1), (2014) 669-689.

[6] Caner Mehmet and Hansen Bruce, Instrumental variable estimation of a threshold model, *Econometric Theory*, *20* (5), (2004) 813-843.

[7] Gyimah-Brempong Kwabena, Paddison Oliver and Mitiku Workie, Higher education and economic growth in Africa, *Development Studies*, *42* (3), (2006) 509-529.

[8] Mankiw Gregory, Romer David and Weil David, A contribution to the empirics of economic growth, *The Quarterly Journal of Economics*, *107* (2), (1992) 407–437.

[9] OECD, Education at a glance 2019: OECD indicators, *OECD Publishing*, (2019).

[10] Ogundari Kolawole and Awokuse Titus.. Human capital contribution to economic growth in Sub-Saharan Africa: Does health status matter more than education?, *Economic Analysis and Policy*, *58*, (2018) 131- 140.

[11] Siddiqui Anjum and Rehman Atiq, The human capital and economic growth nexus in East and South Asia. *Applied Economics*, 49-28, (2017) 2697-2710.

Appendix

Table 1: The dependent variable is the growth rate of GDP per capita

VARIABLES	AE (1)	AE (1)	CSA (3)	CSA (4)	WANALAC (5)	WANALAC (6)
Threshold estimate ($\hat{\gamma}$) 95% Confidence Interval	17.32 17.31− 17.35		13.95 13.91 − 13.99		13.24 12.81 − 13.33	
GrowthGDPt−1	0.172 (0.122)	0.162 (0.124)	-0.0213 (0.307)	0.0925 (0.257)	0.488*** (0.172)	0.483*** (0.174)
Population growth	-0.275** (0.120)	-0.239* (0.126)	0.362 (0.231)	0.349 (0.241)	0.266* (0.154)	0.269* (0.155)
Investment	0.0641 (0.0540)	0.0366 (0.0547)	0.147*** (0.0307)	0.112*** (0.0285)	-0.0339 (0.0353)	-0.0253 (0.0334)
Polity	-0.122 (0.0963)	-0.292** (0.115)	0.0975 (0.0838)	0.0888 (0.0867)	-0.0162 (0.0625)	-0.00698 (0.0583)

Inflation	-0.0307*** (0.00198)	-0.0229*** (0.00349)	-0.0659*** (0.0228)	-0.0491*** (0.0149)	-0.000584 (0.000502)	-0.000596 (0.000504)
Terms of trade	-0.0188 (0.0294)	-0.0127 (0.0280)	0.0490 (0.0385)	0.0229 (0.0279)	-0.0176 (0.0212)	-0.0204 (0.0221)
Public spending	-0.0623 (0.0811)	-0.0925 (0.0766)	-0.0247 (0.0595)	-0.0812 (0.0513)	-0.0805* (0.0484)	-0.0786 (0.0479)
Inscription rate the primary	0.000683 (0.0234)	0.0140 (0.0279)	0.0339 (0.0625)	-0.00359 (0.0487)	0.0213 (0.0275)	0.0190 (0.0278)
Inscription rate the secondary	-0.000146 (0.0287)	0.00630 (0.0307)	0.00503 (0.0226)	0.00473 (0.0276)	0.0812** (0.0368)	0.0827** (0.0374)
Inscription rate the tertiary		-0.0666** (0.0335)		0.0756 (0.123)		-0.0165 (0.0388)
Coefficient below $\hat{\gamma}$	-1.150*** (0.277)		-40.34** (19.75)		4.016* (2.296)	
Coefficient above $\hat{\gamma}$	-0.0649** (0.0310)		0.0412 (0.125)		-0.0155 (0.0382)	
$\hat{\gamma}$	-8.562*** (1.804)		-12.05** (4.942)		3.729** (1.852)	
Constant	17.49*** (3.736)	10.51*** (3.454)	5.545 (5.002)	-2.291 (3.856)	-1.540 (3.297)	2.217 (3.674)
Observations	552	552	575	575	575	575
Number of ctr	24	24	25	25	25	25
AR (1) (p-value)	0.007	0.006	0.001	0.002	0.002	0.002
AR (2) (p-value)	0.705	0.672	0.332	0.112	0.877	0.894
Hansen J (p-value)	0.572	0.493	0.631	0.788	0.811	0.699
Hansen C (p-value)	0.893	0.920	0.833	0.958	0.998	0.953
Country FE	YES	YES	YES	YES	YES	YES
Instruments	31	29	31	29	31	29

Robust standard errors in parentheses.
*** p<0.01, ** p<0.05, * p<0.1.
The number of instruments is limited to avoid the overfitting problem. In all specifications, we reject the null of the AR(1) test, while we accept it for AR(2). Thus, lagged variables can be safely used as instruments. GDP is assumed to be endogenous while all other explanatory variables are assumed to be exogenous.

Table 2: Countries by region

Advanced Economies (AE)	Central,Eastern, Southern Asia and Sub-Saharan Africa (CSA)	Northern Africa, Western Asia, Latin America and the Caribbean (WANALAC)
Australia	Bangladesh	Algeria
Austria	Benin	Brazil
Belgium	Cameroon	Chile
Canada	China	Colombia
Denmark	Ghana	Costa Rica
Finland	India	Cyprus
France	Indonesia	Dominican Republic
Greece	Kenya	Ecuador
Hungary	Lesotho	Egypt
Ireland	Malaysia	El Salvador
Italy	Malawi	Guatemala
Japan	Mali	Honduras
Luxembourg	Mauritius	Haiti
Netherlands	Mozambique	Jamaica
New Zealand	Nepal	Jordan
Norway	Niger	Mexico
Poland	Pakistan	Morocco
Portugal	Philippines	Nicaragua
Spain	Senegal	Panama
Sweden	South Africa	Paraguay
Switzerland	Sri Lanka	Peru
Turkey	Thailand	Sudan
United Kingdom	Togo	Trinidad and Tobago
United States	Zambia	Tunisia
	Zimbabwe	Uruguay

Table 3: The dependent variable is the growth rate of GDP per capita

VARIABLES	AE (1)	CSA (2)	WANALAC (3)
Threshold estimate ($\hat{\gamma}$) 95% Confidence Interval	17.32 17.31 − 17.35	13.95 13.91 − 13.99	13.24 12.81 − 13.41
$GrowthGDP_{t-1}$	0.116 (0.125)	-0.0258 (0.298)	0.530*** (0.174)
Population growth	-0.0395 (0.103)	0.483* (0.250)	0.299* (0.162)
Investment	0.0875* (0.0500)	0.147*** (0.0313)	-0.0216 (0.0320)
Polity	-0.0795 (0.0905)	0.0962 (0.0734)	-0.0616 (0.0785)
Inflation	-0.0323*** (0.00264)	-0.0669*** (0.0220)	-0.000494 (0.000506)
Terms of trade	-0.00984 (0.0222)	0.0580 (0.0401)	-0.0213 (0.0175)

Public spending	-0.171* (0.103)	-0.00359 (0.0631)	-0.0879* (0.0489)
average year primary	0.793* (0.410)	0.238 (0.414)	0.714** (0.357)
average year secondary	-0.633*** (0.217)	-0.145 (0.423)	0.0337 (0.469)
Coefficient below $\hat{\gamma}$	-24.59*** (6.168)	-927.8* (490.4)	110.1** (47.06)
Coefficient above $\hat{\gamma}$	-1.748 (1.139)	-1.953 (2.428)	0.321 (1.162)
$\hat{\gamma}$	-8.123*** (1.494)	-14.21** (6.331)	3.805** (1.827)
Constant	13.41*** (3.825)	5.627 (5.181)	-3.230 (3.140)
Observations	552	575	575
Number of ctr	24	25	25
AR (1) (p-value)	0.009	0.001	0.002
AR (2) (p-value)	0.549	0.371	0.826
Hansen J (p-value)	0.681	0.654	0.796
Hansen C (p-value)	0.994	0.861	0.983
Instruments	31	31	31
Country FE	YES	YES	YES

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1
The number of instruments is limited to avoid the overfitting problem. In all specifications, we reject the null of the AR(1) test of no autocorrelation in the error terms, while we accept it for AR(2). Thus, lagged variables can be safely used as instruments. GDP is assumed to be endogenous while all other explanatory variables are assumed to be exogenous. Hansen J test is a test for over identification and Hansen C test is a test of exogeneity of iv-style instruments.

Table 4: The dependent variable is the growth rate of GDP per capita

|	AE (1)	AE (2)	AE (3)	CSA (4)	CSA (5)	CSA (6)	WANALAC (7)	WANALAC (8)	WANALAC (9)
Threshold estimate ($\hat{\gamma}$)	17.30	17.21	16.66	13.63	14.35	13.95	12.78	15.74	13.80
95% Confidence Interval	17.26 – 17.31	17.20 – 17.24	16.65 – 16.66	13.63 – 14.05	14.31 – 14.36	13.93 – 13.98	12.77 – 13.05	15.72 – 15.75	13.66 – 13.81
Growth GDPt−1	0.136	0.136	0.151	0.102	0.0803	0.0833	0.485***	0.464**	0.480***
	(0.122)	(0.121)	(0.125)	(0.129)	(0.124)	(0.146)	(0.171)	(0.182)	(0.172)
Population growth	-0.284**	-0.294**	-0.216*	0.346*	0.397	0.388*	0.286*	0.366**	0.280
	(0.120)	(0.115)	(0.127)	(0.209)	(0.252)	(0.226)	(0.163)	(0.146)	(0.177)
Investment	0.0727	0.0793	0.0381	0.119***	0.132***	0.137***	-0.0420	0.00401	-0.00456
	(0.0555)	(0.0601)	(0.0539)	(0.0413)	(0.0421)	(0.0377)	(0.0331)	(0.0318)	(0.0301)
Polity	-0.0916	-0.0272	-0.333**	0.0979	0.107	0.112	-0.0194	0.00597	0.0321
	(0.0812)	(0.0656)	(0.160)	(0.0753)	(0.0866)	(0.0810)	(0.0630)	(0.0552)	(0.0614)
Inflation	-0.0294***	-0.0309***	-0.0180***	-0.0530***	-0.0505***	-0.0511***	-0.000577	-0.000655	-0.000560
	(0.00250)	(0.00332)	(0.00260)	(0.0101)	(0.0103)	(0.0119)	(0.000503)	(0.000515)	(0.000484)
Terms of trade	-0.0221	-0.0229	-0.0188	0.0300	0.0277	0.0304	-0.0176	-0.0129	-0.00489
	(0.0307)	(0.0306)	(0.0255)	(0.0283)	(0.0330)	(0.0313)	(0.0220)	(0.0216)	(0.0275)
Public spending	-0.0718	-0.0784	-0.0998	-0.0636	-0.105*	-0.0658	-0.0845*	-0.0784*	-0.0641
	(0.0789)	(0.0769)	(0.0699)	(0.0410)	(0.0534)	(0.0430)	(0.0490)	(0.0474)	(0.0476)
$Inscription\ rate\ the\ primary_{\{t-3\}}$	0.00244			0.0167			0.0261		
	(0.0204)			(0.0496)			(0.0281)		
$Inscription\ rate\ the\ secondary_{\{t-3\}}$	-0.00684			0.0124			0.0930**		
	(0.0268)			(0.0187)			(0.0430)		

$Coefficient\ below\ \hat{\gamma}_{\{t-3\}}$	-0.953* (0.510)			-19.36* (11.32)			6.873 (4.240)		
$Coefficient\ above\ \hat{\gamma}_{\{t-3\}}$	-0.0634** (0.0319)			0.0851 (0.122)			-0.0154 (0.0480)		
$Inscription\ rate\ the\ primary_{\{t-6\}}$		0.00391 (0.0191)			0.0163 (0.0525)			0.0537* (0.0295)	
$Inscription\ rate\ the\ secondary_{\{t-6\}}$		-0.0101 (0.0231)			0.0243 (0.0215)			0.125*** (0.0464)	
$Coefficient\ below\ \hat{\gamma}_{\{t-6\}}$		-1.036** (0.485)			0.613 (0.832)			0.197 (0.171)	
$Coefficient\ above\ \hat{\gamma}_{\{t-6\}}$		-0.0568 (0.0352)			0.0365 (0.129)			-0.0383 (0.0591)	
$Inscription\ rate\ the\ primary_{\{t-9\}}$			0.0181 (0.0190)			0.0447 (0.0527)			0.0230 (0.0286)
$Inscription\ rate\ the\ secondary_{\{t-9\}}$			-0.00967 (0.0217)			-0.00451 (0.0421)			0.0924 (0.0597)
$Coefficient\ below\ \hat{\gamma}_{\{t-9\}}$			-0.525*** (0.135)			0.377 (1.108)			2.796*** (0.817)
$Coefficient\ above\ \hat{\gamma}_{\{t-9\}}$			-0.0640 (0.0427)			-0.0494 (0.150)			-0.0318 (0.0775)
$\hat{\gamma}$	-7.234*** (2.591)	-7.998*** (2.168)	0.314 (1.016)	-6.981*** (2.347)	-2.128** (0.957)	-2.259*** (0.649)	5.251** (2.609)	-0.961 (0.801)	0.206 (0.822)

Constant	16.42***	16.54***	11.23***	2.987	-1.972	-2.494	-3.154	-0.422	-0.355
	(4.701)	(3.656)	(2.971)	(4.566)	(4.185)	(4.037)	(3.846)	(3.317)	(4.302)
Observations	552	552	552	575	575	575	575	575	575
Number of ctr	24	24	24	25	25	25	25	25	25
AR (1) (p-value)	0.006	0.006	0.005	0.014	0.022	0.017	0.002	0.003	0.03
AR (2) (p-value)	0.578	0.615	0.885	0.111	0.193	0.177	0.888	0.992	0.886
Hansen J (p-value)	0.532	0.569	0.741	0.822	0.762	0.615	0.807	0.700	0.702
Hansen C (p-value)	0.923	0.953	0.991	0.894	0.879	0.741	0.981	0.889	0.925
Instrument	31	31	31	30	30	30	31	31	31
Country FE	YES	YES	YES	YES	YES	YES	YES	YES	YES

Robust standard errors in parentheses
*** $p<0.01$, ** $p<0.05$, * $p<0.1$
The number of instruments is limited to avoid the overfitting problem. In all specifications, we reject the null of the AR(1) test of no autocorrelation in the error terms, while we accept it for AR(2). Thus, lagged variables can be safely used as instruments. GDP is assumed to be endogenous while all other explanatory variables are assumed to be exogenous. Hansen J test is a test for over identification and Hansen C test is a test of exogeneity of iv-style instruments.