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HUMAN CAPITAL AND ECONOMIC GROWTH IN LATIN AMERICA: A COINTEGRATION AND CAUSALITY ANALYSIS

Ejiro U. Osiobe
College of Business, Westcliff University, USA.
Email: ejiroosiobe@westcliff.edu

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ABSTRACT

This paper investigates the causal relationship between government spending on education and economic growth in eight selected Latin American countries by using panel unit root test and panel cointegration analysis for the period 2000-2014. A three-variable model was formulated with trade volume as the second independent variable. The findings conclude that government spending on education and economic growth in the selected countries is positively and significantly associated, in the long and short-run, with evidence of a bidirectional Granger causal relationship between the dependent and the variable of interest, a unidirectional Granger causal relationship between trade volume and economic growth. The implication of our results shows that government secondary school spending on education has a positive impact on the selected countries, and our analysis can be replicated with other countries.

Contribution/Originality: The paper's main contribution to the existing literature by investigating the cointegration and Granger causal relationship between human capital and economic growth for eight selected Latin American countries: Argentina, Brazil, Chile, Colombia, Costa Rica, Mexico, Peru, and El Salvador. The study is one of the few studies which have examined this relationship, which makes it unique and of great value to the field of economics and economic development.

1. INTRODUCTION

The concept of human capital emerged from recognizing that the investment in human capital by an individual or a firm has an increasing return to scale on productivity. Human capital can be split into three concepts: talent (natural given ability), acquired qualification(s), and expertise. The term human capital was first used in the late '50s and early '60. Before the '50s and '60s, the term was a suggestive phrase in economics and played no role in the decision-making algorithm when it came to recommending, passing, and implementing educational policies. Upon empirical and practical evidence that there was a high return on quality education and it helped promote a nation's national goals, new ideas on public spending on education as a form of a nation's domestic investment was advocated by academics, policymakers, and practitioners.

This paper contributes to the research of economic growth, that is, human capital and how it fosters economic growth following Lucas Jr (1988); Barro (1991); Mankiw, Romer, and Weil (1992). The paper's main contribution to the existing literature is it analyzes the cointegration and Granger Causal Relationship (GCR) between human capital proxied as Secondary School Government Expenditure $(SGE_{i,t})$, which is the variable of interest and economic growth proxied as $(RGDP_{per\ capita_{ppp_{i,t}}})$ for eight Selected Latin American Countries (SLAC): Argentina, Brazil, Chile, Colombia, Costa Rica, Mexico, Peru, and El Salvador; suggesting that there is:

(a) a bidirectional GCR between $SGE_{i,t}$ and $RGDP_{per\ capita_{ppp_{i,t}}}$ both in the short and long run

(b) an increase in $RGDP_{per\ capita_{ppp_{i,t}}}$ will boost the nation's trade volume $(VT_{i,t})$

(c) a unidirectional GCR between $RGDP_{per\ capita_{ppp_{i,t}}}$ and $VT_{i,t}$, moving from $RGDP_{per\ capita_{ppp_{i,t}}}$ to $VT_{i,t}$.

1.1. Understanding Human Capital

For this paper, human capital will be defined as human labor expertise used to produce other goods and services. Schultz (1961) defined human capital as a value used for measuring human potential. Smith (1776) "[stated that] the improvement to human capital through training, education, and experience makes the individual enterprise more profitable while adding to the collective wealth of the nation. Human capital can be seen as the collective wealth of a society in terms of judgment, skills, training, knowledge, experiences, and talent for a population (Schultz, 1961; Schultz., 1960).

1.2. Return on Human Capital

In a standard growth economic model (Mankiw et al., 1992; Romer, 1989, 1990; Romer, 1996; Romer, 1994) the accumulation of human capital is seen as a (private and public) investment undertaken to promote economic growth and development. The principle of opportunity cost is implemented in the model where the individual trades (some initial proportion of) his/her current income during their education and training period in return for and the hopes of higher future earnings. This trade-off will only be done if the additional schooling or training (i.e., investment in human capital) that translates to higher future earnings compensate the current costs (tuition and training course fees, forgone earnings while at school, and reduced wages during the training period) of the sacrifices.

2. LATIN AMERICA

In the last two decades, our SLAC and Latin America, in general, have achieved remarkable socio-economic progress. The lower and middle class has grown to historic levels; access to education and health care has expanded; poverty has been cut almost in half; property rights are recognized, and prosperity is being shared (World Economic Forum, 2016). As a result, most Latin American countries have now achieved "middle-income" and emerging nation's status, but the work(s) is far from done. If our SLAC is to move onto a path of first-world countries, achieving sustained socio-economic growth, these nations' will have to address numerous challenges– beginning with its lack of high-quality human capital (World Economic Forum, 2016). Today, Latin America's young population has enormous potential, with 67% of the region's total population being counted in the labor force. Population aging is not yet a significant concern, as it is in the developed economies – many workers lack the skills required to fulfill the demand for labor (World Economic Forum, 2016).

Unskilled human capital makes much-needed productivity growth challenging to come by in these regions. Companies in the productive sectors in the areas – which should be creating more and better-quality jobs – struggle to grow due to this human capital crisis, much less compete in the global economy (World Economic Forum, 2016). The continued worldwide technological advancement threatens to increase the existing gap between available skills and those demanded at the worldwide market. If our SLAC and other Latin American countries are to or want to compete effectively and efficiently with those based in developed or emerging economies, the nations' must remedy this by raising the skill level of its workforce (World Economic Forum, 2016).

2.1. Previous Works

Kögel and Prskawetz (2001) analyzed how the advancement of human capital affected the industrialized world and escaping the Malthusian trap characterized by low economic and high population growth to the post-Malthusian regime characterized by high economic and low population growth. The authors' examined the transition between these regimes by constructing a growth model with two types of consumer goods (an agricultural and manufacturing product), endogenous fertility, endogenous technological progress in the manufacturing sector.

Gibbons and Waldman (2004) in their paper, that built on Becker (1964) expressed the economic implications of the third type of human capital *Task-Specific*, which is as essential as the general-purpose and firm-specific. The team *Task-Specific* human capital is a situation when a person is acquiring the skills for a particular job as opposed to the firm or the industry. This type of human capital is based on the simple—plausible ideology that most human capital accumulation is due to *Task-Specific* learning by doing. The authors' concluded by discussing how the concept of human capital can explain the cohort effects and provide an essential perspective regarding job-design issues.

Becker (1964) work on human capital focused on the presupposition on general-purpose and firm-specific human capital. Becker (1964) developed one of the most significant strands of research that focused on human capital and the economic approach to human capital. Teixeira (2014) explored (Becker, 1964) early work on human capital, which Becker considered being a method of analysis rather than an assumption about human emotions, because, an attempt to explain various facets of human behavior through a set of simplified assumptions regarding human behavior, a result of individual choices characterized by utility maximization a forward-looking stance, consistent rationality, and stable and persistent preferences (Becker, 1964). Asserting that the decisions were constrained by income, calculating capabilities, time, opportunities, and imperfect memory (Becker, 1993).

Nerdrum and Erikson (2001) analyzed intellectual capital and found complementary capacities of competence and commitment. Based on theoretically and empirically robust human capital theory, Nerdrum and Erikson (2001) found that intellectual capital generates added value and creates wealth. The authors viewed resources to be perceived to be both tangible and intangible; and an extension of the human capital theory to be included in the intangible capacities of people.

3. METHODOLOGY, MODEL, AND RESULTS

As the world transitions from the millennial generation (1980 – 1995) to generation Z (1996 – 2010) in colleges, it is safe to conclude that the increasing enrollment rate can be attributed to the primary and secondary school net favorable educational policies implemented by educational policymakers. Over the decades, education, which for this paper will be defined as the successful completion of a formal primary school system, has led to the effective use of physical and financial capital leading to the efficient use of units of labor in the production process (Smith, 1776) an overall increase in production.

3.1. Data Definition and Source

The study employs panel data between 2000 – 2014 for eight SLAC: Argentina, Brazil, Chile, Colombia, Costa Rica, Mexico, Peru, and El Salvador. These countries were selected due to data availability. The data was collected from (World Penn Tables, 2019) Real Gross Domestic Product-per capita-purchasing power parity

($RGDP_{per\ capita_{ppp_{i,t}}}$) which is Gross Domestic Product (GDP) converted to international dollars using purchasing

power parity rates divided by total population; return on education ≡ human.

capital ≡ ($HC_{i,t}$), which is based on years of schooling and returns to education. The second source of our data

is (World Development Index (World Penn Tables, 2019) Volume of Trade ($VT_{i,t}$) is net export + net import;

Primary School Government Expenditure ($PGE_{i,t}$), which is the average general government expenditure (current, capital, and transfers) per student in the given level of education, expressed as a percentage of Gross Domestic Product per capita ($GDP_{per\ capita}$); Secondary School Government Expenditure ($SGE_{i,t}$) is the average general government expenditure (current, capital, and transfers) per student in the given level of education, expressed as a percentage of $GDP_{per\ capita}$. Where i = countries and t = years.

3.2. Correlation analysis:

The correlation coefficient (r) was applied to measure the relationships between $HC_{i,t}$, $PGE_{i,t}$, and $SGE_{i,t}$ in our

data set and r is given as:

$$r = \frac{n(\sum HC_{i,t}\,PGE_{i,t}\,SGE_{i,t}) - (\sum HC_{i,t})(\sum PGE_{i,t})(\sum SGE_{i,t})}{\sqrt{[n\sum HC_{i,t}^2 - (\sum HC_{i,t})^2]\,[n\sum PGE_{i,t}^2 - (\sum PGE_{i,t})^2][n\sum SGE_{i,t}^2 - (\sum SGE_{i,t})^2]}} \quad (1)$$

Table-1. Correlation analysis.

Correlation *T-Stat* (P-Value)	$HC_{i,t}$	$PGE_{i,t}$	$SGE_{i,t}$
$HC_{i,t}$	1.00 *n/a* n/a		
$PGE_{i,t}$	0.96 *36.66* (0.00)***	1.00 *n/a* (n/a)	
$SGE_{i,t}$	0.96 *37.69* (0.00)***	0.85 *17.12* (0.00)***	1.00 *n/a* (n/a)

Note:
*indicates significance level at 10%
** indicates significance level at 5%
*** indicates significance at 1%

Given the strong relationship between $HC_{i,t}$, $PGE_{i,t}$, and $SGE_{i,t}$; $HC_{i,t}$ and $PGE_{i,t}$ were dropped from the base model. Equation one shows the correlation coefficient between $HC_{i,t}$, $PGE_{i,t}$, and $SGE_{i,t}$.

Table 1 shows the correlation relationship (see equation one); our result shows a significant relationship between $PGE_{i,t}$, and $SGE_{i,t}$ while Figure 1 shows the graphical representation of our results. $SGE_{i,t}$ was selected to the base model because, according to Feinstein, Robertson, and Symons (1999), the most potent parental input is parental interest in education. Building on this parental input will lead a child to achieve more in their educational career.

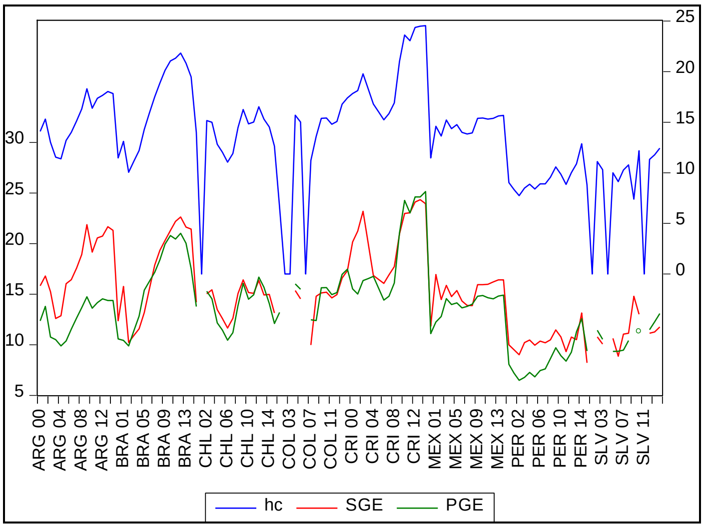

Figure-1. Line graph of the cross-correlation between $HC_{i,t}$, $PGE_{i,t}$, and $SGE_{i,t}$.

Note:
HC: Left Axis.
SGE & PGE: Right Axis.

3.3. Estimation Concerns

To test the Panel Unit Root (PUR) among the explained and explanatory variables, the first step is to examine the unit root properties of the data, because, for our variables to be integrated of the same order, stationarity is required. For this study, the unit root test by Levin, Lin, and Chu (2002); Breitung and Das (2005) and Im, Pesaran, and Shin (2003) were implemented. The Levin et al. (2002) test is based on the Augmented Dickey-Fuller (ADF) test. The null hypothesis of our unit root test is non-stationary of the data. For the panel cointegration test, the Pedroni panel cointegration test (Pedroni, 2002, 2004) was adopted. The test allows various cross-sectional interdependencies along with other different individual effects to establish the cointegration. Then, the Panel Granger Causality, Vector Error Correction Model $(VECM)$ test would be analyzed.

3.4. Model Specification

The theoretical structure of the study will be based on the new endogenous theory of Romer (1994). The Romer model argues that the main factor for economic growth is the accumulation of knowledge, asserting that economic growth is dependent on human capital, labor, physical capital, and technology. Romer's production function is as follows:

$$Y(t) = K(t)\ H(t)p\ Y[A(t)\ L(t)], 1 > x > 0, p > 0, a + p < 1 \quad (2)$$

Romer's production function is as follows:

$$Y_t = K_t^{\alpha} (A, L)^{\beta} l^{\varepsilon} \quad (3)$$

$0 < \alpha < 1$

Then we normalize (L) the simple endogenous growth model, where K embodies both physical capital and human capital.

$Y = AK$

$\frac{Y}{L} = A.\ \frac{K}{L}$

$y = Ak$

The model implicitly assumes that $A > 0$. The also assumes that the labor force is growing at a constant rate of (n), and there is no depreciation of capital. $(\sigma = 0)$. For the study and following Mankiw et al. (1992); Romer (1989); Romer (1990); Romer (1994) and Vieira (2013) the differential equation of the neoclassical growth model is

The paper defines the total factor productivity (A) as

$$A = f(SGE_{i,t}\ and\ VT_{i,t}) = SGE_{i,t}^{\beta_1}\ VT_{i,t}^{\beta_2} \quad (4)$$

Where $Y_t = RGDP_{per\ capita_{ppp}}$ $SGE_{i,t}$ = human capital and $VT_{i,t}$ = volume of trade

Substituting $y = Ak$

$$Y_t = ɳK_t^{\alpha}\left(SGE_{i,t}^{\beta_1}\ VT_{i,t}^{\beta_2}\right)l^{\varepsilon} \quad (5)$$

Taking the logarithm of the variables, differencing $RGDP_{per\ capita_{ppp}}$ we get:

$$lnY_t = \beta_0 + \beta_1 lnSGE_{i,t} + \beta_2 lnVT_{i,t} + \varepsilon_t \quad (6)$$

Where: $lnɳ = \beta_0$, $lnl^{\varepsilon} = 1$, and ln = natural logarithm. Where: K = Physical capital, H = Human capital, A = Technology, L = Labor.

The assumption of $K, H,$ and L are as follows:

$\dot{K}(t) = S_K Y(t)$, $\dot{H}(t) = S_H Y(t)$, and $\dot{L}(t) = nL(t)$

Where: S_K = The portion of output assigned to physical capital accumulation for $\dot{K}$, S_H = the portion of output assigned to human capital accumulation for $\dot{H}$, and n is the growth rate.

3.5. The Dynamics of the Model

Where equation seven represent the Cobb-Douglas production function, showing physical and human capital that is defined as

$$k = \frac{K}{AL}, h = \frac{H}{AL}, and\ y \quad (7)$$

Which implies:

$y(t) = f(k(t, h(t)$

Differentiating with respect to time, we get:

$\Delta y(t) = \Delta f_k k(t) + \Delta f_h h(t)$

The model will be estimated using the stated/base equation/model of the study:

$$lnRGDP = \beta_0 + \beta_1 SGE_{i,t} + \beta_2 lnVT_{i,t} + \varepsilon_{i,t} \quad (8)$$

3.6. Empirical Results

3.6.1. Panel Unit Root Test

Conventionally, macroeconomics time series are non-stationary (Nelson, 1982). It is necessary to test the stationary properties of the data. This requires examining the order of integration of the data set, which is the unit root test. A time series is stable if its mean, variance, and autocovariance are independent of time (Gujarati, 2012).

The panel data technique referred to above has appealed to the researchers because of its weak restrictions. It captures the country-specific effects and allows for heterogeneity in the direction and magnitude of the parameters across the panel and provides a high degree of freedom in the model selection. Following the methodology used in earlier works (Al-Yousif, 2002), we test for the trend and intercept stationary for our variables. With a null of non-stationary, the test is a residual-based test that explores the performance of three different statistics. These three statistics reflect a combination of Levin et al. (2002); Breitung (2000) and Im et al. (2003).

The Levin et al. (2002) test is based on the ADF test, which assumes homogeneity in the dynamics of the autoregressive coefficients for all panel units with cross-sectional independence. The LLC equation is as follows:

$$\Delta X_{it} = \alpha_i + \beta_i X_{i,t-1} + \delta_i t + \sum_{j=1}^{k} \gamma_{ij} X_{i,t-j} + \vartheta_{it}$$

Where: Δ = Is the first difference operator, X_{it} = Is the dependent variable, ϑ_{it} = Is the white-noise disturbance with a variance of σ^2, i = 1,2,…..,n indexes countries, and t = 1,2,….., T indexes time. According to Levin et al. (2002) the hypothesis to test the stationarity of the panel data is: $H_o: \beta_i = 0$ and $H_1: \beta_i < 0$. Where the alternative hypothesis; corresponds to Y_{it} being stationary. The test also finds that while comparing with the single equation of the ADF test, the panel approach substantially increases its power in finite samples. Levin et al. (2002) also specified another equation as follows, which restricts $\hat{\beta_i}$ while keeping it identical across countries.

$$\Delta X_{it} = \alpha_i + \beta_i X_{i,t-1} + \delta_i t + \sum_{j=1}^{k} \gamma_{ij} \Delta X_{i,t-j} + \theta_{it}$$

In the equation, it is assumed that: $H_o{:}\beta_1 = \beta_2 = \cdots = \beta_n = 0$ and $H_1{:}\beta_1 = \beta_2 = \cdots = \beta_n < 0$. Where: $t - statistics = t_{\hat{\beta}}/\sigma(\hat{\beta})$ and $\Delta X_{it} = \alpha_i + \beta_i X_{i,t-1} + \delta_i t + \sum_{j=1}^{k} \gamma_{ij} \Delta X_{i,t-j} + \theta_{it} = \hat{\beta}$ *and its standard error* $= \sigma(\hat{\beta})$. The Breitung unit root test is based on Breitung (2000); Breitung and Das (2005) developed a pooled panel unit root test that does not require bias correction factors. This is achieved by (depending upon case considered) variable transformation. The Breitung unit root test has better small-sample performance; that is, it is pre-whitening[1].

$$\Delta y_{it} = \alpha_i + \sum_{j=1}^{P_i} y_{ij} \Delta y_{it-j} + v_{it}$$

In which the residuals $\widetilde{e_{it}}$ and $\widetilde{f_{it}}$ are computed as follows:

$$\widetilde{e_{it}} = \Delta y_{it} - \sum_{j=1}^{P_i} \widehat{\gamma_{ij}} \Delta y_{it} - j$$

$$\widetilde{f_{it-1}} = y_{it} - 1 - \sum_{j=1}^{P_i} \widehat{y_{ij}} y_{it} - j - 1$$

The residuals at the base model are

$$\Delta y_{it} = \alpha_i + \sum_{j=1}^{P_i} y_{ij} \Delta y_{it-j} + v_{it}$$

Then standardized by the regression standard error to $\widetilde{e_{it}}$ and $\widetilde{f_{it-1}}$. Then, the residuals of $\widetilde{e_{it}}$ and $\widetilde{f_{it}}$ are orthogonalized as follows:

$$e_{it}^{*} = \sqrt{\frac{T-t}{T-(t+1)}}\left(\Delta \widehat{e_{it}} - \frac{1}{T-t}\left(\Delta \hat{e}i_{t+1} + \cdots + \Delta \hat{e}i_{T}\right)\right)$$

$$f_{it}^{*} = \hat{f}_{it-1} - \hat{f}_{i1} + \frac{t-1}{T}\left(\hat{f}_{iT} - \hat{f}_{i1}\right)$$

Where: T = The sample size after the auxiliary regressions. Then the unit root is performed in the pooled regression.

[1] Pre-whitening involves the first step regressions (for each i).

$e_{it}^{*} = \emptyset^{*} f_{it}^{*} + v_{it}^{*}$

Where our hypothesis is: $H_o: \emptyset^{*} = 0$ and $H_1: -1 < p_i < 1$. Where: i = 1, …., N_1 and p_i = 1 for $i = N_1, \ldots, N$. The Breitung unit root test shows the t-statistic of the test that has a standard Normal limiting distribution (for a sequential limit of the first $T \rightarrow \infty$ followed by $N \rightarrow \infty$).

The IPS is based on Im et al. (2003) which uses the average of the $t_{\beta i}$ statistics from

$$\Delta X_{it} = \alpha_i + \beta_i X_{i,t-1} + \delta_i t + \sum_{j=1}^{k} \gamma_{ij} \Delta X_{i,t-j} + \theta_{it}$$

Then it's used to perform the following $\bar{Z}$ statistic. Where: $\bar{Z} = \sqrt{N}\,[\bar{t} - E(\bar{t})]/\sqrt{V}(\bar{t})$ $\bar{t} = \left(\frac{1}{N}\right)\sum_{i=1}^{N} t_{\beta i}$, $E(\bar{t})\ and\ V(\bar{t})$ = are the mean and variance of each $t_{\beta i}$ statistic. Eventually, the $\bar{Z}$ converges to a standard normal distribution. So, the IPS test is based on the average individual unit root test, and it is expressed by $\bar{t} = \left(\frac{1}{N}\right)\sum_{i=1}^{N} t_{\beta i}$. The result of the PUR test is in Table 2. The table includes the Levin et al. (2002); Breitung (2000); Breitung and Das (2005) and Im et al. (2003).

Table-2. Panel Unit Root Table (Trend and Intercept).

	LLC	*IPS*	**Breitung**	*LLC*	*IPS*	**Breitung**
Variable	***Levels***			***1st Difference***		
$RGDP_{per\ capita_{ppp_{i,t}}}$	0.00***	0.13	0.09*	n/a	0.00)***	(0.01)***
$SGE_{i,t}$	0.04**	0.11	0.76*	n/a	(0.00)***	(0.04)**
$VT_{i,t}$	0.00***	0.49	0.23	n/a	(0.00)***	(0.00)***

Notes:
* indicates significance level at 10%
** indicates significance level at 5%
*** indicates a significance level at 1%.

3.6.2. Lag Selection Criteria Test

Given our variables are now rendered stationary, we then test for the existence of a cointegrating relationship. To analyze the cointegration test, the lag length is first determined using the Lag Selection Criteria test. Five lag length selection criteria have been employed in this study to assess the Autoregressive (AR) lag length of our variables. The AR lag length p is unknown and can, therefore, be estimated using the lag selection criteria. The analysis would be carried out using the likelihood ratio (LR) test, according to Sims (1980).

$$LR = (T - c)|\log|\Omega_1| - log|\Omega_2|$$

Where: T = Sample size, c = Total number of parameters estimated in the model, Ω_1 = Is the maximum likelihood estimate of the variance-covariance matrix of the residuals in the Vector Autoregression (VAR) model under the null hypothesis, and Ω_2 = Is the maximum likelihood estimate of the variance-covariance matrix of the residuals in the VAR model under the alternative hypothesis. The LR test is a chi-square distributed with the degrees of freedom equal to the number of restrictions that are tested. Final Prediction Error (FPE) is given as:

$$FPE(p) = |\tilde{\Sigma}(p)| + (\frac{\hat{T} + M_p + 1}{\hat{T} - M_p - 1})^2$$

Akaike Information Criterion (AIC) , according to and Akaike (1974) is given as

$$AIC(p) = \ln|\hat{\Sigma}_p| + \frac{2k^2p}{T}$$

Where: T = Is the number of observations, k = Is the dimension of the time series, p = Is the estimated number of lags, $\hat{\Sigma}_p$ = Is the estimated white noise covariance matrix. Shibata (1976) proves that the AIC criterion, in the univariate $AR(p)$ representation, is inconsistent in the sense that asymptotically it overestimates the exact order with a nonzero probability. Schwarz Information Criterion (SC), according to Schwarz (1978) the equation is given as

$$SC(p) = \ln|\hat{\Sigma}_p| + \frac{k^2 p \ln T}{T}$$

and Hannan-Quinn Criterion (HQ) is given as

$$HQ(p) = \ln|\hat{\Sigma}_p| + \frac{2pk^2 \ln \ln T}{T}$$

Table 3 shows the lag length selection results.

Table-3. Lag length selection criteria test.

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-229.34	N/A	1.27e-05	8.59	8.85	8.69
1	517.05	1275.65	1.25e-16*	-16.77	-14.72*	-15.97*
2	566.07	71.31*	1.36e-16	-16.77*	-12.93	-15.28
3	604.18	45.73	2.55e-16	-16.37	-10.75	14.20

Note:
*Indicates lag order selected by the criterion.
LR: sequential modified LR test statistic (each test at 5% level).
FPE: Final prediction error.
AIC: Akaike information criterion.
SC: Schwarz information criterion.
HQ: Hannan-Quinn information criterion.

3.6.3. Panel Cointegration Test

Our study identifies two kinds of test statistics the pooling residuals within the dimension of the panel and the other without the dimension. The long-run equilibrium equations are as follows:

Panel V-Statistic

$$Z_v = \left(\sum_{i=1}^{N} \sum_{t=1}^{T} \hat{L}_{11i}^{-2} \hat{e}_{it-1}^{2} \right)^{-1}$$

Panel rho-Statistic

$$Z_p = \left(\sum_{i=1}^{N} \sum_{t=1}^{T} \hat{L}_{11i}^{-2} \hat{e}_{it-1}^{2} \right)^{-1} \sum_{i=1}^{N} \sum_{t=1}^{T} \hat{L}_{11i}^{-2} \left(\hat{e}_{it-1}^{2} \Delta \hat{e}_{it} - \hat{\lambda}_i \right)$$

Panel PP-Statistic

$$Z_t = \left(\sum_{i=1}^{N} \sum_{t=1}^{T} \hat{L}_{11i}^{-2} \hat{e}_{it-1}^{2} \right)^{-1/2} \sum_{i=1}^{N} \sum_{t=1}^{T} \hat{L}_{11i}^{-2} \left(\hat{e}_{it-1}^{2} \Delta \hat{e}_{it} - \hat{\lambda}_i \right)$$

Panel ADF-Statistic

$$Z_t^{*} = \left(\hat{\sigma}^{*2} \sum_{i=1}^{N} \sum_{t=1}^{T} \hat{L}_{11i}^{-2} \hat{e}_{it-1}^{2} \right)^{-1/2} \sum_{i=1}^{N} \sum_{t=1}^{T} \hat{L}_{11i}^{-2} \left(\hat{e}_{it-1}^{*} \Delta \hat{e}_{it}^{*} \right)$$

Group rho-Statistic

$$\tilde{Z}_p = \sum_{i=1}^{N} \left(\sum_{t=1}^{T} \hat{e}_{it-1}^{2} \right)^{-1} \sum_{t=1}^{N} \left(\hat{e}_{it-1}^{2} \Delta \hat{e}_{it} - \hat{\lambda}_i \right)$$

Group PP-Statistic

$$\tilde{Z}_t = \hat{\sigma}^{2} \left(\sum_{t=1}^{T} \hat{e}_{it-1}^{2} \right)^{-1/2} \sum_{t=1}^{T} \left(\hat{e}_{it-1} \Delta \hat{e}_{it} - \hat{\lambda}_i \right)$$

Group ADF-Statistic

$$\tilde{Z}_t^{*} = \sum_{i=1}^{N} \left(\sum_{t=1}^{T} \hat{s}_i^{2} \hat{e}_{it-1}^{*2} \right)^{-1/2} \sum_{t=1}^{T} \left(\hat{e}_{it-1}^{*} \Delta \hat{e}_{it}^{*} \right)$$

Where: $\hat{e}_{it}$ = Is the estimated residual from our primary equation

$$lnRGDP_{per\ capita_{ppp_{i,t}}} = \beta_0 + \beta_1 lnSGE_{i,t} + \beta_2 lnVT_{i,t} + \varepsilon_{i,t} \quad (9)$$

Where: $\hat{L}_{11i}^{-2}$ = Is the estimated long-run covariance matrix for $\Delta \hat{e}_{it}^{*}$, $\hat{\sigma}_i^{2} = \hat{s}_i^{2} \left(\hat{S}_i^{*2} \right)$ = Are the long run and contemporaneous variance for the country i. The Panel V-Stat, Panel rho-Stat, Panel PP-Stat, Panel ADF-Stat, Group rho-State, Group PP-Stat, and Group ADF-Stat are normally and asymptotically distributed. The results are as follows:

Table-4. Pedroni panel cointegration test.

Panel Group Statistics	Statistic	Prob
Panel V-Statis tic	5.90	0.00***
Panel rho-Statis tic	3.33	0.99
Panel PP-Statis tic	-2.64	0.00***
Panel ADF-Statis tic	-2.84	0.00***
Group rho-Statis tic	4.01	1.00
Group PP-Statis tic	-5.74	0.00***
Group ADF Statis tic	-3.03	0.00***

Note:
* indicates significance at 10%
** indicates significance at 5%
*** indicates significance at 1%

3.6.4. Fully Modified Ordinary Least Squares ($FMOLS$)

The study employed the $FMOLS$ technique to determine the coefficients of the long-run relationship between the explained and the explanatory variables. The $FMOLS$ estimates show the cointegration regression by accounting for serial correlation effects and endogeneity in the regression (Phillips, 1995). Pedroni (2002); Pedroni (2004) $FMOLS$ can accommodate considerable heterogeneity across individual members of the panel. Pedroni (2002) further stated that the cointegration test determines whether our variables are cointegrated without providing estimated coefficients for the individual variables in the panel.

Table-5. Results of long-term coefficient estimates by $FMOLS$.

Variables	Model
$SGE_{i,t}$	0.005 (0.00)***
$VT_{i,t}$	0.36 (0.00)***
R-squared (Adj-R)	87% (86%)

Note:
p-value in parenthesis
* indicates significance level at 10%
** indicates significance level at 5%
*** indicates significance at 1%

Table 5 shows a positive, statistically significant long-run relationship between $RGD\,P_{per\ capita_{ppp_{i,t}}}$ and $SGE_{i,t}$ with a coefficient of 0.005. This indicates that a 1% increase in $SGE_{i,t}$ is associated with a 0.005%-point increase in $RGD\,P_{per\ capita_{ppp_{i,t}}}$ in our LAC. The 0.005%-point associated with $SGE_{i,t}$ implies that there is an incentive for a nation to increase its expenditure on secondary school education as it will translate to improved skillset, knowledge, and innovative ideas. This improvement, in the long run, will lead to the creation of new jobs, (an) increase in productivity, an increase in the disposable income of employees, and an increase in the consumption of consumer goods and services. This result indicates that the incentive to increase expenditure on $SGE_{i,t}$ of a nation would yield a positive outcome as it translates to an increase in $RGD\,P_{per\ capita_{ppp}}$. This result is consistent with Edrees (2016), Mehrara and Musai (2013); Khembo and Tchereni (2013); Rahman (2011) and Sharma and Sahni (2015) and Osiobe

(2020) which is a similar vein study that analyzes the relationship among $RGDP_{per\ capita_{ppp_{i,t}}}$ (as a proxy for economic growth) and the examined variable, $HC_{i,t}$, (as a proxy for human capital) $CS_{i,t}$ (as a proxy for physical capital), and $TB_{i,t}$ as the explanatory variables between 1950-2014, and expands on the countries used in the paper, by adding Bolivia, Honduras, Nicaragua, Panama, Uruguay, and Venezuela. The $VT_{i,t}$ showed a positive, statistically significant result with a coefficient of 0.36. This implies that a 1% increase in the $VT_{i,t}$ is associated with a 0.36%-point increase in $RGDP_{per\ capita_{ppp_{i,t}}}$ in our LAC as the nation becomes more trade-friendly.

3.6.5. Panel Granger Causality (VECM)

The study of the causal relationship among economic variables has been one of the main objectives of empirical econometrics. According to Engle (1987) cointegrated variables must have an error correction representation. One of the implications of the Granger representation theorem is that if non-stationary series are cointegrated, then one of the series must Granger cause the other (Gujarati, 2012). To examine the direction of causality in the presence of cointegrating vectors, the GC test is estimated using the following specifications:

$$\begin{pmatrix} \Delta lnRGDP_{per\ capita_{ppp\ i,t}} \\ \Delta SGE_{i,t} \\ \Delta lnVT_{i,t} \end{pmatrix} = \begin{pmatrix} \emptyset_{i,1} \\ \emptyset_{i,2} \\ \emptyset_{i,3} \end{pmatrix} + \sum_{l=1}^{m} \begin{pmatrix} \theta_{1,2,3,4,k} \\ \theta_{2,1,3,4,k} \\ \theta_{3,1,2,4,k} \end{pmatrix} \begin{bmatrix} \Delta lnRGDP_{i,t} \\ \Delta SGE_{i,t} \\ \Delta lnVT_{i,t} \end{bmatrix} + \begin{pmatrix} \lambda_1 \\ \lambda_2 \\ \lambda_3 \end{pmatrix} ECT_{i,t-1} + \begin{pmatrix} \varphi_{1,i,t} \\ \varphi_{2,i,t} \\ \varphi_{3,i,t} \end{pmatrix} \quad (10)$$

Where: Δ = the first differences, $\emptyset_{i,j}(j,k = 1,2)$ = fixed country effect, $I(I = 1, \ldots m)$ = Is the lag length determined by SIC, $ECT_{i,t-1}$ = Is the estimated lagged error correction term (ECT) derived from the long-run cointegrating relationship, λ_i = Is the adjustment coefficient, and $\emptyset_{1,I,t}$ = Is the disturbance term, which is assumed to have a zero mean.

Table-6. The estimate of the panel vector error correction model.

Explained Variable	Explanatory Variables – Chi-square value (Wald test)			
	$RGDP_{per\ capita_{ppp_{i,t}}}$	$SGE_{i,t}$	$VT_{i,t}$	ECT (-1) t-Test
$RGDP_{per\ capita_{ppp_{i,t}}}$		7.98 (0.04)**	2.51 (0.47)	-0.031 [-2.44]
$SGE_{i,t}$	7.32 (0.02)**		1.83 (0.40)	-1.12 [-3.67]
$VT_{i,t}$	6.22 (0.10)*	2.01 (0.57)		-0.00 [-0.24]

Note:
*indicates significance level at 10%
** indicates significance level at 5%
*** indicates significance at 1%

Table 6 and 7 shows our estimates indicate a significant bidirectional GCR between $RGDP_{per\ capita_{ppp_{i,t}}} \leftrightarrow SGE_{i,t}$ and unidirectional GCR between $RGDP_{per\ capita_{ppp_{i,t}}} \rightarrow VT_{i,t}$. The bidirectional GCR between $RGDP_{per\ capita_{ppp_{i,t}}} \leftrightarrow SGE_{i,t}$ implies a chicken and egg GCR , but the $VECM$ doesn't tell us which of our variables comes first. If it is the dependent variable ($RGDP_{per\ capita_{ppp_{i,t}}}$) or the independent ($SGE_{i,t}$). In light of this dilemma, our results can be associated with; the following interpretation as a nation's $RGDP_{per\ capita_{ppp_{i,t}}}$ increases, this will lead to a rise in the country's real gross domestic product, increasing the nation's net expenditure on $SGE_{i,t}$, which will increase the supply and the demand for quality blue-collar and Artisan jobs. The unidirectional GCR between $RGDP_{per\ capita_{ppp_{i,t}}} \rightarrow VT_{i,t}$ implies ceteris paribus as $RGDP_{per\ capita_{ppp_{i,t}}}$ starts to rise, Marginal Propensity to Consume (MPC) will increase, as well as Marginal Propensity to Save (MPS), which in turn will increases net investment, creating more jobs in the domestic market, increasing the total output of consumer and producers goods and services within the country, which will translate and expand into the international market, thus increasing the volume of trade (Import + Export) and boosting the wealth of the national real gross domestic product.

4. SUMMARY STATEMENT, CONCLUSION, AND EDUCATIONAL POLICY RECOMMENDATIONS

The results contained in Table 6 support the long-term GCR between our explained and explanatory variables in all the selected countries. In contrast, the short-run GCR results from our variables can be found in Table 7. Our results imply that $SGE_{i,t}$ does Granger cause $RGDP_{per\ capita_{ppp_{i,t}}}$ in the short-run and long-run, and vice versa in the respective countries. Given the results obtained, the importance of $SGE_{i,t}$ in boosting economic growth can't be overemphasized. While $VT_{i,t}$ does not GC $RGDP_{per\ capita_{ppp_{i,t}}}$ in the short-run, but the reverse holds to be true, and in the long-run, it does GC economic growth in the respective countries. This study investigates the GCR between $SGE_{i,t}$ and economic growth in SLAC. The study employs a time series annual data between 2000–2014 for a panel of eight SLAC: Argentina, Brazil, Chile, Colombia, Costa Rica, Mexico, Peru, and El Salvador.

Table-7. Summary of main findings of short-run causality.

Variables	Direction of Causality	Implication
$RGDP_{per\ capita_{ppp_{i,t}}} \leftrightarrow SGE_{i,t}$	Bidirectional	Granger causality runs from $RGDP_{per\ capita_{ppp\ i,t}}$ to $SGE_{i,t}$
$RGDP_{per\ capita_{ppp_{i,t}}} \rightarrow VT_{i,t}$	Unidirectional	Granger causality runs from $RGDP_{per\ capita_{ppp\ i,t}}$ to $VT_{i,t}$

Note:
↔ indicates causality running in both direction
→ indicates causality from left to right
← indicates causality from right to left
↑ increase
↓ decrease
— leads too

The data was collected from World Penn Tables (2019). The empirical findings reveal that after controlling for $SGE_{i,t}$ $VT_{i,t}$, and $RGDP_{per\ capita_{ppp\ i,t}}$ there is a positive statistically significant long-run relationship between $RGDP_{per\ capita_{ppp\ i,t}}$ and $SGE_{i,t}$ with a coefficient of 0.005. This indicates that a 1%-point increase in $SGE_{i,t}$ will lead to a 0.005%-point increase in $RGDP_{per\ capita_{ppp_{i,t}}}$ in the SLAC. This result indicates that the incentive to improve the secondary school attainment rates and levels (HDI) of a nation would yield a positive outcome as it translates to creating new blue-collar workers and an increase in $RGDP_{per\ capita_{ppp_{i,t}}}$ in the SLAC. The $VT_{i,t}$ has a positive statistically significant long-run relationship with $RGDP_{per\ capita_{ppp_{i,t}}}$, with a coefficient of 0.36%. That is a one percent increase in $VT_{i,t}$ causes an increase in $RGDP_{per\ capita_{ppp_{i,t}}}$ by 0.36%-point. Our results also indicate a significant causal link between $RGDP_{per\ capita_{ppp\ i,t}}$ and $SGE_{i,t}$ with a bidirectional GCR, moving from $RGDP_{per\ capita_{ppp_{i,t}}}$ to $SGE_{i,t}$ and vice versa. While $RGDP_{per\ capita_{ppp_{i,t}}}$ and $VT_{i,t}$ has a unidirectional GCR, moving from $RGDP_{per\ capita_{ppp_{i,t}}}$ to $VT_{i,t}$. Further studies need to be examined using different methodologies to investigate the effect of how spending in education translates to higher economic growth, community development, and higher productivity. Notwithstanding, specific government spending on different tiers of education (higher education) needs to be investigated. The policy implications of this research involve the following: first, Our SLAC will provide incentives that would promote academic spending in the primary and secondary education levels and overall educational advancement in the region.

In conclusion, this paper adopted the Mankiw et al. (1992) technique and supports that education is imperative for economic growth and development for the SLAC. Despite this widespread belief that investment in education is a key determinant of economic growth and shortly will lead to economic development, the empirical estimations, especially focusing on low-income countries, are less than conclusive. Quiggin (2002); Devarajan, Swaroop, and Zou (1996); Benhabib and Spiegel (1994). This can be attributed to how schooling, investment, and successes are measured.

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REFERENCES

Akaike, H. (1974). A new look at the statistical model identification. *IEEE Transactions on Automatic Control*, *19*(6), 716-723. Available at: https://doi.org/10.1109/TAC.1974.1100705.

Al-Yousif, Y. K. (2002). Financial development and economic growth: Another look at the evidence from developing countries. *Review of Financial Economics*, *11*(2), 131-150. Available at: https://doi.org/10.1016/S1058-3300(02)00039-3.

Barro, J. R. (1991). Human capital and growth in cross-country regressions. *The Quarterly Journal of Economics*, *106*(2), 407-443. Available at: https://doi.org/10.2307/2937943.

Becker, G. S. (1964). *Human capital: A theoretical and empirical analysis, with special reference to education*. Chicago, IL: University of Chicago Press.

Becker, G. S. (1993). Nobel lecture: The economic way of looking at behavior. *Journal of Political Economy*, *101*(3), 385-409. Available at: https://doi.org/10.1086/261880.

Benhabib, J., & Spiegel, M. M. (1994). The role of human capital in economic development evidence from aggregate cross-country data. *Journal of Monetary Economics*, *34*(2), 143-173. Available at: https://doi.org/10.1016/0304-3932(94)90047-7.

Breitung, J., & Das, S. (2005). Panel unit root tests under cross-sectional dependence. *Dutch Statistics*, *59*(4), 414-433. Available at: https://doi.org/10.1111/j.1467-9574.2005.00299.x.

Breitung, J. (2000). The local power of some unit root test for panel data. *JAI*, *15*, 161-178. Available at: https://doi.org/10.1016/S0731-9053(00)15006-6.

Devarajan, S., Swaroop, V., & Zou, H.-f. (1996). The composition of public expenditure and economic growth. *Journal of Monetary Economics*, *37*(2), 313-344. Available at: https://doi.org/10.1016/S0304-3932(96)90039-2.

Edrees, A. (2016). Human capital, infrastructure, and economic growth in Arab world: A panel granger causality analysis.

Engle, R. A. (1987). Co-integration and error correction: representation, estimation, and testing. *Econometrica*, *55*(2), 251-276. Available at: Co-integration and error correction: representation, estimation, and testing.

Feinstein, L., Robertson, D., & Symons, J. (1999). Pre-school education and attainment in the national child developement study and british cohort study. *Education Economics*, 7(3), 209-234. Available at: https://doi.org/10.1080/09645299900000019.

Gibbons, R., & Waldman, M. (2004). Task-specific human capital. *American Economic Review*, *94*(2), 203-207. Available at: https://doi.org/10.1257/0002828041301579.

Gujarati, N. P. (2012). Basic econometrics.

Im, K. S., Pesaran, M. H., & Shin, Y. (2003). Testing for unit roots in heterogeneous panels. *Journal of Econometrics*, *115*(1), 53-74. Available at: https://doi.org/10.1016/S0304-4076(03)00092-7.

Khembo, F., & Tchereni, B. H. (2013). The impact of human capital on economic growth in the SADC Region. *Developing Country Studies*, *3*(4), 144-152.

Kögel, T., & Prskawetz, A. (2001). Agricultural productivity growth and escape from the Malthusian trap. *Journal of Economic Growth*, *6*(4), 337-357. Available at: https://doi.org/10.1023/A:1012742531003.

Levin, A., Lin, C.-F., & Chu, C.-S. J. (2002). Unit root tests in panel data: Asymptotic and finite-sample properties. *Journal of Econometrics*, *108*(1), 1-24. Available at: https://doi.org/10.1016/S0304-4076(01)00098-7.

Lucas Jr, R. E. (1988). On the mechanics of economic development. *Journal of Monetary Economics*, *22*(1), 3-42. Available at: https://doi.org/10.1016/0304-3932(88)90168-7.

Mankiw, N. G., Romer, D., & Weil, D. N. (1992). A contribution to the empirics of economic growth. *The Quarterly Journal of Economics*, *107*(2), 407-437. Available at: https://doi.org/10.2307/2118477.

Mehrara, M., & Musai, M. (2013). The relationship between economic growth and human capital in developing countries. *International Letters of Social and Humanistic Sciences*, *5*(55), 55-62. Available at: https://doi.org/10.18052/www.scipress.com/ILSHS.5.55.

Nelson, R. C. (1982). Trends and random walk in macroeconomics time series. *Journal of Monetary Economics*(10), 139-162. Available at: https://doi.org/10.1016/0304-3932(82)90012-5.

Nerdrum, L., & Erikson, T. (2001). Intellectual capital: A human capital perspective. *Journal of Intellectual Capital*, *2*(2), 127-135. Available at: https://doi.org/10.1108/14691930110385919.

Osiobe, E. U. (2020). Understanding Latin America's educational orientations: Evidence from 14 nations. *Education Quarterly Review*, 249-260. Available at: https://doi.org/10.31014/aior.1993.03.02.137.

Pedroni, P. (2002). Critical value for cointegration test in heterogeneous panels with multiple regressors. *Oxford Bulletin of Economics and Statistics*, *61*(S1). Available at: https://doi.org/10.1111/1468-0084.61.s1.14.

Pedroni, P. (2004). Panel cointegration: Asymptotic and finite sample properties of pooled time series test with an application to the PPP hypothesis. *Economic Theory*, *20*(3), 325-597. Available at: https://doi.org/10.1017/S0266466604203073.

Phillips, C. P. (1995). Fully modified least squares and vector autoregression. *Econometrica*, *63*(5), 1023 - 1078. Available at: www.jstor.org/stable/2171721.

Quiggin, J. (2002). Human capital theory and education policy in Australia. *Australian Economic Review*, *32*(2). Available at: https://doi.org/10.1111/1467-8462.00100.

Rahman, M. M. (2011). Causal relationship among education expenditure, health expenditure and GDP: A case study for Bangladesh. *International Journal of Economics and Finance*, *3*(3), 149-159. Available at: https://doi.org/10.5539/ijef.v3n3p149.

Romer, P. (1989). Human capital and growth: Theory and evidence. NBER Working Paper No. 3173.

Romer, P. (1990). Endogenous technological change. *Journal of Political Economy*, *98*(5), 71-102. Available at: https://doi.org/10.1086/261725.

Romer, D. (1996). *Advanced macroeconomics.* New York: Mc Graw Hill Education.

Romer, P. M. (1994). The origins of endogenous growth. *The Journal of Economic Perspective*, *8*(1), 3-22. Available at: https://doi.org/10.1257/jep.8.1.3.

Schultz, T. (1961). Investment in human capital. *American Economic Review*, *51*(1), 1-17.

Schultz., T. W. (1960). Capital formation by education. *Journal of Political Economy*, *68*(6), 571-583. Available at: https://doi.org/10.1086/258393.

Schwarz, G. (1978). Estimating the dimension of a model. *The Annals of Statistics*, *6*(2), 461-464. Available at: https://doi.org/10.1214/aos/1176344136.

Sharma, P., & Sahni, P. (2015). Human capital and economic growth in India: A cointegration and causality analysis. *Ushus Journal of Business Management - Journals*, *14*(2), 1-18. Available at: https://doi.org/10.12725/ujbm.31.1.

Shibata, R. (1976). Selection of the order of an autoregressive model by akaike's Information criterion. *Biometrika*, *63*(1), 117-126. Available at: https://doi.org/10.1093/biomet/63.1.117.

Sims, A. C. (1980). Macroeconomics and reality. *Econometrica*, *48*(1), 1-48. Available at: https://doi.org/10.2307/1912017.

Smith, A. (1776). An inquiry into the nature and causes of the wealth of nations. Available at: https://doi.org/10.1093/oseo/instance.00043218.

Teixeira, P. N. (2014). Gary becker's early work on human capital–collaborations and distinctiveness. *IZA Journal of Labor Economics*, *3*(1), 1-20. Available at: https://doi.org/10.1186/s40172-014-0012-2.

Vieira, F. H. (2013). Growth and exchange rate volatility: A panel data analysis. *Applied Economics*, *45*(26). Available at: https://doi.org/10.1080/00036846.2012.730135.

World Economic Forum. (2016). Skilling up: Human capital and Latin America. Retrieved from World Economic Forum: https://www.weforum.org/agenda/2016/12/skilling-up-human-capital-and-latin-america.

World Penn Tables. (2019). Retrieved from: http://datacentre2.chass.utoronto.ca/pwt/alphacountries.html.