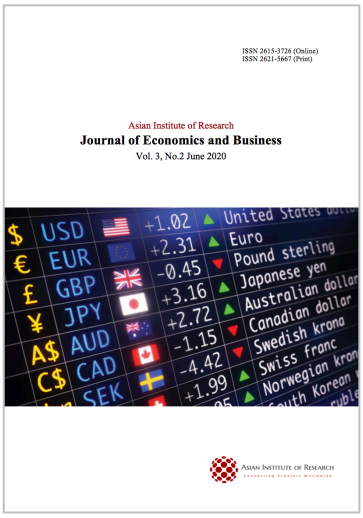

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Human Capital, Capital Stock Formation, and Economic Growth: A Panel Granger Causality Analysis

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Abstract
Fostering educational practices, increasing enrollments rate, and improving learning is a central part of most economic development strategies. Most economists from the 20th and early 21st century see the idea of increasing the public's aggregate per capita investment in human capital as a controversial topic; because the expansion of education has not guaranteed improved economic conditions in some regions. The variables used in the study include 14 Latin American countries that have been analyzed, and the results show a strong causal relationship between real gross domestic product per capita–purchasing power parity and human capital. Although the study doesn't find a direct Granger causal relationship moving from human capital to real gross domestic product per capita-purchasing power parity, there is an indirect Granger causal relationship between our variables of interest. The association can be found in the bidirectional Granger causal relationship between human capital and trade balance.

Keywords: Unit Root, Panel Cointegration, Granger Causality, Human Capital, Latin American Countries, Educational Investment, Sustainable Economic Growth

Introduction

This paper contributes to the literature on human capital, education, and Latin America studies by presenting our empirical results on the effect(s) of human capital and economic growth in Latin America grounded on Smith's (1776) learning by doing and Ricardo (1803) division of labor ideology and economic growth theory. The human capital theory focuses on health and the return on education investment as an input to economic production. In 1997, the United Nations (UN) defined human capital as productive wealth embodied in labor, skills, and knowledge (UN, 2016 and 2020). For this study, human capital is defined as education and training (formal, informal, and culture); knowledge; labor; skills (general, industry, firm, job, and task-specific); experience.

They are incorporated and called human capital because people can't be separated from the stated factors in the way they can be separated from their financial and physical capital during the production process. Education affects the quality of labor and the level of technical progress, which in turn affects economic growth, development, and stability of a country. However, trade liberalization is often considered an essential tool for increasing a nation's productivity level. There is almost a unilateral concession among economists that a liberal and open trade policies increase trade volume to Gross Domestic Product (GDP), resulting in a more favorable trade balance (+/-) as it is evaluated based on the differences between spending on consumer or producer goods. Today, developing nations are liberalizing their economies to become attractive to foreign direct investments. This paper aims to analyze the impact of human capital on economic growth and development. The empirical analysis tries to determine the Granger Causal Relationship (GCR) between human capital and economic growth in 14 Selected Latin American Countries (LAC) by using the panel unit root test and panel cointegration analysis for the period 1950-2014.

Chronicle of Economic Growth Theory

The net impact(s) of human capital on economic growth, development, and stability has received significant attention in recent years, especially from emerging countries. But to address the underlying question of this study, there are two vital approaches to take. First, human capital is seen as an essential factor of production in the production process and second, as a production facilitator.

Smith (1776) argues that specialization, learning by doing, at all levels of the production line, can be enhanced by ensuring that each job position can be improved (production per capita and quality per unit) by reducing the job requirement. He asserted with empirical backings that the productivity of skilled workers is higher than the unskilled, and hence his justification for higher-earning per individual marginal productivity, as a result of the individual (per workers') investment.

Malthus (1798), a classic work, set two underlying assumptions. First, an increase in Gross Domestic Product per capita ($GDP_{per\ capita}$) above the economic equilibrium level of consumption will lead to a rise in the economy population size. Second, a country's increasing population size will reduce the nation's resources per capita, and as a consequence, consumption per capita will fall back to its equilibrium level. As a result of this stated underlying assumptions, any economy will be trapped in economic stagnation. This view, now heavily criticized for not factoring the effect of technological advancement, accurately described the demography and economic status of the 18th century. The author concludes his argument by saying that an increase in agricultural productivity leads to an increase in population size with zero long-run improvements in living standards.

Ricardo (1817) discussed the division of labor and the consequences of technological progress in society. Ricardo Agreed with Smith's division of labor, specialization, and mechanization of the production process as a net benefit to any community, leading to a reduction in cost per unit and a net increase in total production. Later changing his position but not opposed to technology, he argued that the introduction of machinery in the production process might lead to permanent unemployment if the expenditure is financed with circulating fixed capital and not savings. He concludes by saying, if the investment is made with net-savings, entrepreneurs will search for more profits venture by increasing productivity through technological advancements or investing abroad.

Mill's (1871) view was contrasted to Ricardo's, arguing that lower prices don't bring additional investment because the demand for a good or service, although correlated, doesn't affect the demand for [its] labor. Marx (1844 & 1867) sociological and philosophical critique of the market economy upon workers' life as distinct from economic well-being. Marx argues that private property and mechanization of production lead to the degrading and dehumanization of workers. But several scholars believe that Smith's Wealth of Nations (Smithian treatment of alienation) was an essential precursor of Marxist socialism (Marxian treatment of alienation) (West, 2020).

Empirical Foundation and Methods of Analysis

The study employs a time series annual data analysis between 1950–2014 for a panel of 14 LAC: Argentina, Bolivia, Brazil, Chile, Colombia, Costa Rica, Honduras, Mexico, Nicaragua, Panama, Peru, El Salvador, Uruguay, and Venezuela. The LAC was selected due to the availability of data compared to other countries that lacked comprehensive data from our data source (Penn World Table (PWT), 2019). Table 1 provides a list of the variables used in the study and abbreviations.

Variables

Table 1: Variables used in our based Model

Variables	Meaning
$RGDP_{per\ capita_{ppp_{i,t}}}$	Real gross domestic product-per capita–purchasing power parity is gross domestic product converted to international dollars using purchasing power parity rates per individual.
$HC_{i,t}$ (lowest 0.1 – 13.4 highest)	Is based on years of schooling and returns to education
$CS_{i,t}$ at constant (2011 USD)	It is the plant, equipment, and other assets that help with production.
$TB_{i,t}$ as a % of $RGDP$	Trade Balance as a share of real gross domestic product

Source: (PWT, 2019)
i = countries
t = years

The descriptive statistic shows the maximum, minimum, mean, and standard deviation of all variables (See Table 2). The variables used in the study are $RGDP_{per\ capita_{ppp_{i,t}}}$; $HC_{i,t}$ our variable of interest and an explanatory variable. $RGDP_{per\ capita_{ppp_{i,t}}}$ from our econometric equation, is operationalized as Real Gross Domestic Product-purchasing power parity ($RGDP_{ppp}$) $\equiv RGDP_{per\ capita_{ppp_{i,t}}}$ by dividing $RGDP_{ppp}$ by the total population. $HC_{i,t}$ it is measured as the number of years of schooling and the returns to education of the entire population. The Human Development Index (HDI) from (Barro & Lee, 2013) is based on the average years of schooling, and an assumed rate of return to education, which comes from the Mincer equation estimates explained by (Psacharopoulos, 1994) is used as the measuring tool for $HC_{i,t}$. The HDI formula is:

$$\emptyset(s) = \begin{Bmatrix} 0.134.s & if\ s \leq 4 \\ 0.134.4 + 0.101(s-4) & if\ 4 < s \leq 8 \\ 0.134.4 + 0.101.4 + 0.068(s-8) & if\ s > 8 \end{Bmatrix} \quad (1)$$

Where s is the average years of schooling from the dataset. The correlation of decadal growth rates, $\emptyset \frac{s_{it}}{\emptyset(s_{it-10})} - 1$ (PWT equation: human capital in PWT 9.0, 2019); $CS_{i,t}$ an explanatory variable, which measures the infrastructure of a nation (2011 USD); and $TB_{i,t}$ is an explanatory variable, which measures the monetary value of the net exports of a nation as a share of $RGDP$, where: $TB_{i,t} = \frac{Exports-Imports}{RGDP}\ .100$.

Table 2: Descriptive Statistics of Variables (1950 – 2014)

Variables	$RGDP_{per\ capita_{ppp_{i,t}}}$	$HC_{i,t}$	$CS_{i,t}$	$TB_{i,t}$
Mean	196112	1.96	814383.10	-0.03
Median	419923.58	1.91	127792.50	-0.02
Maximum	3080764	3.05	13311433	0.43
Minimum	1328.68	1.22	6753.31	-0.40
Standard Dev.	402363.1	0.45	1798829	0.10

Source: (PWT, 2019)
Author's calculation

Model Specification

The theoretical structure of the study is based on the endogenous growth theory. The model supports the conclusion that an essential factor for economic growth is the accumulation of knowledge in the form of human capital. ((Mankiw et al., 1992), (Romer, 1989, 1990, & 1994), modeled the production as a function of human capital (HC) physical capital (PC), technology (T), and labor (L) in their growth theory. Holland et al. (2013) explained the production function in the same way. Based on the following literature, our $HC_{i,t}$ using the Augmented Solow Growth Model $(ASGM)$ is as follows:

$$Y_t = AH^{\alpha}K_t^{\beta}L^{\gamma} \tag{2}$$

where Y_t is output, H is human capital, K is physical capital, L is labor, A is technology, and the parameters α, β, and γ messages the return to scale. $0 < \alpha, \beta, \gamma < 1$. Restating in per capita terms:

$$\frac{Y}{L} = A\left(\frac{H}{L}\right)^{\alpha}\left(\frac{K}{L}\right)^{\beta} \equiv y_t \equiv Ah^{\alpha}k^{\beta} \tag{3}$$

To operationalize equation (3), we define the total factor productivity (A) as

$$A = f(T_i) = T_t^{\delta} \tag{4}$$

Substituting equation (3) into (4) and taking the natural log, we get:

$$lny_t = \beta_0 + \alpha lnh_t + \beta lnk + \delta lnT_t \tag{5}$$

To create the study's econometric-equation; the theoretical model was transformed into an empirical by using $RGDP_{per\ capita_{ppp_{i,t}}}, HC_{i,t}, CS_{i,t},$ and $TB_{i,t}$ to represent $y_t, h_t, k_t,$ and T_t where y_t is $RGDP_{per\ capita_{ppp_{i,t}}}$, h is $HC_{i,t}$; k is $CS_{i,t}$; and T is $TB_{i,t}$.

The econometrics equation is given as

$$lny_{i,t} = \beta_0 + \alpha HC_{i,t} + \beta lnCS_{i,t} + \delta TB_{i,t} + \varepsilon_{i,t} \tag{6}$$

where $\varepsilon_{i,t}$ = error term.

The Vector Error Correction Model (VEC) was employed in this study as the estimation technique. This technique was selected because it allows the exploration of the causal relationship between human capital and economic growth. The Vector Autocorrection has four steps one, the panel unit root test, which determines the stationarity of our data Using the (Levin–Lin–Chu (LLC), 2002), Breitung and Das (Breitung), 2005), and (Im–Pesaran–Shin (IPS), 2003) were implemented. The LLC test is based on the Augmented Dickey-Fuller (ADF) analysis, which assumes homogeneity in the dynamics of the autoregressive coefficients for all panel units with cross-sectional independence. The LLC equation is as follows:

$$\Delta X_{int} = \zeta_i + \eta_i X_{in,t-1} + \theta_i t + \sum_{j=1}^{k} \lambda_{ij} X_{i,t-j} + \mu_{ijt} \tag{7}$$

where: i is an index of variables:$RGDP_{per\ capita_{i,t}}, HC_{i,t}, CS_{i,t},$ and $TB_{i,t}$; t is a time index from 1950 to 2014; n is a country index running across 14 LAC; Δ is the first difference operator; X_{it} is $lnHC_{i,t}, lnCS_{i,t},$ and $lnTB_{i,t}$; and $\mu_{i,t}$ = the error term disturbance with a variance of σ_i^2.

According to (Levin, Lin, & Chi, 2002), the hypothesis of the stationarity of the panel data is: $H_o: \eta_i = 0$ and $H_1: \eta_i < 0$, where the alternative hypothesis corresponds to X_{it} of being stationary. (Levin, Lin, & Chi, 2002) also specified another equation as follows, which restricts $\hat{\beta}_i$ while keeping it identical across countries, which substantially increases the power of the test in a panel data.

$$\Delta X_{it} = \nu_i + o_i X_{i,t-1} + \pi_i t + \sum_{j=1}^{\rho} \phi_{ij} \Delta X_{i,t-j} + \psi_{it} \quad (8)$$

In equation (8), it is assumed that: $H_o: o_1 = o_2 = \cdots = o_n = 0$ and $H_1: o_1 = o_2 = \cdots = o_n < 0$, where $t-statistics = t_{\hat{o}}/\sigma(\hat{o})$. Equation (8) equals $\hat{o}$ and its standard error = $\sigma(\hat{o})$.

The Breitung unit root test is based on (Breitung 2000), who developed a pooled panel unit root test that does not require bias correction factors. Table 5 includes the Levin et al. (Levin, Lin, & Chi, 2002), the (Breitung, 2000), and the (Kyung, Pesaran, & Shin, 2003) unit root results.

Step two, the determination of the lag length; given our variables are now rendered stationary, we tested for the existence of a cointegrating relationship and to analyze the cointegration test. The lag length is first determined by using the Lag Selection Criteria (LSC) test. Five lag length selection criteria have been employed in this study to determine the Autoregressive (AR) lag length of our variables. The AR lag length p[1] is unknown and can, therefore, be estimated using the LSC. The analysis would be carried out using the likelihood ratio (LR) test, according to (Sims 1980).

$$LR = (T-c)|\log|\Omega_1| - log|\Omega_2| \quad (9)$$

where T is the sample size; c the total number of parameters estimated in the model; Ω_1 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.

The FPE is given as

$$FPE(\omega) = \left|\breve{\Sigma}(\omega)\right| + \left(\frac{\hat{T}+M_\omega+1}{\hat{T}-M_\omega-1}\right)^2 = \det\left(\frac{1}{N}\sum_i^N e(t,\widehat{\tau_N})\right)\left(e(t,\widehat{\tau_N})\right)^T\left(\frac{1+d/N}{1-d/N}\right) \quad (10)$$

where N is the number of values in the estimates; $e(t)$ is the $ny-by-1$ vector of prediction error; τ_N is the estimated parameters; and d the number of estimated parameters.

The AIC, according to (Akaike, 1969 & 1974), is given as

$$AIC(\varrho) = \ln\left|\hat{\Sigma}_\varrho\right| + \frac{2k^2 p}{T} \quad (11)$$

where T is the number of observations; k is the dimension of the time series; ϱ is the estimated number of lags; and $\hat{\Sigma}_\varrho$ is the estimated error term covariance matrix.

Shibata (1976) proves that the AIC, in the univariate $AR(p)$ representation, is inconsistent in the sense that, asymptotically, it overestimates the true order with a nonzero probability. In the Schwarz Information Criterion (SIC), according to (Schwarz, 1978), the equation is given as

$$SC(\varrho) = \ln|\hat{\Sigma}_\varrho| + \frac{k^2 \varrho \ln T}{T} \quad (12)$$

and the HQC is given as

[1] In which its current value is dependent on its first ϱ lagged values AR(ϱ).

$$HQC(\varrho) = \ln\left|\hat{\Sigma}_{\varrho}\right| + \frac{2\varrho k^2 ln \ln T}{T} \quad (13)$$

Step three, the Padroni cointegration test using the panel, the Cointegration Test, the Kao Residual Cointegration Test (Kao, 1999), Pedroni Panel Cointegration Test (Pedroni, 2002) (Pedronic, 2004), and Fisher Panel Cointegration Test (Yate & Fisher, 1925) were used. These tests allow various cross-sectional interdependencies, along with other different individual effects, to establish the cointegration. Given that our variables are integrated, of the order one, we then tested for the existence of a cointegration relationship. This was carried out using the Pedroni Cointegration Test, Kao Residual Cointegration Test, and Fisher Panel Cointegration Test. These tests enable us to investigate the long-run relationship between the variables. The Pedroni test allows various cross-sectional interdependencies along with other different individual effects to establish the cointegration. 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:

where Panel V-Statistic: $T^2N^{3/2}Z_{v\,N,T} \equiv \left(\sum_{i=1}^{N}\sum_{t=1}^{T}\hat{L}_{l1i}^{-2}\,\hat{e}_{it-1}^{2}\right)^{-1}$; Panel rho-Statistic: $T\sqrt{N}Z_{p\,N,T-1} \equiv T\sqrt{N}\left(\sum_{i=1}^{N}\sum_{t=1}^{T}\hat{L}_{l1i}^{-2}\,\hat{e}_{it-1}^{2}\right)^{-1} \sum_{i=1}^{N}\sum_{t=1}^{T}\hat{L}_{l1i}^{-2}\left(\hat{e}_{it-1}^{2}\Delta\hat{e}_{it} - \hat{\lambda}_i\right)$; Panel PP-Statistic: $Z_{t\,N,T} \equiv \left(\sigma^2 N,T\sum_{i=1}^{N}\sum_{t=1}^{T}\hat{L}_{l1i}^{-2}\,\hat{e}_{it-1}^{2}\right)^{-1/2} \sum_{i=1}^{N}\sum_{t=1}^{T}\hat{L}_{l1i}^{-2}\left(\hat{e}_{it-1}^{2}\Delta\hat{e}_{it} - \hat{\lambda}_i\right)$; Panel ADF-Statistic: $Z_{t\,N,T}^{*} \equiv \left(s_{N,T}^{*2}\sum_{i=1}^{N}\sum_{t=1}^{T}\hat{L}_{l1i}^{-2}\,\hat{e}_{it-1}^{2}\right)^{-1/2} \sum_{i=1}^{N}\sum_{t=1}^{T}\hat{L}_{l1i}^{-2}\left(\hat{e}_{it-1}^{*}\Delta\hat{e}_{it}^{*}\right)$; Group rho-Statistic: $N^{-1/2}\tilde{Z}_{t\,N,T^{-1}} \equiv TN^{-1/2}\sum_{i=1}^{N}\left(\sum_{t=1}^{T}\hat{e}_{it-1}^{2}\right)^{-1}\sum_{t=1}^{N}\left(\hat{e}_{it-1}^{2}\Delta\hat{e}_{it} - \hat{\lambda}_i\right)$; Group PP-Statistic: $N^{-1/2}\widetilde{Z^{*}}_{t} \equiv N^{-\frac{1}{2}}\sum_{i=1}^{N}\left(\sigma_i^2\sum_{t=1}^{T}e_{i,t-1}^{*2}\right)^{-1/2}\sum_{t=l}^{T}\left(\hat{e}_{it-1}\Delta\hat{e}_{it} - \hat{\lambda}_i\right)$; and Group ADF-Statistic: $\tilde{Z}_{t\,N,T}^{*} \equiv \sum_{i=1}^{N}\left(\sum_{t=1}^{T}\hat{s}_i^2\hat{e}_{it-1}^{*2}\right)^{-1/2}\sum_{t=1}^{T}\left(\hat{e}_{it-1}^{*}\Delta\hat{e}_{it}^{*}\right)$ where $\lambda_i\ is\ \frac{1}{T}\sum_{S+1}^{k_i}\left(1 - \frac{2}{k_i+1}\right)\sum_{t=s+1}^{T}\widehat{\mu_{\iota,t}}\,\widehat{\mu_{\iota}},t-s, s_i^2 \equiv \frac{1}{T}\sum_{t=1}^{T}\hat{\mu}_{i,t}\,\widehat{\sigma_{\iota}}^{2} = \widehat{s_{\iota}}^{2} + 2\widehat{\lambda_{\iota}}, \widetilde{\sigma_{N,T}} \equiv \frac{1}{N}\sum_{i=l}^{N}\widehat{L_{\iota\iota_\iota}^{-2}}\widehat{\sigma_{\iota}^{2}}; \widehat{S_{\iota}^{2}} \equiv \frac{1}{t}\sum_{t=1}^{T}\widehat{\mu_{\iota,t}^{2}},\ \widetilde{s_{N,T}^{*2}} \equiv \frac{1}{N}\sum_{i=1}^{N}\widehat{s_{\iota}^{*2}},\ \widehat{L_{\iota\iota1}^{2}} = \frac{1}{T}\sum_{t=1}^{T}\widehat{\eta_{\iota,t}^{2}} + \frac{2}{T}\sum_{s=1}^{k_i}\left(1 - \frac{s}{k_i+1}\right)\sum_{t=s+1}^{T}\widehat{\eta_{\iota,t}}\,\widehat{\eta_{\iota}}\ t-s$ and where the residuals $\widehat{\mu_{\iota,t}}$, $\widehat{\mu_{\iota,t}^{*}}$, and $\widehat{\eta_{\iota,t}}$ are obtained from the following regressions: $\widehat{e_{\iota,t}} = \widehat{\gamma_{\iota}}\,\widehat{e_{\iota,t-1}} + \widehat{\mu_{\iota,t}}\ \widehat{e_{\iota,t}} = \widehat{\gamma_{\iota}}\widehat{e_{\iota,t-1}} + \sum_{k=1}^{k_i}\widehat{\gamma_{\iota}}\ k\Delta\widehat{e_{\iota}},t-k + \widehat{\mu^{*}}i,t,\ \Delta y_{i,t} = \sum_{m=1}^{M}\widehat{b_{m,\iota}}\Delta x_{mi,t} + \widehat{\eta_{\iota,t}}$ (Pedroni, 2002 & 2004).

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 (see Table 6).

Step four, the VEC, which estimates the long-run and short-run relationship ((E-view, 2019) (Batchelor, 2018) (Stata, 2019)). The study employed the Fully Modified Ordinary Least Squares ($FMOLS$) 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). According to (Pedroni 2002 & 2004), the $FMOLS$ 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 individual-variables in the panel.

Table 3: Panel Unit Root Results

	Intercept						Trend and Intercept					
	LLC	***IPS***	**Bretung**	***LLC***	***IPS***	**Bretung**	***LLC***	***IPS***	**Bretung**	***LLC***	***IPS***	**Bretung**
Variable	*Levels*			*1st Difference (2nd Difference)*			*Levels*			*1st Difference (2nd Difference)*		
$RGDP_{per\ capita_{ppp_{i,t}}}$	1.00	1.00	n/a	0.00*	0.00*	n/a	1.00	1.00	1.00	0.00*	0.00*	0.00*
$HC_{i,t}$	0.00**	0.00**	n/a	n/a	n/a	n/a	0.00**	0.00**	0.04**	n/a	n/a	n/a
$CS_{i,t}$	1.00	1.00	n/a	0.00*	0.00*	n/a	1.00	1.00	0.00*	0.00*	0.00*	n/a
$TB_{i,t}$	0.00**	0.00*	n/a	n/a	n/a	n/a	0.00**	0.00*	0.00*	n/a	n/a	n/a

Notes: variables are in real terms
*** indicates significance level at 10%
** indicates significance level at 5%
*indicates a significance level at 1%.
Source: Author's calculation

Table 4: Lag Length Selection Criteria Test

Lag	*LogL*	*LR*	*FPE*	*AIC*	*SIC*	*HQC*
0	-1838.11	NA	0.0007	4.13	4.15	4.13
1	2858.91	9341.44	2.04e-08	-6.36	-6.25*	-6.32
2	2902.01	85.34*	1.92e-08*	-6.42*	-6.23	-6.34*
3	2909.60	14.95	1.95e-08	-6.40	-6.12	-6.29
4	2917.86	16.21	1.99e-08	-6.38	-6.02	-6.24
5	2924.95	13.85	2.03e-08	-6.36	-5.91	-6.19
6	2930.96	11.69	2.07e-08	-6.34	-5.80	-6.14
7	2935.49	8.77	2.13e-08	-6.31	-5.69	-6.08
8	2940.79	10.21	2.18e-08	-6.29	-5.58	-6.02

*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
HQC: Hannan-Quinn information criterion
Source: Author's calculation

Table 5: Pedroni Panel Cointegration Test

Panel Group Statistics	**Statistic**	**Prob**
Panel V-Statistic	-1.17	0.43
Panel rho-Statistic	2.42	0.98
Panel PP-Statistic	-1.84	0.00***
Panel ADF-Statistic	-1.84	0.00***
Group rho-Statistic	2.62	2.00
Group PP-Statistic	-3.61	0.00***
Group ADF Statistic	-3.55	0.00***

* indicates significance at 10%
** indicates significance at 5%
*** indicates significance at 1%
Source: Author's calculation

.

Table 6: Kao Residual Cointegration Test

	T-Statistic	Prob
ADF	-1.97	0.02**

* indicates significance at 10%
** indicates significance at 5%
*** indicates significance at 1%
Source: Author's calculation

.

Table 7: Fisher Panel Cointegration Test

	Stat	Prob
None*	129.5	0.00***
At most 1*	53.20	0.00***
At most 2*	29.46	0.11
At most 3*	20.25	0.86

* indicates significance at 10%
** indicates significance at 5%
*** indicates significance at 1%
Source: Author's calculation

.

Table 8: Results of Long-term Coefficient Estimates by FMOLS

Variables	Model
$HC_{i,t}$	0.21 (0.00)***
$CS_{i,t}$	0.13 (0.00)***
$TB_{i,t}$	-0.43 (0.004)***
R-squared	36%
(Adj-R)	36%

Note
p-value in parenthesis
* indicates significance level at 10%
** indicates significance level at 5%
*** indicates significance at 1%
Source: Author's calculation

Results

From Table 3, we find that $RGDP_{per\ capita_{ppp_{i,t}}}$ and $CS_{i,t}$ are non-stationary at level terms. Hence, we fail to reject the null hypothesis indicating that the variables contain a unit root. However, after the first order differentiation, the test statistic shows that we can reject the null hypothesis of non-stationarity for $RGDP_{per\ capita_{ppp_{i,t}}}$ and $CS_{i,t}$ at the 1% significant level while $HC_{i,t}$ and $TB_{i,t}$ were stationary at level terms. Hence, we rejected the null hypothesis of non-stationarity at the 1% significant level.

Table 4 shows the lag length selection results. Out of the five statistics, four—LR, FPE, AIC, and HQC—indicate a lag length of two, while SIC suggested a lag length of one. Therefore, the study selected two lag lengths, viewing the loss of efficiency, which is less of an issue than bias. Tables 5, 6, and 7 show that we can reject the null hypothesis of no cointegrating relationship between our variables. Hence, the Pedroni, Kao, and

Fisher's cointegration tests provide a benchmark for the existence of a panel cointegration between our explained and explanatory variables in the study.

Table 8 shows a positive, statistically significant long-run relationship between $RGDP_{per\ capita_{ppp_{i,t}}}$ and $HC_{i,t}$ with a coefficient of 0.21. This indicates that a 1% increase in $HC_{i,t}$ is associated with a 0.21%-point increase in $RGDP_{per\ capita_{ppp_{i,t}}}$ in our LAC. $HC_{i,t}$ implies that there is an incentive for a nation to improve its citizens' skill-set, knowledge, and innovative ideas. This improvement 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 improve the $HC_{i,t}$ index of a nation would yield a positive result as it translates to an increase in $RGDP_{per\ capita_{ppp}}$. This result is consistent with (Edrees, 2016), (Mehrara & Musai, 2013), (Khembo & Tchereni, 2013), (Rahman, 2011), and (Sharma & Sahni, 2015).

$CS_{i,t}$ was used as a proxy for domestic investment in private and public infrastructures. It showed a positive, statistically significant result with a coefficient of 0.13. This implies that a 1% increase in the $CS_{i,t}$ is associated with a 0.13%-point increase in $RGDP_{per\ capita_{ppp_{i,t}}}$ in our LAC and should increase their investments in the nation's plants and infrastructures. This will lead to the creation of new jobs in the construction sector of their economies, which will lead to an increase in disposable income of the construction worker, which in turn, will lead to an increase in the consumption of more consumer goods and services in the economy, which will increase sales and have a positive impact on the economy. The results indicate that in our LAC, domestic investment, plants, and good infrastructures contribute significantly to the growth of the economy in terms of $RGDP_{per\ capita_{ppp_{i,t}}}$.

$TB_{i,t}$ is a percentage of $RGDP$ (see Table 2) and has a negative and statistically significant long-run relationship with $RGDP_{per\ capita_{ppp_{i,t}}}$. A 1% increase in $TB_{i,t}$ decreases $RGDP_{per\ capita_{ppp_{i,t}}}$ by 0.43%-point. This implies that a negative trade balance affects economic growth in our LAC: an increase in TB will negatively affect the economic growth of the LAC. These countries are net importers of consumer goods and services; hence, these countries should substitute their current economic policy of importing consumer goods and services from the international market to importing more capital goods ($CS_{i,t}$-materials) and services ($HC_{i,t}$). This consumption shift will increase the nations' opportunities for exporting more consumer goods and services in the future in the international market and improve their country's $RGDP_{per\ capita_{ppp_{i,t}}}$.

The study of causal relationships among economic variables has been one of the main objectives of empirical econometrics. According to (Engle & Granger, 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 GC the other (Gujarati et al., 2012). To examine the direction of GCR in the presence of cointegrating vectors, GC is conducted based on the following specifications:

$$\begin{pmatrix} \Delta lnRGDP_{per\ capita_{ppp_{i,t}}} \\ \Delta HC_{i,t} \\ \Delta lnCS_{i,t} \\ \Delta TB_{i,t} \end{pmatrix} = \begin{pmatrix} \emptyset_{i,1} \\ \emptyset_{i,2} \\ \emptyset_{i,3} \\ \emptyset_{i,4} \end{pmatrix} + \sum_{l=1}^{m} \begin{pmatrix} \theta_{1,2,3,4,k} \\ \theta_{2,1,3,4,k} \\ \theta_{3,1,2,4,k} \\ \theta_{4,1,2,3,k} \end{pmatrix} \begin{bmatrix} \Delta lnRGDP_{per\ capita_{ppp_{i,t-l}}} \\ \Delta HC_{i,t-l} \\ \Delta lnCS_{i,t-l} \\ \Delta TB_{i,t-l} \end{bmatrix} + \begin{pmatrix} \lambda_1 \\ \lambda_2 \\ \lambda_3 \\ \lambda_4 \end{pmatrix} ECT_{i,t-1} + \begin{pmatrix} \varphi_{1,i,t} \\ \varphi_{2,i,t} \\ \varphi_{3,i,t} \\ \varphi_{4,i,t} \end{pmatrix} \quad (14)$$

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

Table 9: The estimate of the Panel Vector Error Correction Model Explanatory Variables – Chi-square value (Wald test)

	$RGDP_{per\ capita_{ppp_{i,t}}}$	$HC_{i,t}$	$CS_{i,t}$	$TB_{i,t}$	**ECT (-1) [t-Test]**
$RGDP_{per\ capita_{ppp_{i,t}}}$		0.00 (0.99)	0.05 (0.95)	9.33 (0.00)***	-0.013 [-2.63]
$HC_{i,t}$	3.27 (0.04)**		2.05 (0.12)	5.43 (0.00)***	-0.05 [-1.95]
$CS_{i,t}$	2.92 (0.05)**	1.06 (0.35)		4.73 (0.00)***	-0.03 [-1.15]
$TB_{i,t}$	1.39 (0.25)	4.91 (0.00)***	5.13 (0.00)***		-0.01 [-5.31]

*indicates significance level at 10%
** indicates significance level at 5%
*** indicates significance at 1%
Source: Author's calculation

Table 9 and 10 shows our estimates indicate a significant unidirectional GCR between $RGDP_{per\ capita_{ppp_{i,t}}} \rightarrow HC_{i,t}$, $RGDP_{per\ capita_{ppp_{i,t}}} \rightarrow CS_{i,t}$, and $RGDP_{per\ capita_{i,t}} \leftarrow TB_{i,t}$. and a bidirectional GCR between $HC_{i,t} \leftrightarrow TB_{i,t}$, and $CS_{i,t} \leftrightarrow TB_{i,t}$. The unidirectional causality link between $RGDP_{per\ capita_{ppp_{i,t}}} \rightarrow HC_{i,t}$ implies that when an individual or nation invests in $HC_{i,t}$ (training people). It takes time to see any return on one's investment. Example, in training an individual to become a world-class/skilled researcher or economist, it will take 12 years of formal education and 2–4 years of post-doctoral training (optional), then the individual will need to have a minimum of 5 years of industrial experience or more in some cases before the country/economy can reap the benefits of the initial investment in $HC_{i,t}$. The unidirectional causality link between $RGDP_{per\ capita_{ppp_{i,t}}} \rightarrow CS_{i,t}$ implies that when a country invests in the construction of infrastructure, it takes time for these projects to be completed, such as the case of new roads, railways, dams with hydro-electric generators, and airports. These projects will take a minimum of 6–10 years before the nation can use them at an optimal level. The unidirectional causality link between $RGDP_{per\ capita_{ppp_{i,t}}} \leftarrow TB_{i,t}$ shows that these LAC are heavily dependent on the importation of consumer goods and services. The bidirectional is $HC_{i,t} \leftrightarrow TB_{i,t}$ and $CS_{i,t} \leftrightarrow TB_{i,t}$, which implies that our LAC is lacking in $HC_{i,t}$ and $CS_{i,t}$; hence, their importation on consumer goods and services is high. So, these countries need to increase their import of more capital goods, $HC_{i,t}$ (skilled expatriate) and $CS_{i,t}$ (raw-materials). Increased importation of $HC_{i,t}$ will translate into $HC_{i,t}$ ↑ — productivity ↑ — exportation of consumer goods and services ↑ — importation of consumer goods and services ↓. Likewise, if $CS_{i,t}$ ↑ — productivity ↑ — exportation of consumer goods and services ↑ — importation of consumer goods and services ↓. This implies that the variation in $RGDP_{per\ capita_{ppp_{i,t}}}$ is useful in predicting the variation in $HC_{i,t}$ and $CS_{i,t}$, while the variation in $TB_{i,t}$ is useful in predicting the variation in $RGDP_{per\ capita_{ppp_{i,t}}}$. In a bidirectional causality, the variation in the two variables is useful in predicting the variation in the other.

Table 10: Summary of Main Findings of Short-run Causality

Variables	Direction of Causality	Implication
$RGDP_{per\ capita_{ppp_{i,t}}} \rightarrow HC_{i,t}$	Unidirectional	Granger causality runs from $RGDP_{per\ capita_{ppp_{i,t}}}$ to $HC_{i,t}$
$RGDP_{per\ capita_{ppp_{i,t}}} \rightarrow CS_{i,t}$	Unidirectional	Granger causality runs from $RGDP_{per\ capita_{ppp_{i,t}}}$ to $CS_{i,t}$
$RGDP_{per\ capita_{ppp_{i,t}}} \leftarrow TB_{i,t}$	Unidirectional	Granger causality runs from $TB_{i,t}$ to $RGDP_{per\ capita_{ppp_{i,t}}}$
$HC_{i,t} \leftrightarrow TB_{i,t}$	Bidirectional	Granger causality runs from $HC_{i,t}$ to $TB_{i,t}$ vice versa
$CS_{i,t} \leftrightarrow TB_{i,t}$	Bidirectional	Granger causality runs from $CS_{i,t}$ to $TB_{i,t}$ vice versa

↔ indicates causality running in both direction
→ indicates causality from left to right
← indicates causality from right to left
↑ increase
↓ decrease
─ leads too
Source: Author's Calculation

Summary Statement, Conclusion, and Educational Policy Recommendations

The results contained in Table 9 support the long-term GC between our explained and explanatory variables in all the selected countries, while the short-run GC results from our variables can be found in Table 10. Our results imply that $HC_{i,t}$ does not GC $RGDP_{per\ capita_{ppp_{i,t}}}$ to increase in the short-run, while in the long-run, it does GC economic growth in the respective countries. Given the results obtained, the importance of $HC_{i,t}$ in boosting economic growth can't be overemphasized. Also, $CS_{i,t}$ does not GC $RGDP_{per\ capita_{ppp_{i,t}}}$ to increase in the short-run while in the long-run, it does GC economic growth in the respective countries. On the other hand, $TB_{i,t}$ does GC $RGDP_{per\ capita_{ppp_{i,t}}}$ to increase both in the short-run and long-run.

This study investigates the GCR between $HC_{i,t}$ and economic growth in LAC. The study employs a time series annual data between 1950–2014 for a panel of 14 LAC: Argentina, Bolivia, Brazil, Chile, Colombia, Costa Rica, Honduras, Mexico, Nicaragua, Panama, Peru, El Salvador, Uruguay, and Venezuela. The data was collected from (PWT, 2019).

The empirical findings reveal that after controlling for $CS_{i,t}$, $TB_{i,t}$, $HC_{i,t}$, and $RGDP_{per\ capita_{ppp_{i,t}}}$, there is a positive statistically significant long-run relationship between $RGDP_{per\ capita_{ppp_{i,t}}}$ and $HC_{i,t}$ with a coefficient of 0.21. This indicates that a 1%-point increase in $HC_{i,t}$ will lead to a 0.21%-point increase in $RGDP_{per\ capita_{ppp_{i,t}}}$ in the LAC. This result indicates that the incentive to improve the HDI of a nation would yield a positive outcome as it translates to an increase in $RGDP_{per\ capita_{ppp_{i,t}}}$. This result is consistent with (Edrees, 2016), (Mehrara & Musai, 2013), (Khembo & Tchereni, 2013), (Rahman, 2011), (Sharma & Sahni, 2015) and (Osiobe, 2020) which is a similar vein study that analyzes relationship among $RGDP_{per\ capita_{ppp_{i,t}}}$ (as a proxy for economic growth) and the examined variable, $SGE_{i,t}$, ((Secondary School Government Expenditure) as a proxy for human capital), and $VT_{i,t}$ (Trade Volume) as the explanatory variables between 2000-2014. The study preceded this paper with less countries analyzed (excluding Bolivia, Honduras, Nicaragua, Panama, Uruguay, and Venezuela).

$CS_{i,t}$ was used as a proxy for domestic investment in private and public infrastructures. It showed a positive, statistically significant result with a coefficient of 0.13. This implies that a 1%-point increase in the $CS_{i,t}$ will lead to a 0.13%-point rise in $RGDP_{per\ capita_{ppp_{i,t}}}$ in the LAC. The results indicate that in our LAC, domestic investment, plants, and excellent infrastructures contribute significantly to the growth of the economy in terms of $RGDP_{per\ capita_{ppp_{i,t}}}$. The $TB_{i,t}$ has a negative and statistically significant long-run relationship with $RGDP_{per\ capita_{ppp_{i,t}}}$. A one percentage point increase in $TB_{i,t}$ causes a decrease in $RGDP_{per\ capita_{ppp_{i,t}}}$ by 0.43%-point. This implies that a negative $TB_{i,t}$ affects economic growth in the LAC.

Our results also indicate a significant causal link between $RGDP_{per\ capita_{ppp_{i,t}}}$ and $HC_{i,t}$ with a unidirectional a GCR, moving from $RGDP_{per\ capita_{ppp_{i,t}}}$ to HC. $RGDP_{per\ capita_{ppp_{i,t}}}$ and $CS_{i,t}$ with a unidirectional GCR, moving from $RGDP_{per\ capita_{ppp_{i,t}}}$ to $CS_{i,t}$, and $RGDP_{per\ capita_{ppp_{i,t}}}$ and $TB_{i,t}$ with a unidirectional GCR, moving from $TB_{i,t}$ to $RGDP_{per\ capita_{ppp_{i,t}}}$. While a bidirectional significant GCB can be found between $HC_{i,t}$ and $TB_{i,t}$, and, $CS_{i,t}$ and $TB_{i,t}$. The results imply that the variation in $RGDP_{per\ capita_{ppp_{i,t}}}$ is useful in predicting the variation in $HC_{i,t}$ and $CS_{i,t}$, while the variation in $TB_{i,t}$ is useful in predicting the variation in $RGDP_{per\ capita_{ppp_{i,t}}}$. In a bidirectional causality, the variation in the two variables is useful in predicting the variation in the other.

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 (primary, secondary, and higher education) needs to be investigated.

Although the study doesn't find a direct GCR moving from, $HC_{i,t} \rightarrow RGDP_{per\ capita_{ppp_{i,t}}}$, there is an indirect causal relationship between our variables of interest. This association is the bidirectional GCR between $HC_{i,t} \leftrightarrow TB_{i,t}$. The relationship exists because $TB_{i,t}$ is an explanatory factor of $GDP \equiv RGDP \equiv RGDP_{per\ capita} \equiv RGDP_{per\ capita_{ppp}} \equiv RGDP_{per\ capia_{ppp_{i,t}}}$ in this study and $TB_{i,t}$ is derived from net exports. The result supports the long-term GCR between our explained and explanatory variables in all of the LAC. Meanwhile, the short-run GC results from our variables can be found, and our results imply that $HC_{i,t}$ does not GC $RGDP_{per\ capita_{ppp_{i,t}}}$ to increase in the short-run, while in the long-run, it does GC economic growth in the respective countries. Given these results obtained, the importance of $HC_{i,t}$ in boosting economic growth confirmed our sample. Also, $CS_{i,t}$ does not GC $RGDP_{per\ capita_{ppp_{i,t}}}$ to increase in the short-run, while in the long-run, it does GC economic growth in the respective countries. On the other hand, $TB_{i,t}$ does GC $RGDP_{per\ capita_{ppp_{i,t}}}$ to increase both in the short-run and long-run. This study provides information that will serve as a guide for future studies, as well as the formulation and implementation of short- and long-term development goals of the Latin American region (not limited to the selected countries).

The policy implications of this research involve the following: first, Our Latin America study sample should provide incentives that would foster, attract, and retain public and private investment in $HC_{i,t}$ development and educational advancement in the region. These incentives should be regulated at the regional level under the umbrella of a decentralized governing body for each country. Second, a legal framework regulating government expenditure on education and the educational sector in the region should be strengthened. This will create a conducive learning environment for both the students and teachers.

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