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Dynamic Relationship between Human Capital and Economic Growth in Sri Lanka: A Co-Integration Analysis

S. Vijesandiran[1] --- T. Vinayagathasan[2*]

[1,2]Department of Economics and Statistics, Faculty of Arts, University of Peradeniya, Sri Lanka

Abstract

Annual data from Sri Lanka was used to analyze dynamic linkage between human capital and economic growth rate. ADF, PP, and Ng-Perron unit root tests confirmed that all the series that has been included in the model are stationary at first difference. Co-integration test identified one co-integrating vector, suggesting long-run relationship between the variables. Both co-integration and VECM test revealed a positive long-run relationship between health index and per capita GDP. We also found the long-run equilibrium of the model for the real per capita GDP, real capital expenditure on human capital and real labor expenditure on human capital. The results of VECM suggested a short-term relationship between per capita GDP and health care, education level and per capita income and health care and education.

Keywords: Human capital, Economic growth, Cob-douglas model, Endogenous growth theory, Co-integration, Error correction model.
JEL Classification: J24, F43, O47.

Contents

** Corresponding Author*

1. Introduction

In the current global trend of advancing technology and growing competition, improvement of human capital has become imperative for every nation since it plays an indispensable role on sustainable economic growth (Lucas, 1988; Barro, 1991; Sala-i-Martin *et al.*, 2004). Thus, the role of human capital on economic development has been regarded as an investment by School of Human Capital since the early 1960s.

Sri Lanka is one of the pioneers in providing free education and free health services through public spending since independence which elevated its health and education indices to be par with developed countries. The education system introduced by the British during the colonial period has been gradually expanded throughout the country. Its primary objective was to produce the necessary human capital for the plantation sector at a low cost. As a result, Sri Lanka had the highest literacy rate in Asia at the time of independence of the country (Wilson, 1977). Further, Karunathilaka (2008) explains that more than 95% of the educational institutions and hospitals in the country are belongs to the government. In this regard, life expectancy at birth has progressively increased up to 74.07 years in 2012 compared to 58.25 years in 1953 and literacy rate has risen from 69% in 1953 to 92.7% in 2013 (Central Bank of Sri Lanka, 2014). Moreover, per capita GDP based on purchasing power parity has increased from US $ 3339.64 in 1990 to US $ 10043.5 in 2013 (World Bank, 2014). As a result, Sri Lanka's Human Development Index (HDI) has progressively increased to 0.750 in 2014 compared to 0.513 in 1980. The country, up by two notches from last year's rank, is placed at the 73rd position, the highest among the South Asian countries in the index that is a composite national measure of health, education and income for 187 countries. The average HDI value for the Asian region, at 0.588 is below the world average of 0.702 and only Sri Lanka in the South Asian region is above the average UNDP - United Nation Development Programme (2014). Ratnayaka and Saliya (2010) pointed out that although Sri Lanka was unable to utilize these favorable conditions to achieve higher economic growth rate. Sri Lanka's education and health indicators, especially its literacy rate, school enrolment rate, fertility rate, life expectancy and infant mortality rate were at desirable levels compared to other Asian countries in the last 5 decades. Hence, this helped to achieve the highest social development level in Sri Lanka which is similar to or sometimes higher than some of the newly industrialized economies (NIEs) and ASEAN countries in Asia.

Although the relationship between human capital and economic growth is still considered controversial, education and training are seen as the most important investments in human capital. Literature on this subject can be divided into two major groups. The first group confirms a strong positive correlation between human capital and economic growth (Mbanefoh, 1980; Akangbou, 1983; Barro, 1991; Mankiw *et al.*, 1992; Burnett *et al.*, 1995; Grammy and Assane, 1996; Bloom and Sachs, 1998; Abbas, 2000; Qadri and Waheed, 2011). The second group found a negative or insignificant or weak relationship between these two variables (Islam, 1995; Hoeffler, 1997; Pritchett, 2001; Wang and Yao, 2001; Adamu, 2003; Ayara, 2003). Further, Bloom *et al.* (2006) and Kent *et al.* (2005) identified three major categories of benefits from human capital development which are defined as 'public' and 'private' benefits; monetary and non-monetary benefits and social and economic benefits.

The reason for weak/insignificant relationship in the country's lack of progress was failure to indigenize (Sri Lankanize) the imported education system to meet the country's specific needs. Another argument is that whether Sri Lanka's education system introduced 'moral education' as a subject in primary and secondary education to create a disciplined labour force and furthermore promote communal harmony like in Japan? The answer for this question is that, Sri Lanka has failed in this aspect and the failure to indigenize the education system was that people who studied in their own language i.e. Sinhala, and Tamil had poor skills, were not able to contribute to Sri Lanka's economic growth. Although, this would allow all people to participate equally in the country's socioeconomic development, unfortunately, it was the people from the middle class and urban areas who fully benefited. The most serious problem is that it excludes people, in whose education the country invested a huge amount of money with free education, from participating in development activities. Because of the language dilemma, the human capital developed under the British-style education could not be used productively (Ratnayaka and Saliya, 2010). This shows that education alone will not benefit society and the economy unless the quality of education, particularly the attitudes and understanding of labour force are improved. It is because Sri Lankans believe that free education is their right, with no obligation to return something back to the country.

Even with the negative aspects of language dilemma in human capital formation and continuous disturbances due to civil war to both national harmony and the environment which are conducive for economic progress since early 1980s. As a result, Sri Lanka has experienced an average annual growth rate of 5% in real GDP over the recent past (Cooray, 2011). The World Bank (2015) illustrates that economic growth in Sri Lanka became the fastest in South Asia in recent years where average growth rate was 6.3% between 2002 and 2013, with Gross Domestic Product (GDP) per capita rising from US$ 859 in 2000 to US$ 3,256 in 2013.

However, the efficacy of public spending on human capital and its role on promoting economic growth in Sri Lanka remains scantly researched in recent times and it has become a widely debated issue. Even past studies used either government expenditure or human capital indices to perform their study, exploring the relationships using recent data on expenditure and indices of human capital simultaneously are still neglected in Sri Lanka. Hence, this study focuses on examining the role of human capital in economic growth of Sri Lanka using an annual data set from 1970 to 2013.

2. Literature Review

Despite there being many factors that affect the growth rate of an economy, human capital has been identified as the most prominent factor in recent decades by researchers. Recent decades have seen an explosion in research, both theoretical and empirical, that attempts to focus on the correlation between human capital and economic growth. Thus, it is crucial that we review the related literature, if we are to understand the precise relationship between these two variables. This section briefly reviews the relevant theoretical studies, and then goes on to discuss the findings of existing empirical studies that pertain to the human capital–economic growth nexus.

Theoretical studies identified a positive relationship between human capital and economic growth (e.g., (Lucas, 1988; Mankiw *et al.*, 1992; Bergheim, 2005; Maritra and Mukhopadhyay, 2012). Maritra and Mukhopadhyay (2012) confirm that investing on education and health accumulates human capital and leads to innovative technological progress which increases productivity and thus accelerates the economic growth in the long run. Lucas (1988) suggests that public expenditure contributes positively to income growth in the short run.

Moreover, Qadri and Waheed (2011) illustrate that a healthier worker can contribute more in the production process than the unhealthy counterpart through many channels: (i) healthier worker has higher physical and mental capabilities, vigor and stamina; (ii) healthier person can learn more than an unhealthier one from a given level of education. In this way, improvement in health increases output due to increased strength and also due to more learning from a given level of education. Nutrition has a strong line with productivity, output and economic growth. That is, a person who consumes nutritious food is likely to be more productive due to higher vigor and strength Taniguchi and Wang (2003). Therefore, providing adequate nutrition is considered as an investment in human capital. Bergheim (2005) demonstrates that education is the most important determinant of human capital which affects the output through various channels: (i) education raises knowledge which helps to produce more output in a shorter time and intuitionally it is known that an educated person could learn much faster, (ii) increase in the level of education leads towards better health due to an increase in the awareness of the benefits of healthy living which in turn increases output, (iii) education enhances labor force participation in an economy particularly in the case of female participation and leads to output increases. Along with education, the role of experience is also very important in productivity growth. Experience generally reduces the chances of errors and increases the output during a given time period. Moreover, human capital is necessary for optimum utilization of physical capital i.e. increase in the stock of human capital in any economy attracts investment in physical capital which in turn increases output (Abbas, 2000; 2001). In addition, the basic production function expresses the importance of labor, capital and technology in determining economic growth. In this regard Karunathilaka (2008) states that "the contribution of labour to the expansion of output depends on the size of the labour force and its productivity. There is close and positive association between human capital and productivity". Hence, educated and trained labour, the human capital, enables efficient and optimal combination of labour and capital with a given state of technology.

The empirical studies reached two types of conclusions regarding the responsiveness of economic growth to human capital. In the first strand, there is a positive relationship between human capital and growth rate, especially education and economic growth (e.g. (Mbanefoh, 1980; Akangbou, 1983; Barro, 1991; Mankiw *et al.*, 1992; Burnett *et al.*, 1995; Grammy and Assane, 1996) and health and economic growth (e.g. (Bloom and Sachs, 1998)).

Using Nigerian data of different levels of education such as primary, secondary and tertiary, Akangbou (1983) and Mbanefoh (1980) found evidence to the positive role of human capital on economic growth. Barro (1991) identified a positive relationship between school enrolment rate and real per capita growth rate of 98 countries over the period of 1960- 1985. By examining the Solow growth model with and without human capital Mankiw *et al.* (1992) detected that human capital augmented Solow model fits in explaining cross-country income variations. To this study, they used date data from 121 countries relating to the period from 1960 to 1985. This study uses a variable "School" as a proxy for human capital, which was constructed through taking the percentage of the people, aged 12 to 17 enrolled in the secondary schools. Similarly, Burnett *et al.* (1995) show that massive investment in both primary and lower secondary school education significantly explained the development 'miracle' experienced in East Asia. Using varied forms of human capital variables such as school enrolment, human development and economic liberty index Grammy and Assane (1996) pointed out that human capital formation positively contributes to economic growth. Using school enrolment rates at primary, secondary and higher secondary levels as proxies for human capital variable for Pakistan and India over the period of 1970-1994, Abbas (2000) observed that secondary schooling has a significant and positive correlation with economic growth for both the countries whereas primary education significantly stimulates economic growth only for India (at 1% level) and higher education effects positively only in Pakistan at 10% level of significance. Abbas and Foreman-Peek (2007) use the co-integration technique to estimate the effect of human capital on the economic growth of Pakistan during the period from 1961 to 2003. They took stock of human capital as a proxy for human capital which was calculated through the perpetual inventory method by using the secondary enrolment data. Also this study considered health expenditures (% of GDP) as a proxy for human capital. The authors conclude that investing in health sector raises the physical and human capital which stimulate growth rate of an economy.

Bloom and Sachs (1998) use life expectancy as proxy for health which is proxied for human capital and found that increases in life expectancy accelerates GDP per capita growth. For this purpose they used cross country data for the period 1965-1990. Qadri and Waheed (2011) used health adjusted education indicator as proxy for human capital and found that human capital positively affects economic growth of Pakistan in the long run, which necessitates a special focus on the health and education sectors of the economy simultaneously.

There are some studies, which address the importance of gender dimension in human capital investment. For instance, using an overlapping generation framework, Lagerlof (1999) examines the impact of gender inequality in education on fertility and economic growth. He argues that gender inequality in education can lead to a self-perpetuating equilibrium of continued gender inequality, with the consequence of high fertility and low economic growth. Schultz (1994) also argues that reducing gender inequality through access to education and the labour market will help reduce poverty, thereby increasing the rate of economic growth.

Wang and Yao (2001) analyzed the role of factor accumulation as well as TFP growth on China's rapid growth in the post-reform period using annual data from 1953 to 1999 and employed growth accounting techniques. The study used average years of schooling of population aged between 15 to 65 years as a proxy for human capital. They conclude that in the pre-reform period (1953 to 1977) growth was factor led and TFP growth was negative while in post-reform period, factor accumulation as well as TFP growth played a role in the robust growth.

Another group of studies discuss the importance of training for human capital that enhances economic growth. For instance: Adamu (2003) examined the impact of human capital formation on economic growth for Nigeria during

the period 1970-2000 using co-integration and error-correction mechanisms. The results indicate that investment in human capital in the form of education and training can lead to economic growth via labour productivity. Moreover, Uwatt (2003) investigated the role of human resource development on economic growth in Nigeria using the augmented Solow growth model and relying on co-integration and error-correction techniques. The results showed that human resource development has a strong positive significant correlation with economic growth. Mustafa *et al.* (2005) emphasized the role of human resource development and vocational training for economic growth in Pakistan. This study analyzed the status of vocational training-related policies and practices and their impact on development of human resource. The output growth variability was regressed on the rate and variability of the institutions, enrolment, and teachers to find out the growth and the variability impact of the vocational indicators on the output growth variability. They noticed a positive and significant relationship between the growth of institutions and output growth variability. Also enrolment and teachers play a significant role in determining the output growth variability.

In the second strand, there is an inverse relationship between human capital and the economic growth rate (e.g. (Pritchett, 2001; Ayara, 2003)). They include the following explanation in their model: (i) existence of brain drain, (ii) the newly created educational capital might have gone into privacy that is, privately remunerative but socially unproductive activities, (iii) incessant strike actions by the academic and non-academic staff of Nigerian universities, (iv) failure of the educational system to provide qualified manpower that would enhance productivity growth, (v) there may be slow growth in the demand for educated labour, so that the supply of educational capital has out-stripped demand and returns to schooling have declined.

When we consider the case of Sri Lanka, using Pakistan and Sri Lankan data between 1970 and 1994 Abbas (2001) identified a positive and significant link between human capital (secondary and higher secondary level education respectively for the above countries) and economic growth in both countries. He took enrolment rates at primary, secondary and higher secondary levels as a proxy for human capital. Duma (2007) found a positive relationship between human capital and economic growth in Sri Lanka but identified a very low contribution of human capital. He used an augmented production function and 1980-2006 data to achieve this objective. However, the author found a very low contribution of human capital to growth, i.e. human capital only contributed to around 10% of output growth while physical capital and labor contributed 17% and 27% respectively. The major contribution to growth was TFP which contributed around 46%. The author detected that in the period after the 1980's there was a slow-down in the labor intensive product line along with a rapid growth in the output of capital intensive industries with higher productivity level. Kasturi and Abhayaratne (2007) analyzed the contribution of health and education expenditure on economic growth in Sri Lanka using multiple liner regression model and they found a positive relationship between these variables in the long run.

It is apparent that most of the studies found a positive relationship between human capital and economic growth while some of the other studies found it to be negative. Using these empirical evidence and theoretical underpinnings as a base, the present study hypothesizes that accumulation of human capital, particularly through education and health (hereafter human capital or human resource) benefits by the services especially from formal institutions funded through public spending contribute to the enhancement in productivity and working attitude of the labour force, efficient use of material resources and to good governance which promote economic growth.

3. Definition, Measurement and Concepts of Human Capital

United Nation Economic Commission for Africa (UNECA) (1990) defined human capital as "the knowledge, skills, attitudes, physical and managerial effort required to manipulate capital, technology, and land among other things, to produce goods and services for human consumption". Sheffrin (2003) defined human capital as "the stock of skills and knowledge embodied in the ability to perform labor so as to produce economic value". Frank and Bernanke (2007) defined human capital is "an amalgam of factors such as education, experience, training, intelligence, energy, work habits, trustworthiness and initiative that affect the value of a worker's marginal product. However, Organization of Economic Cooperation and Development (OECD) publication Keeley (2007) broadly defined human capital as "the knowledge, skills, competencies and attributes embodied in individuals that facilitate the creation of personal, social and economic well-being." It is clear that human capital is critical to sustainability, productivity, and the current and future health of a country. In response, people are becoming valuable assets. In the economic perspective, capital refers to factors of production used to create goods or services. The human is the subject to take charge of all economic activities such as production, consumption, and transaction. Thus, it can be recognized that human capital means one of production elements which can generate added values through using it.

The other is that human capital can be viewed as the target of investment through education, training and health. Throughout the investment in education and health in order to enhance human capital, an individual's acquired knowledge, skills, abilities that can easily transfer certain goods and services with practical values (Romer, 1990). Consequently, human capital simultaneously includes both the instrumental concept to produce certain values and the "endogenous" meaning to self-generate it Kwon (2009).

As referred to in various definitions, the concept of human capital refers to the knowledge, skills, attitudes, physical and managerial effort required to manipulate capital, technology, and land among other things, to produce goods and services for human consumption (UNECA, 1990). Human capital formation, on the other hand, refers to the process of acquiring and increasing the number of persons who have the skills, education and experience that are critical for the sustainable growth and development of a country. The economic benefits of human capital formation arise from making people more productive by improving their nutrition, health, education and other social indices through adequate and proper investments.

According to Okojie (1995) human capital formation is associated with investment in man and his development as a creative and productive person. It is a continuum, a continuing process from childhood to old age and a must for any society or enterprise that desires to survive under the complex challenges of a dynamic world. Strategies for human capital development include: expenditure incurred for formally organized education at the elementary, secondary and higher levels; investment in health facilities and services, broadly conceived to include all expenditure

that affect the life expectancy, strength and stamina; activities related to on-the-job training, including old-type apprenticeships organization by firms; study program for adults, seminar, conference, including extension programs; In line with this, human capital formation concerns the three-fold objective of enhancing knowledge, building skills and improving capabilities for productive employment of non-utilized or underutilized manpower. All stem represent the form of education and training and health services are known to be institutional mechanisms for enhancing people's knowledge, skills and capabilities.

The conventional standard to measure human capital stock has been largely categorized into three parts: Output, Cost and Income-based approaches. Output-based approach attempted to measure the stock of human capital utilizing "school enrollment rates" as a proxy for human capital (Barro, 1991; Barro and Jong, 1993). Cost-based approach is based on measuring the stock of human capital through summing costs invested for one's human capital that values the human capital stock at the cost of producing it. A frequently cited text on the cost-based method is Kendrick (1976) which measures human investment using the cost of rearing children, educating people, and other human capital-related activities. The income-based approach values the human capital stock using the earnings of the persons in that stock which measure human capital using lifetime incomes in present discounted value (Jorgenson and Barbara, 1989) are seminal applications of the income-based approach. Income-based approach is based on the returns which an individual obtains from a labor market throughout educational investment. To begin with the new approaches, OECD developed a new measurement on human capital identified as 'Human Development Index' (HDI) which was introduced to the world by the United Nations Development Program (UNDP) in 1990 based on a human development conceptual framework. HDI is closely linked to international comparable statistics considering investment in human capital, quality adjustments and result of education. The structure of the index is constituted to health, knowledge, and standard living with many sub-variables such as life expectancy at birth, adult literacy rate, gross enrollment ratio and GDP per capita.

4. Methodology

4.1. Model Specification

Dauda (2010) suggests that endogenous factors such as government policies, political stability, market distortions, human capital etc., can significantly affect economic growth. Therefore, most suitable model for this type of study is the endogenous growth model which is widely used to investigate human capital-economic growth nexus. Therefore, this study follows Human Capital Model of Endogenous Growth Theory and Qadri and Waheed (2011) and Asghar *et al.* (2012) empirical studies to formulate the model. Also we adapt neo-classical production function as a framework for this study. The neo-classical model based Cobb-Douglas function is given as:

$$Y = F(A, K, L) \tag{1}$$

Where Y, K, and L are output, physical capital and labour force respectively, and A denotes technical progress or total factor productivity. Thus, the conventional type of Cob-Douglas relationship is given below:

$$Y_t = AK_t^{\alpha_1} L_t^{\alpha_2} \tag{2}$$

Where, $\alpha_1 \text{and } \alpha_2 < 1$, implying decreasing returns to scale. When we differentiate Eq (2) with respect to time, divide by Y and rearrange the terms, it gives equation as:

$$\left[\frac{\Delta Y}{Y}\right] = \left[\frac{\Delta A}{A}\right] + \left[F_K \frac{\Delta K}{K}\right]\left[\frac{K}{Y}\right] + \left[F_L \frac{\Delta L}{L}\right]\left[\frac{L}{Y}\right] \tag{3}$$

Where; $\frac{\Delta Y}{Y}$ is a growth rate of output, $\frac{\Delta K}{K}$ is a growth rate of capital, $\frac{\Delta L}{L}$ is a growth rate of labor, $\frac{\Delta A}{A}$ is a rate of change in technological progress and F_K and F_L are social marginal product of capital and labor respectively.

However, modern economic growth depends on the accumulation of physical capital and an increase in labour force with improved technological embodiment. Without it labour cannot be effective. Thus, Human capital is a factor influencing labour productivity because it facilitates the absorption of new technology, increases the rate of innovativeness and promotes efficient management (Adamu, 2003). Consequently, for high labour productivity, an integral part of technological progress is investment in human capital and thus is termed endogenous factor because accumulation of physical capital is enhanced by the knowledge, skills, attitudes and health status of the people who partake in such exercise. Thus, there is a strong and positive relationship between investment in human capital and output growth. In this regard, incorporating human capital in to the Cob-Douglas model provides the following transformation:

$$Y_t = AK_t^{\alpha_1} L_t^{\alpha_2} C_t^{\alpha_3} \tag{4}$$

Where; C is the investment in human capital.

In addition to the traditional variable K and L, in the above Equation (4) the variable C can be divided in to two components: Education (E) and health (H) based on the literature and objective of this study. Thus, based on this modification, the following model is specified to evaluate the impact of human capital formation on economic growth in Sri Lanka.

$$Y_t = AK_t^{\alpha_1} L_t^{\alpha_2} E_t^{\alpha_3} H_t^{\alpha_4} e^{\varepsilon_t} \tag{5}$$

Where, $\alpha_1, \alpha_2, \alpha_3 \text{ and } \alpha_4 > 0$ and represents the coefficients of elasticity of explanatory variables Capital (K_t), Labor (L_t), Education (E_t) and Health (H_t). The real capital expenditure on human capital, real labor (recurrent) expenditure on human capital, educational index, health index and per capita GDP are used a as proxies for the variables K_t, L_t, E_t, H_t and Y_t respectively (See Table 1 bellow for calculation formula).

Table-1. Method of Calculation of Explanatory Variables

Proxies for Capital and Labor	Proxies for Education and Health
RCE on HC (K) $= \frac{\text{TCE on E and H}}{\text{GDP Deflator}}$	Eduction Index $= \left[\frac{2}{3} * \text{ALI}\right] + \left[\frac{1}{3} * \text{GEI}\right]$ Where, ALI $= \frac{\text{ALR}-0}{100-0}$ and GEI $= \frac{\text{CGER}-0}{100-0}$
RLE on HC (L) $= \frac{\text{TRE on H and E}}{\text{GDP Deflator}}$	Health Index $= \left[\frac{\text{LE}-25}{85-25}\right]$ where LE: Life expectancy

Note: RCE on HC denotes the Real Capital Expenditure on Human Capital; TCE on H and E denote the Total Capital Expenditure on Education and Health; RLE on HC denotes the Real Labor (recurrent) Expenditure on Human Capital; and TRE on H and E represent the Total Recurrent Expenditure on Health and Education. We followed Asghar *et al.* (2012) to calculate Education Index (EI) and Health Index (HI). Where, ALI denotes Adult Literacy Index, GEI represents Gross Enrolment Index and CGER is the Combined Gross Enrolment Rate. LE represents the Life Expectancy in years. (CGER is combined primary, secondary and tertiary Gross Enrolment Index with one third weightage).

Thus, the Equation (5) can be transformed to natural logarithm as follows:

$$\ln Y = \ln A + \alpha_1 \ln K + \alpha_2 \ln L + \alpha_3 \ln E + \alpha_4 \ln H + \varepsilon_t \quad (6)$$

Where, lnY is the dependent variable that represents log of per capita GDP, lnA is the constant term denotes the total factor productivity; lnK is log of physical capital which is proxied through real capital expenditure (Investment) on human capital, lnL is the log of labor input measured through labor force proxied by real labor (recurrent) expenditure on human capital and lnE and lnH are log of education and log of health proxied through Education Index (EI) and Health Index (HI) respectively. In this study, we constructed two new proxies for human capital. That is, the variable EI is constructed through combining adult literacy rate and enrolment rates at primary, secondary and tertiary levels with one third weightage and the other variable HI is constructed using life expectancy rate. The reason for including health in this study is that health is an important factor in determining the returns from human capital and improvement in health tends to increase the physical capabilities of labour force and also engages labour for longer period in production process which enhances productivity growth. These two new proxies are relatively better measures of human capital inputs since they are output-based indicators compared to the other traditional proxies for human capital which are cost-based measures i.e. public expenditures on education and health.

4.2. Data and Sources

The study covers the period of 1970 – 2013. The data for real per capita GDP (Y), real capital expenditure (K) and real labor/recurrent expenditure (L) were collected from the annual reports of Central Bank of Sri Lanka and data for literacy rate, life expectancy and school enrolment rate at various levels of schooling are collected from World Development Indicator (WDI) data base and the value of all the variables were transformed into natural logarithm.

4.3. Model Estimation and Testing

Model estimation begins with the analysis of the order of integration of each variable using Augmented Dickey Fuller (ADF), Philips-Perron (PP) and Ng-Perron unit root test for this analysis. The co-integration test was conducted using Johansen approach to test long run relationship between variables. The model described as:

$$\ln Y_t = \alpha_0 \ln A + \alpha_1 \ln K_t + \alpha_2 \ln L_t + \alpha_3 \ln E_t + \alpha_4 \ln H_t + \varepsilon_t \quad (7)$$

Error correction model (ECM) was employed to test the short-run and long-run relationship between variables as well as long-run equilibrium of the variables using the following model:

$$\Delta \ln Z_t = \alpha_0 + \Pi \ln Z_{t-1} + \sum_{i=1}^{p-1} \Phi_i^* \Delta \ln Z_{t-i} + \varepsilon_t \quad (8)$$

Where,$\boldsymbol{\Pi}$ and the $\boldsymbol{\Phi}^*$are functions of the Φ's specifically, $\Phi_j^* = -\sum_{i=j+1}^{p} \Phi_i, \quad j = 1, \ldots, p-1, \ \Pi = \left(I - \Phi_1 - \cdots - \Phi_p\right) = -\Phi(1)$, If $\Pi = 0$, then there is no cointegration, If Π has full rank, K, then the x's cannot be I(1) but are stationary and $\Pi = \alpha\beta'$. where, α is coefficient of the error correction term or (5×1)cointegrating vector, β' is the (1×5) vector of cointegrating coefficients. $Z_t = [Y_t, K_t, L_t, E_t, H_t]'$vector of endogenous variables, Z_{t-i} is the lagged value of the variables and ε_t is the white noise error term.

5. Results and Discussions

The order of integration is confirmed using three alternative unit root test methods. The results of ADF and PP are reported in Table 2 and Ng-Perron is presented in Table 3.

Table-2. Results of ADF and PP Unit Root Test (Without Trend): 1970-2013

Variables	ADF Test Statistics		PP Test Statistics	
	Logarithm	Difference Log	Logarithm	Difference Log
Y	1.35	-4.26*	1.10	-4.20*
E	-0.60	-5.00*	-0.63	-5.01*
H	1.04	-2.75***	-1.04	-2.88***
K	0.07	-7.23*	-0.28	-10.6*
L	-0.63	-8.27*	-0.04	-17.9*
Mac-Kinnon Critical Value				
1%	-3.60		-3.60	
5%	-2.94		-2.94	
10%	2.61		2.61	

Note: *,**, *** show significant at 1%, 5% and 10% level respectively.

Both ADF and PP tests confirmed that all the variables are stationary at their first difference of logarithm. However, H is stationary at 10% level of significance in both tests whereas Y, K, L and E are stationary at 1% level of significance. Therefore, this results suggest that all five variables are integrated in the same order, i.e. I(1).

Table-3. Results of NG-Perron Unit Root Test (Without Trend): 1970-2013

Variables	MZ_a	MZ_t	MSB	MPT
Logarithm				
lnY	-2.70	-1.24	0.13	1.67
lnE	0.07	0.04	0.54	21.8
lnH	-2.53	-0.81	0.32	8.32
lnK	-0.11	-0.05	0.55	21.5
lnL	0.07	0.04	0.55	22.1
Logarithm of First Difference				
ΔlnY	-5.83***	-1.89***	0.26***	3.60***
ΔlnE	-18.1*	-2.99*	0.16*	1.40*
ΔlnH	-5237.7*	-51.1*	0.01*	0.01*
ΔlnK	-37.9*	-4.35*	0.11*	0.65*
ΔlnL	-20.2*	-3.16*	0.15*	1.24*
Critical Values[a]				
1%	-13.8	-2.58	0.17	1.78
5%	-8.10	-1.98	0.23	3.17
10%	-5.70	-1.62	0.27	4.45

Note: *,**, *** show significant at 1%, 5% and 10% level respectively. a: asymptotic critical value taken from Ng-Perron (2001, Table 1). MZ_a: Modified Philips-Perron test. MZ_t: Modified PP t-test. MSB: Modified Sargan-Bhargava test. MPT: Modified Point Optimal test.

Ng-Perron unit root test also confirmed that all five variables are stationary at their log of first difference. However, Y is stationary at 10% level of significance whereas K, L, E and H are stationary at 1% level of significance. Therefore, this result also suggests that all five variables are integrated in the same order, i.e. I(1). Once we established the order of integration, the study process requires the estimation of the long-run relationships among the variables included. However, before estimating this relationship we need to identify the optimal lag length of the model. The lag length selection results are provided in the Table 4.

Table-4. Results of Optimal Lag Length Selection Results

Lag	LogL	LR	FPE	AIC	SC	HQ
0	398.9912	NA	6.79e-16	-20.73638	-20.52091*	-20.65972
1	430.2417	52.63245	4.95e-16	-21.06535	-19.77252	-20.60537
2	465.2865	49.80043*	3.14e-16*	-21.59403*	-19.22383	-20.75073*
3	480.9051	18.08477	6.24e-16	-21.10027	-17.65272	-19.87366
4	508.6943	24.86400	8.17e-16	-21.24707	-16.72216	-19.63714
5	531.6020	14.46803	2.10e-15	-21.13695	-15.53468	-19.14370

Note: * indicates lag order selected by the criterion. LR: sequential modified likelihood ratio test statistic, FPE: final prediction error, AIC: Akaike information criterion, SC: Schwarz information criterion and HQ: Hannan Quinn information criterion test statistics

Using VAR model, all the lag length selection criteria except SC suggest that to use two lag as an optimal lag length for this study. Therefore, we included two lags in our model. The results of Johansen and Juselius co-integration test are presented in Table 5.

Table-5. Results of Johansen and Juselius Cointegration Test (1970-2013)

Part 1: Trace Statistics				
Null Hypothesis	**Alternative Hypothesis**	**Test Statistic**	**Critical Value (5%)**	**Probability****
$H_0: r \leq 0$	$H_1: r > 0$	99.79**	69.81	0.000
$H_0: r \leq 1$	$H_1: r > 1$	63.03**	47.85	0.001
$H_0: r \leq 2$	$H_1: r > 2$	35.29**	29.79	0.010
$H_0: r \leq 3$	$H_1: r > 3$	15.45	15.49	0.051
$H_0: r \leq 4$	$H_1: r > 4$	4.986	3.84	0.025
Part 2: Maximal Eigen Value Statistics				
Null Hypothesis	Alternative Hypothesis	Test Statistic	Critical Value (5%)	Probability**
$H_0: r = 0$	$H_1: r = 1$	36.75**	33.87	0.022
$H_0: r = 1$	$H_1: r = 2$	27.74**	27.58	0.047
$H_0: r = 2$	$H_1: r = 3$	19.83	21.13	0.075
$H_0: r = 3$	$H_1: r = 4$	10.47	14.26	0.182
$H_0: r = 4$	$H_1: r = 5$	4.986	3.841	0.025
Part 3: Normalized Cointegrating Vector				
lnY	lnK	lnL	lnE	lnH
1.000	0.000	0.000	-1.10 (-2.39)	-4.90 (-6.56)
0.000	1.000	0.000	-2.35 (-2.20)	-3.74 (-2.16)
0.000	0.000	1.000	0.26 (0.20)	-9.27 (-4.46)

Note: ** show significant at 5% level

Trace test statistics identified three co-integrating relations in the system of equation at 5% level of significance since we reject null hypothesis at rank 0, 1 and 2 but we failed to reject null hypothesis at rank 3. Whereas maximum Eigen value test identified two co-integrating relation since we reject null hypothesis at rank 0 and1 but we failed to reject null hypothesis at rank 2. This indicates the existence of long-run correlation between the variables. However, in our ECM, we use three co-integrating relations using trace statistics.

The Table 6 below shows the results of ECM and1st panel of this Table shows the short-run positive and significant relationship between real per capita GDP and health index and no significant relationship found between real per capita GDP and education index.

Table-6. Results of VECM

Panel 1: Short-run Relationship					
Variables	D(lnY)	D(lnK)	D(lnL)	D(lnE)	D(lnH)
$D(\ln Y_{t-1}$	-0.30 (-1.34)	0.06 (0.04)	-0.69 (-0.33)	0.009 (0.05)	0.07** (1.99)
$D(\ln Y_{t-2}$	-0.02 (-0.13)	-0.27 (-0.24)	-0.47 (-0.29)	0.02 (0.19)	-0.04 (-0.14)
$D(\ln K_{t-1})$	0.04 (0.82)	0.70** (2.24)	-0.37 (-0.84)	-0.01 (-0.31)	0.01 (1.45)
$D(\ln K_{t-2})$	0.0002 (0.006)	0.05 (0.22)	-0.34 (-1.01)	-0.012 (-0.50)	0.008 (1.29)
$D(\ln L_{t-1})$	-0.01 (-0.33)	-0.25 (-1.04)	0.87 (2.55)	0.02 (1.07)	-0.004 (-0.70)
$D(\ln L_{t-2})$	0.002 (0.08)	0.06 (0.35)	0.49*** (1.86)	0.02 (1.26)	-0.004 (-0.82)
$D(\ln E_{t-1})$	0.13 (0.43)	-2.10 $(-1.04$	0.19 (0.07)	-0.36*** (-1.75)	-0.02 (-0.41)
$D(\ln E_{t-2})$	0.19 (0.69)	1.80 (0.98)	2.79 (1.08)	0.05 (0.29)	-0.09*** (-1.93)
$D(\ln H_{t-1})$	-1.64 (-0.51)	-33.3 (-1.57)	4.08 (0.13)	1.79 (0.81)	1.00*** (1.84)
$D(\ln H_{t-2})$	1.48 (0.46)	18.7 (0882)	-21.7 (-0.72)	-2.12 (-0.96)	-0.10 (-0.19)
C	0.001	0.013	0.012	0.0003	0.0007
Panel 2: Long-run Relationship (From Cointegrating Vector)					
$\mathrm{DlnY} = 0.04 - 0.91\mathrm{DlnE}(-1)^{*} + 0.404\mathrm{DlnH}(-1)^{*}$ (-1.85) (1.67)					
$\mathrm{DlnE} = 0.03 + 0.93\mathrm{DlnE}(-1) - 3.25\mathrm{DlnH}(-1)$ (0.64) (-1.01)					
$\mathrm{DlnH} = 0.02 + 1.05\mathrm{DlnE}(-1) + 1.59\mathrm{DlnH}(-1)$ (0.57) (0.39)					
Panel 3: Speed of Adjustment					
Coint-Eq1 $EC_{1(t-1)}$	-0.23*** (-1.68)	-0.12 (-0.09)	-0.46 (-0.25)	-0.16 (-1.20)	0.12* (3.76)
Coint-Eq2 $EC_{2(t-1)}$	-0.01 (-0.09)	-0.77* (-3.48)	0.70 (0.98)	0.04 (0.77)	-0.02 (-1.63)
Coint-Eq3 $EC_{3(t-1)}$	0.01 (0.12)	0.05 (0.14)	-0.24* (-4.74)	-0.03 (-0.98)	0.01 (0.82)

Note: *, **, *** show significant at 1%, 5% and 10% level respectively.

The 2nd panel of the same Table identifies three co-integrating relations which confirm the long-run relationship among the regressions. The 1st co-integrating vector shows the positive correlation between real per capita GDP and health index while negative interaction between real per capita GDP and education index in the long-run at only 10% level of significance. The negative impact of education on GDP can be explained by two reasons: (1) due to the grade repetition at all levels of education among students resulted in a delay in entering the labor force which may have no immediate impact on growth, (2) the mismatch between educational qualification and demand for labor in both public and private sectors may lead to limit use of labour in production just after schooling.

The Panel 3 of Table 6 denotes the coefficients of speed of adjustment which explain how the above model is adjusted towards long-run equilibrium. Negative and significant error correction coefficient (-0.23) of Y (1st elements of Coint-Eq1) reveals that 23% disequilibrium is corrected by each year which implies that per capita GDP growth moves downward towards long run equilibrium path. In the same equation (Coint-Eq1) coefficients of health is positive and significant which implies that there is long run equilibrium between per capita GDP and health. The significant and negative error correction coefficient (-0.77) of K (2nd elements of Coint-Eq2) reveal that 77% disequilibrium is corrected by each year indicating that capital moves downward towards long run equilibrium path. However, in this equation (Coint-Eq2) other variables are not statistically significant. The significant and negative error correction coefficient (-0.24) of L (3rd elements of Coint-Eq3) indicates a 24% disequilibrium is corrected by each year. However, in this equation also (Coint-Eq3) other variables are not statistically significant at any level.

6. Conclusion

Annual data from Sri Lanka was used to analyze the relationship between human capital variables and per capita GDP growth rate. The unit root tests confirmed that all the variables are stationary at their first difference. Both Johansen and Juselius co-integration test and VECM co-integrating vectors identified that the economic growth has

long run positive relationship with health index and negative relationship with education index while the real capital expenditure on human capital and the real labor (Recurrent) expenditure on human capital has no significant relationship with economic growth in Sri Lanka. VECM test revealed a positive relationship between health index and economic growth in the short-run. Moreover, VECM test identified three co-integrating equations: (i) real per capita GDP growth (lnY), (ii) real capital expenditure on human capital (lnK) and (iii) real labour expenditure on human capital (lnL). Thus, error correction coefficients of these variables are significant and negative which suggest 23%, 77% and 24% disequilibrium errors are corrected by each year for above variables respectively. The study confirms that the health component of human capital has significant impact on economic growth of Sri Lanka in long-run since there is long-run relationship and long run equilibrium between real per capita growth rate and health index. Therefore, special attention needs to be given by the government to health sector improvement.

In the meantime, many countries in the region who were poorer relative to Sri Lanka have achieved more impressive economic progress over time. If the current trends continue, Sri Lanka lagging behind many more countries would be inevitable. So, the challenge before the nation is to create an environment conducive to foster high and sustainable growth. In addition to achieving lasting peace, Sri Lanka faces challenges in many fronts, such as strengthening law and order, improving macroeconomic balances, infrastructure development and stability in macroeconomic policies for creating a supportive environment to achieve high and sustainable growth. Further, relatively low productivity and high inflation in a highly competitive global environment demands Sri Lanka to develop human capital to withstand eroding competitiveness.

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