Effect of health on economic growth in Ghana:An application of ARDL bounds test to cointegration

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EFFECT OF HEALTH ON ECONOMIC GROWTH IN GHANA: AN APPLICATION OF ARDL BOUNDS TEST TO COINTEGRATION

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ABSTRACT

In this paper, the growth effect of health in Ghana is examined for the period 1982 to 2012. We use life expectancy at birth as a proxy for health, and real per capita GDP as a proxy for economic growth. After employing ARDL bounds test approach to cointegration, and controlling for the effects of education, international trade, FDI, inflation, and accumulation of physical capital, we find that economic growth is significantly driven by health, both in the short and long run. However, the favourable growth effect of health in the short run is found to be lower. The implication is that improvement in health status of the population raises output in the economy. In this regard, policy should aim at raising health sector investment and strengthen the healthcare system to improve health status.

JEL Codes: I1, I15, O1, O4, O15

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1. INTRODUCTION

In traditional growth literature, physical capital accumulation, labour and technological advancement have been considered the determinants of economic growth. Following the assumed exogenous nature of labour and technology, investment in reproducible physical capital accumulation is considered the main driver of economic growth (see Solow, 1956). However, recent studies on growth have recognised the favourable growth effects of human capital, i.e., health, knowledge, and skills (see for instance Barro, 1991; and Mankiw et al., 1992).

While investment in health is a welfare enhancing activity, it also represents a major component of human capital. Investments in health, thus, improve the welfare of citizens — for people are happy to be healthy. At the same time, such investments improve the productive and earning capacity of individuals and consequently for nations (see for instance Grossman 1972a). Further, healthy people make effective and sustained use of their educationally acquired knowledge and skills, and as such raises the favourable growth effects of education (see Barro, 1996b; Schultz, 1999). Thus, improvement in health raises the stock of human capital for higher productivity and income both for the individual and the nation.

Most parts of the world, for instance Sub-Saharan Africa (SSA), experience low growth, high rate of income poverty and low infrastructural development. According to Arora (2001), and Cole and Neumayer (2006), the underdevelopment in most of these areas is partly due to poor health. This is because, economic development of a nation is generally tied to capital formation and the knowledge and skills possessed by its population. While knowledge and skills depend on such factors as child nutrition, educational and household resources, capital formation is determined by the level of savings rate, which is also a function of adult health (Scrimshaw, 1996; Bhargava et al., 2001).

Indeed, the World Health Organisation (WHO) posits that improvement in health, such as increases in life expectancy at birth, has a great potential to raise economic growth in such regions as SSA (WHO, 2001). In this respect, empirical evidence on indicators of health capital have also been found to explain about 22 to 30 percent of growth in aggregate output (see for instance Bloom and Canning, 2003; Bloom et al., 2004; and Gyimah-Brempong and Wilson, 2004). Thus, good health is an important factor in the economic and social development process in that it enhances the efficiency of labour.

Conversely, improvement in health conditions of people can be also attributed to economic development. Thus, higher levels of developments results in improved nutrition and sanitation, advances in medical knowledge and technologies that reduces mortality among the population there by increasing their life expectancy at birth or at specific age. In fact, improvements in health conditions such as rising life expectancy, and reduced child mortality, have also been attributed to economic performance of countries (see for instance Preston 1976; Filmer and Pritchett, 1997, 1999; and Issa and Ouattara, 2005). Thus, there is a bi-directional relationship between health and growth or development. In effect, wealth and health may be thought of as complementary.

Globally, there has been a tremendous improvement in health status. Medical technology has improved tremendously. Nutrition has improved while mortality among infants and children has declined culminating in the dramatic improvement in life expectancy at birth in almost all countries in the last few decades (World Bank, 2004). Increases in health investments will further improve health conditions, especially in developing countries such as those in Sub-Saharan Africa where mortality (maternal, infant and under-five), and prevalence of diseases such as malaria, tuberculosis, and HIV/AIDS are high (WHO, 2001; Anyanwu and Erhijakpor, 2007).

Ghana has made a significant progress economic growth in recent years culminating in her status as a lower middle-income country though a lot more work is needed to sustain this achievement. Real per capita GDP nearly doubled between 1990 and 2012. More specifically, real per capita GDP increased from US$ 377 in 1990 to US$ 730 in 2012. At the same time, health status has improved. Life expectancy at birth has improved. For instance, life expectancy at birth rose from 56 years in 1990 to 61 years in 2012 following the decline in infant and under-five mortality (see World Bank, 2014). These improvements in economic growth and health conditions are likely to continue within the subsequent decades.

While it is common to regard improvements in health conditions as the product of economic growth, it is similarly possible to attribute the economic progress to improved health conditions. It is against this background that we examine the effect of health, as a component of human capital, on economic growth using data on Ghana. Some studies have investigated the factors influencing Ghana's economic growth (see for instance Adu et al., 2013; Adu, 2013; Harvi et al., 2013; Agbola, 2013; and Adams and Opoku, 2015). However, none of these studies captured the effect of health on growth. Therefore, our objective in this paper is to examine the effects of improved health on economic growth in Ghana given that most studies assessing the effects of human capital on growth mainly use education (see Agbola, 2013). That is, the present study investigates the growth effects of improved health in Ghana to help policymakers in evaluating the relative cost and benefits of health improvements.

2. REVIEW OF RELATED LITERATURE

In this section, we provide a brief review of literature on the effects of health on output. The review is into fold: theory and empirics. The first part provides the theoretical framework for analysing the effects of health on economic growth while the second part is devoted to empirical literature on the effects of health on economic growth.

2.1. Theoretical framework

The standard theoretical framework for empirically analysing the sources of economic growth emanate from the neoclassical growth theory pioneered by Solow (1956). Similarly, the endogenous growth theory pioneered by Romer (1986) also helps to explain the sources of growth.

The neoclassical growth theory assumes that output is determined by the amount of capital, labour, and the existing level of technical knowledge in the economy. Thus, changes in output over time are mainly caused by changes in inputs: capital and labour. In the Solow model, the assumption of constant or decreasing returns to scale is imposed on the aggregate production function such that doubling the inputs doubles the quantity produced or less than doubles output respectively. Further, aside capital, labour and technical knowledge all other inputs such as natural resources are considered relatively unimportant in the neoclassical growth theory. Meanwhile, technical knowledge (i.e., technology), savings rate, and population are exogenously determined in the Solow model (see Mankiw et al., 1992; Romer, 1996). In effect, capital accumulation is the main determinant of output growth within the neoclassical framework. However, the difficulty in explaining US economic growth led economists to recognise and attribute the missing factor in growth to factors other than physical capital, and consequently human capital theory evolved (see for example Shultz, 1959).

In this respect, Mankiw et al. (1992), for example, in their contribution to growth theory, extended the Solow growth model to account for the changing trends in human capital accumulation. The model, generally known as Augmented Solow model (ASM), assumes human capital to be an important input in a neoclassical production function. Along this line, human capital, e.g., health and education, can be seen as separate input or labour augmenting in the production process (see for instance Mankiw et al., 1992; Knowles and Owen, 1997; Barro, 1997, and Bloom et al., 2001, 2004). Thus, growth in output is due to improvement in capital accumulation (both physical and human) given the level of technology in the economy. Hence, the importance of human capital in the development of nations is well underscored in the neoclassical ideology.

The endogenous growth theory, on the other hand, is based on the premise that economic growth is mainly determined by human capital, innovation and knowledge. It assumes that investment in human capital has a positive externality effect on the economy and also reduces the diminishing returns to reproducible physical capital assumed under the neoclassical framework. Thus, improvement in the stock of human capital aids in the development of new technologies via research and development. It also makes effective and efficient use of productive resources. By this, the endogenous growth theory assumes a production function that exhibits non-decreasing returns to scale, i.e., constant or increasing returns, (Romer, 1986; and Romer, 1996). Thus, human resources, technology and knowledge are the main drivers of economic growth for countries within the spirit of the endogenous growth model.

Regardless of the growth theory, the contribution of human capital, e.g., health and education, to economic development is widely accepted among economist. This presupposes that both neoclassical and endogenous growth theories can help model the effects of human capital on growth. Most studies investigating the effect of health, and/or other forms of human capital on economic growth applied the ASM (see for instance Mankiw et al., 1992; and Bloom et al., 2001; 2004). Thus, health capital is considered a separate input in the production function just as reproducible physical capital, or as labour augmenting input in the production process in the neoclassical growth theory. In this study, we aim to examine the effect of health on growth within the augmented neoclassical framework, i.e., ASM.

2.2. Previous studies

Most of the conclusions from empirical studies on the effect of human capital on growth are positive. Thus, human capital is a major contributor to economic growth. However, most of these studies narrowly defined human capital to be improvement in education and/or experience (see for example Barro, 1991, 1999; and Mankiw et al., 1992). In the last few decades, health as a separate input in the production function or augmenting other inputs such as labour has attracted attention. This stems from the simple fact that, unhealthy people cannot work. The effects of health on productivity and output can be analysed at the micro or individual level and macro or regional and country level. In both developing and developed countries, micro level studies have shown that improvement in health enhances productivity of individuals and improve wages (see for example Bhargava, 1997; Stronks et al., 1997; and Strauss and Thomas, 1998; and Schultz, 2005). Thus, the argument advanced by Grossman (1972a), that the state of one's health determines his/her market activities, has been supported by individual level data.

At the macro level, the analysis on economic growth, health and physiology by Fogel (1994) suggests that approximately one third of income growth in Britain during the period 1790 - 1980 emanated from improvements in health and better nutrition. It therefore recognised public health and medical care as labour-enhancing technological change. Similar findings on the positive effects of health on growth have been reported by Barro and Sala-i-Martin (1995). Also, findings from Sachs and Warner (1997) show a quadratic relationship between health capital (i.e., life expectancy at birth) and the rate of output growth between 1965 and 1990 for 83 countries. However, health capital was found to increase economic growth at a decreasing rate. Thus, better health contributes significantly to output.

Using life expectancy at birth, at ages; five, ten, fifteen, twenty, and structure of adulthood as health status for 10 industrial countries, Arora (2001) concludes that improvement in health status has increased the pace of long-term economic growth by 30-40 percent. Consequently, he concedes that poor health, as seen in high rate of disease prevalence and deaths, is the major cause of poor growth in developing countries. Bhargava et al. (2001) also uses adult survival rate to proxy health status in modelling the effect of health on growth. They find a positive relationship between adult survival rate and economic growth. Similar results were obtained when life expectancy is used. Specifically, they find that, in poor countries, raising adult survival rate by 1% was associated with 0.05% growth in output.

Likewise, Mayer (2001) examined the effects of health on growth by using the probability of adult survival (by gender and age groups) as a measure of health. The findings were that improvement in health status causes economic growth in Latin America generally, and specifically in Brazil and Mexico. The favourable growth effect of improvement in health was higher for females than that of males. In another study, Bloom et al. (2001, 2004) also find, from OLS/2SLS estimations, that life expectancy and education have a positive and significant effect on income or GDP. That is, improved health conditions increases output not only through labour productivity, but also through the capital accumulation. In fact, Bloom and Canning

(2003) have demonstrated that healthier people affect the economy in four distinct channels (i.e., more productive at work and so earn higher incomes; spend more time in the labour force; invest more in their own education that increases their productivity; and save more). Individuals with poor health would not undertake such activities. In their examination of the effect of health on economic growth, Jamison et al. (2003) find that investment in physical capital, education and better health plays critical role in boosting the economic growth of countries.

In a similar study, Gyimah-Brempong and Wilson (2004) find that investment in health and the stock of health capital have a positive and significant effect on growth of per capita income. They find a quadratic relationship between health and output growth. The authors conclude that investment in health in developing countries will boost economic growth in the short run and increases the level of income in the long run following an increase in the stock of human capital. In addition, findings from Lorentzen et al. (2005) show that high mortality rate reduce economic growth by curtailing the time horizon for those individuals in the labour force. Thus, poor health reduces investment in physical and human capital thereby reducing output. Findings from Weil's (2005) microeconomic construct also suggest that better health is an important factor determining economic growth, and that about 17-20% of income variations among countries can attributed to differences in health conditions.

Most recent studies, except for instance Acemoglu and Johnson (2007), find health (as a component of human capital) to be very influential on economic growth, mostly in the long run. Thus, improvement in health contributes significantly to output growth (see for instance Akram et al., 2008; He, 2009; Aghion et al., 2010; and Arthur, 2013). The findings from Acemoglu and Johnson (2007) suggest that improvement in health conditions reduces per capita income or GDP. They argue that improvement in health usually causes population growth to be higher than of GDP thus causing a fall in per capita income or GDP.

Other factors that have equally attracted attention in the growth literature are international trade[2] (see e.g., Barro, 1999; Adu, 2013; Agbola, 2013; and Sakyi et al., 2015), foreign direct investment (e.g., Lensink and Morrisey, 2006; Agbola, 2013; Harvi et al., 2013; Sakyi et al., 2015; and Adams and Opoku, 2015), volatility in the macro-economy such as inflation (see Barro, 1999; Adu, 2013; Agbola, 2013; Harvi et al., 2013; and Adams and Opoku, 2015), and

[2] International trade is usually measured by, for instance, terms of trade, net exports, and trade openness (see e.g., Barro, 1999, Adu, 2013, and Sakyi et al., 2015).

financial development (e.g., Khan 2008; Adu, 2013; and Adu et al., 2013). Thus, in addition to good health, there are several other factors influencing the economic progress of a country. The extant literature has shown that improvement in health has positive effects on economic growth. While copious literature on the theme exists on most parts of the world and/or countries, no study exist on Ghana, as per our current knowledge. This study contributes to the literature by investigating the effect of improvements in health conditions in Ghana on economic growth. This investigation is of high relevance from policy perspective as Ghana aims to achieve a higher income status through higher growth rates.

3. METHODOLOGY

In this section, we provide the methodological framework within which we aim to examine the growth effects of health. This paper is devoted to study the relationship between health and economic growth and the direction of causation. Thus, we aim to test whether the progress in health could help explain Ghana's economic growth. Our data and variables are described in section 3.1 while the econometric methodology is explained in section 3.2.

3.1. Data and Variables

The data for the present study is abstracted from World Development Indicators (WDI) 2014 Microsoft Excel database published by the World Bank. The annual time series data on Ghana spans between 1982 and 2012 inclusive. We make use of per capita GDP (constant 2005 US$) as a measure of economic growth while life expectancy at birth (in years) is used as proxy for health status or stock of health capital. Life expectancy at birth shows the average number of years a new-born is expected to live given that the prevailing mortality trends at the time of birth remains throughout its life, and is one of the most widely used measures of health status. The wide acceptance of life expectancy at birth, despite criticisms, stems from the fact that it accounts for mortality rates at different stages in life, not biased by age structure, and it is available for almost all countries for longer periods (see Herzer and Nunnenkamp, 2015).

Guided by previous empirical growth literature, we account for education, capital formation (i.e., investment), labour force, international trade, foreign direct investment (FDI) and inflation. The level of education among the population is measured by gross secondary school enrolment rate (gross percentage)[3]. Labour is defined as the percentage of population (male and female) in the active labour force, usually in the 15-64 age group. However, we exclude data on labour force following the use of per capita production function (i.e., per capita

[3] Interpolation was done to fill the gaps in the data.

income/GDP to represent output per worker) as the dependent variable. Capital (or investment) is defined as gross fixed capital formation (percentage of GDP) while international trade (i.e., net exports) is measured as difference between exports and imports of goods and services and measured as percentage of GDP. Inflation rate is measured by the consumer price index.

3.2 The Model

Following from the health-growth literature, we study the effect of health on economic growth within the framework of the ASM. Guided by Mankiw et al. (1992), Knowles and Owen (1997) and Bloom et al. (2001, 2004), we assume that growth in output emerges from input combination and technology (i.e., the level of and changes in technology). In the present study, our inputs are reproducible physical capital (K), labour (L), human capital (H), and technological progress, A. We decompose human capital (H) into health (h) and education (i.e. formal schooling and other forms of training, (s)). The aggregate Cobb-Douglas production function is therefore given as:

$$Y = AK^{\alpha}L^{\beta}e^{\varphi h + \delta s + \mu_t} \text{……………….(1).}$$

According to Grossman (1972a; 2000) and Bloom et al. (2001; 2004), the stocks of health and knowledge or education determines the time spent on market and non-market activities. Thus, the worker's ability to earn is dependent on his/her level of health status, and knowledge or education. Every worker therefore supplies labour (i.e., man hours) and some form of human capital (i.e., health, knowledge, experience, and skills). With this understanding, equation (1) can be rewritten as:

$$y = Ak^{\alpha}e^{\varphi h + \delta s + \mu_t} \text{…………………(2).}$$

Equation (2) shows the per capita/worker production function. Taking logs of equation (2) yields:

$$lny = lnA + \alpha lnk + \varphi h + \delta s + \mu_t \text{……………….(3).}$$

As indicated earlier, A is a measure of technological advancement in the economy, which explains output growth that is not accounted for by changes in physical capital and/or labour (i.e., number of workers). This is usually referred to as the Solow residual. Similar to Adu (2013), we assume that technology evolves through the economy. That is to say, that, the level and changes in technological advancement is dependent on such economic variables as international trade, foreign direct investment, and macroeconomic [in]stability (e.g., inflation) within the spirit of the endogenous growth theory. Thus, international trade (X)[4], foreign direct investment (FDI), and macroeconomic stability (i.e., inflation (IFL)) influence the level of technology. Therefore, our empirical health-growth model is given as:

$$lny = \beta_0 + \alpha lnk_t + \varphi h_t + \delta s_t + \beta_1 lnX_t + \beta_2 lnFDI_t + \beta_3 lnIFL_t + \mu_t \ldots\ldots\ldots (4).$$

Where the variables are as defined before and the parameters to be estimated are $\alpha, \varphi, \delta, \beta_1, \beta_2, \beta_3$ and β_0 is the constant term. The error term is captured by μ_t and is assumed to be normally distributed with zero mean and constant variance while *t* represents time.

In the empirical estimation, this study makes use of the autoregressive distributed lag model (ARDL) approach to cointegration due to Pesaran et al. (2001). The ARDL model or the bounds test approach to cointegration is applicable irrespective of the order of integration of the underlying variables. However, the absence of *I(2)* variable should be guaranteed so as to avoid spurious results or a crush of the ARDL procedure. It is therefore important to test for unit root in each series before using the ARDL co-integration methodology. In this spirit, we employed the Dickey-Fuller GLS de-trending unit root test to examine the time-series properties of the data.

Further, we do acknowledge the possibility of a bidirectional relationship between economic growth and improvement in human capital, i.e., health and education. This usually creates an endogeneity or simultaneity problem in empirical estimations. It is for this reason that we use the ARDL procedure, which is able to correct simultaneity issues by allowing for an unrestricted number of lags for the regressand and regressors. Another reason for the use of ARDL estimator stems from its efficiency in studies using finite or small samples (Pesaran et al., 2001). Thus, in determining the long-run relationship between economic growth and other variables we use the ARDL bounds test approach to cointegration. We first estimate equation (4) using an ARDL specification of the form:

$$\Delta y_t = \gamma_0 + \sum_{i=1}^{r} \gamma_1 \Delta y_{t-i} + \sum_{i=1}^{r} \gamma_2 \Delta h_{t-i} + \sum_{i=1}^{r} \gamma_3 \Delta s_{t-i} + \sum_{i=1}^{r} \gamma_4 \Delta k_{t-i} + \sum_{i=1}^{r} \gamma_5 \Delta FDI_{t-i} + \sum_{i=1}^{r} \gamma_6 \Delta X_{t-i} + \sum_{i=1}^{r} \gamma_7 \Delta IFL_{t-i} + \beta_1 y_{t-i} + \beta_2 h_{t-1} + \beta_3 s_{t-1} + \beta_4 k_{t-1} + \beta_5 FDI_{t-1} + \beta_4 X_{t-1} + \beta_5 IFL_{t-1} + \mu_t \ldots\ldots\ldots (5)$$

[4] We define international trade in terms of net exports, i.e., the difference between exports and imports of goods and services measured as percentage of GDP.

where meaning of variables are the same as previously defined, γ_0 is the drift component, and μ_t is the error term. The next step in the ARDL bounds test procedure is to test for a long-run relationship among the variables using an *F(W)*-statistic after which an error correction model is estimated to determine the short run dynamics or multipliers in the model and the speed of adjustment towards equilibrium.

4. EMPIRICAL RESULTS AND DISCUSSION

4.1. Results from Unit root test

The aim for the unit root test was to ensure the absence of variables that are integrated of order two, *I(2)*. This was to avoid spurious ARDL regression. In this regard, the variables considered in the study were found to be a mixture of stationary, *I(0),* and non-stationary *I(1)* series. More specifically, education was stationary after first differencing while life expectancy at birth and log of inflation were stationary at levels. Again, the natural log of real per capita income/GDP, physical capital (also known as investment), international trade, and foreign direct investment were integrated of order one, I(1) under DF-GLS unit root test. It is observed that the log of real per capita income was stationary when constant and trend specifications were included. No variable was integrated of order two. All the series were stationary. Table 1 reports a summary of unit root tests.

Table 1: Results from Unit Root Test

Series	DF-GLS		Remarks/Decision
	Test statistic		
	Constant	Constant & Trend	
Lny	1.3462	-0.7217	I(1)
h	3.6886***	-5.3618***	I(0)
s	-0.3049	-1.1985	I(1)
lnk	-0.8982	-2.2087	I(1)
lnFDI	-0.8259	-2.8382	(1)
lnX	-1.9433	-2.5624	I(1)
lnIFL	-3.3452***	-4.7473***	I(0)
Δlny	1.2145	-4.7081***	
Δh	-1.9852**	-1.6932	
Δs	-4.2656***	-5.1670***	
Δlnk	-5.1691***	-5.9326***	

ΔlnFDI	-3.1925***	-4.6152***
ΔlnX	-2.2582**	-7.2675***
ΔlnIFL	-0.1135	-5.7853***

****(**) * denotes the rejection of the null hypothesis of unit root at the 1%, 5% and 10% significance levels respectively. Test statistics for DF-GLS are compared with simulated critical values from MacKinnon (1996). The lag length in the DF-GLS test is based on the Schwarz Information Criterion (SIC), Δ is first difference operator. Results are obtained from Eviews 7 econometric package.*

The mixture of *I(0)* and *I(1)* variables justifies our choice of ARDL model for the present study since the ARDL estimator allows *I(0)* and *I(1)* variables to be included in the same equation. Once the absence of *I(2)* variables is established, the next step is to find the existence of cointegrating relationship between economic growth and the other variables in equation (4).

4.2 Results from ARDL cointegration test

There is ample evidence to suggest that there exists a long run relationship between economic growth and the variables presented in equation (4). The results from the bounds test approach to cointegration are presented in Table 2 below:

Table 2: Critical value bounds for F- and W-statistics

K	95% Level		90% level		F(W)-statistics
	Lower bound	Upper bound	Lower bound	Upper bound	
6	2.9859	4.4420	2.4652	3.7475	10.1232
6	(20.9012)	(31.0940)	(17.2566)	(26.2323)	(70.8627)
F(W) y[y ❘ h, s, k, FDI, X, IFL]					

Note: K is the number of regressors while W-statistic and its critical values are in parenthesis. If the statistic lies between the bounds, the test is inconclusive. If it is above the upper bound, the null hypothesis of no level effect is rejected. If it is below the lower bound, the null hypothesis of no level effect can't be rejected.

As shown in Table 2, the null hypothesis of no cointegration among the variables is rejected at 5% and 10% levels. This is because the computed test statistics are above the upper bounds. Thus, there is a long run relationship following the normalisation of economic growth on the independent variables. The ARDL estimates were very healthy. The diagnostic test results are presented in Table 3 below.

Table 3: Diagnostic test for ARDL Regression

Test Statistics	LM Test statistic	F-version
A: Serial correlation	CHSQ(1) = 2.0232[.155]	F(1,21) = 1.4663[.239]
B: Functional form	CHSQ(1) = 1.2994[.254]	F(1,21) = .91875[.349]
C: Normality	CHSQ(2) = 1.0919[.579]	Not applicable
D: Heteroscedasticity	CHSQ(1) = 1.3323[.248]	F(1,29) = 1.3023[.263]

A:Lagrange multiplier test of residual serial correlation; B:Ramsey's RESET test using the square of the fitted values; C:Based on a test of skewness and kurtosis of residuals; D:Based on the regression of squared residuals on squared fitted values

Once the establishment of cointegrating relationship between economic growth and the independent variables is made, the next step is to estimate the long-run coefficients in the ARDL model with a lag length based on SBIC. The long-run estimates from the ARDL (1, 1, 0, 0, 0, 0, 0) specification is presented in Table 4.

Table 4: Long-run estimates based on ARDL (1, 1, 0, 0, 0, 0, 0) approach

Variable	Coefficient	Standard Error	T-statistic
h	0.0366	0.0135	2.7175**
s	0.0172	0.0028	6.1352***
lnk	0.2133	0.0540	3.9492***
lnFDI	-0.0247	0.0160	-1.5471
lnX	0.2241	0.0665	3.3673***
lnIFL	-0.0335	0.0166	-2.0134*
Intercept	2.8675	0.6861	4.1797***

****(**)* denotes significance at 1%, 5% and 10% significance level respectively. Results obtained from Microfit 5.01 (demo version) econometric package.*

Four of the six independent variables presented in the model were statistically significant in influencing long-term growth in Ghana within the study period. The coefficient of health, measured by life expectancy at birth, was 0.0366 and statistically significant at 5% level while that of education was 0.0172 and statistically different from zero at 1% level. The stock of physical capital, and international trade were also statistically significant at 1% level with elasticities of 0.2133 and 0.2241 respectively. While both the elasticity coefficients of foreign direct investment (-0.0247) and inflation were negative, only inflation (-0.0335) was statistically significant at 10% level.

The next step in our econometric analysis is to model the short-run dynamics to capture the speed of adjustment towards equilibrium following a shock in the system. The results of the error correction model (ECM) are presented in Table 5:

Table 5: Error Correction Model (ECM) based on ARDL (1, 1, 0, 0, 0, 0, 0)

Variable	Coefficient	Standard Error	T-statistic
Δh	0.0137	0.0056	2.4567**
Δs	0.0027	0.0023	1.1781
Δlnk	0.0800	0.0135	5.9328***
$\Delta lnFDI$	-0.0095	0.0045	-2.0540*
ΔlnX	0.0840	0.0322	2.6061**
$\Delta lnIFL$	-0.0126	0.0061	-2.0652**
ecm(-1)	-0.3747	0.0881	-4.2546***
*ecm = lny -0.036627*h -0.017244*s -0.21327*lnk + 0.024707*lnFDI - 0.22408*lnX + 0.033522*lnIFL -2.8675*INPT*			
Regression Summary Statistics			
R^2	*0.8656*	*F (7, 23)*	*20.2457****
R^2 *Adj.*	*0.8168*	*RSS*	*0.0056*
S.E of Regression	*0.0159*	*DW*	*2.4663*
AIC	*80.7287*	*SBIC*	*74.2758*

****(**)* denotes significance at 1%, 5% and 10% significance level respectively. Δ is the lag operator. Lag length selected based on SBIC. Results obtained from Microfit 5.01 (demo version) econometric package.*

In the short-run, the coefficient of health was 0.0137 and statistically significant at 5% level. Though coefficient of education was positive, it was statistically insignificant in influencing economic growth. While the statistical significance of the elasticity coefficient of capital did not change in the short-run, its positive elasticity dropped from 0.2133 to 0.0800. Again, both the elasticity coefficient and significance of international trade dropped. Precisely, the elasticity coefficient of international was 0.0840 and statistically significant at 5% unlike its 1% level significance in the long run.

While the negative signs of the elasticity coefficients of foreign direct investment and inflation did not alter in the short run, their significance levels and magnitudes changed. The elasticity coefficient of FDI was -0.0095 and statistically significant at 10% level while the elasticity coefficient of inflation was -0.0126 with 5% level significance. The coefficient of ECM was - 0.3747 and statistically significant at 1% level. The summary statistics of the error correction model shows that 81.68% of the variations in economic growth the short-run are explained by the variables presented in the model. This suggests that the error correction model is well fitted.

4.3 Discussion of long run and short run results

This study has estimated the effect of health on economic growth in Ghana while controlling for the effects education, physical capital accumulation, international trade, FDI, and inflation. We find that the long-term economic growth achieved in Ghana within the study period has been significantly influenced by improvement in health, physical capital accumulation, international trade and education.

First, we find that better health improves economic performance of the country. This follows from the positive and significant relationship between health and economic growth both in the short and long run. However, the growth effect of health was greater than education in both short and long terms as shown by their magnitudes. The results suggest that increasing life expectancy by a year boosts the productivity of workers and that increases economic growth by 3.66% in the long-term. Our long run results could be due to the effectiveness and high level of productivity among healthy workers.

Another possible reason for the long-term positive effect of health emanates from the sustained labour that healthy people provide and their educational investment that enhances productivity. The savings of such healthy people also made available more funds for productive ventures, which has increased the performance of the Ghanaian economy. These points have been emphasised by Bloom and Canning (2003). Again, in the short term, the growth effect of health is positive. More specifically, improvement in health, i.e., extra year of life expectancy, boosts economic growth by 1.37%. The short run results, perhaps, is due to low level of absenteeism resulting from improved health.

While these findings on the positive effect of health on economic growth deviate from those reported by Acemoglu and Johnson (2007) and the short run results from Akram et al. (2008), they corroborate with that of Bloom et al. (2001, 2004) who find, from cross-national data, that improvement in health raises output by 4%. Similar findings have also been reported by, for example, Arthur (2013), Aghion et al. (2010), He (2009), Akram et al. (2008), Gyimah-Brempong and Wilson (2004), Arora (2001), Bhargava, et al. (2001), Knowles and Owen (1997) and Barro and Sala-i-Martin (1995) regarding the favourable long-term growth effect of health (either measured by life expectancy at birth, mortality rates, and/or adult survival rates). One possibility of the deviation from Acemoglu and Johnson (2007) can be attributed to our use of per capita GDP or income instead of total or aggregate GDP as a measure of economic growth. Thus, aside welfare improvement, health is an important factor contributing to output via productivity and efficiency levels among workers.

Education has also been found to contribute significantly to output. Our results suggest that any additional enrolment improves the level of literacy and skills of the labour force that raises output by 1.72% in the long-term. This suggests that improvement in the level of knowledge via schooling has the potential to increase long-term economic growth. Our findings agree with those of, for example, Arthur (2013), Akram et al. (2008), Bloom et al. (2001, 2004) and Barro (1999). However, we find this coefficient of education to be lower than the other variables in the model. A possible reason for the low long run coefficient of education could attributed to brain-drain. Most educated people leave the country after their education to seek greener pastures abroad and thus leaving less number of skilled labour for productive activities hence the low growth effect of education.

The effect of education in the short-run, however, is not statistically different from zero at conventional levels of significance. Thus, in the short-run, enrolling an extra person in school has no significant positive effect on output growth. The short-run results could be due to long-term nature of educational investments. It takes a longer period for educational investments to yield returns hence its insignificant effect on output in the short term. While education had no significant positive effect on Ghana's growth in the short term, it was a high contributing factor to Pakistan's short-term growth between 1972 and 2006 (see Akram et al., 2008).

Further, accumulation of physical capital was a significant contributor of economic growth, both in the short-run and long run. Specifically, our findings about the positive elasticity coefficient of physical capital accumulation suggest that long-term economic growth rises by 2.13% following a 10% increase in physical capital accumulation. This elasticity confirms the assumption of decreasing returns to scale in neoclassical growth theory. Thus, percentage growth in output is lower than percentage growth in input, in this case, capital stock. The implication is that capital accumulation has been one of the driving forces of economic growth in Ghana. Indeed, infrastructural investments *inter alia* in roads, factories, telecommunications, hospitals, and machinery and equipment have occurred in the last three decades. While these findings agree with those reported by, for example, Bloom et al. (2001, 2004), Knowles and

Owen (1997), and Barro (1999), the findings from Sub-Saharan Africa data reported by Arthur (2013) suggest otherwise. Similarly, Adu et al. (2013), Havi et al. (2013), and Adu (2013) have found that investment or capital formation has been an important driver of economic growth in Ghana. Thus, accumulation of physical capital is a strong determinant of economic growth in Ghana.

Another important determinant of economic growth is international trade. Our results suggest that increasing international trade enhances the growth potential of the country. Thus, open economies will tend to have higher growth rate than closed economies. The elasticity coefficient of international trade implies that 10% increase in international trade causes long-term growth to rise by 2.24%. It is important to remark, however, that our proxy for international trade is net exports. The implication is that a country must record positive net exports in order to benefit from trade. Our results can be attributed to export growth strategies adopted by government in the last three decades. Arthur (2013) found that export is significant contributor to economic growth. In the short term, 10% growth in trade (net exports) contributes 0.84% to economic growth. Similar findings on the favourable growth effects of international trade have been reported by Barro (1999) in Chile, Akram et al. (2008) in Pakistan, Adu (2013), and Sakyi et al. (2015) in Ghana. These studies considered international trade based on the terms of trade, exports, and/or trade openness. However, trade openness was found to exert a negative influence on Ghana's economic growth (Adu, 2013). The findings suggest that international trade, and in particular positive net export, is an important driver of economic growth both in the short-term and long-term.

Regarding FDI, we find a negative relationship between FDI and economic growth, both in the long-term and short-term. However, it was not significant at conventional levels. This implies that FDI is not a robust determinant of economic growth in Ghana either in the short run or in the long run which is contrary to the favourable FDI-growth nexus findings reported by, for instance, Agbola (2013), Harvi et al. (2013), and Sakyi et al. (2015). Perhaps, FDI inflows have not gone into productive sectors of the Ghanaian economy (e.g., manufacturing sectors). Indeed, in a very recent study, Adams and Opoku (2015) have argued that FDI inflows to sub-Saharan Africa work well in the presence of regulation. Thus, the ineffectiveness of FDI in stimulating growth could be due to lack of proper regulatory framework to channel FDI inflows into productive sectors of the Ghanaian economy. A larger share of FDI inflows enter the mining sectors whose linkages with other sectors of the economy is weak or non-existent, hence the expected benefits of FDI inflows are not fully realised (Adams and Opoku, 2015; Sakyi et al., 2015; and Ndikumana and Verick, 2008). The negative coefficient of FDI resonates with the findings reported from 1990-2007 data on African countries by Agbloyor et al. (2014) in the absence of well-developed financial systems.

The current study also finds that inflation is a robust determinant of economic growth in the short-run than in the long-term. More specifically, our results imply that a rise in inflation by 1% will cause economic growth to decline by 0.013% in the short-term. The magnitude is quite small but significant at conventional level. While our long-run results resonate with those reported by, for instance, Adu (2013), they deviate from the results of Barro (1999), Agbola (2013) and Harvi et al. (2013) who find that inflation is a robust determinant of economic growth. Like the present study, these studies have reported that inflation impacts negatively on economic growth, even though at varying significance. In fact, Adu (2013) finds that inflation is statistically insignificant in explaining long-term growth in Ghana though its effect on growth is negative. However, Adams and Opoku (2015), Agbola (2013), Harvi et al. (2013), and Barro (1999) find inflation to be robustly endangering economic growth.

Our results are robust and satisfactory as well (see Table 3). For instance, the error correction model suggests that 81.68% of the short-run variations in economic growth are explained by the variables presented in the model. The highly significant coefficient of ECM was -0.3747 implies that 37.47% of the disequilibrium in previous year's growth is corrected in the current year. Thus, the speed of adjustment, following a shock in any of the independent variables, towards equilibrium was 37.47%. This seems to suggest that the speed of adjustment towards equilibrium was a bit slower.

5. CONCLUSION

Understanding the factors that drive economic growth is getting increasingly important, especially in low-and-middle income economies. In this study, our aim is to examine the effect of health on economic growth in Ghana. The findings imply that health, education, accumulation of physical capital, and international trade are key in determining long-term economic growth in Ghana. The negative effect of inflation on long-term growth was, however, weak. In the short-run, the effects of health, international trade, and accumulation of physical capital are positive and robust while that of education is statistically insignificant. The effect of inflation on growth is negative and robust in the short-run. FDI is not a robust determinant of economic growth in Ghana in the present study.

These findings have some implications for policy. First, there is the need to increase health investments to improve health conditions. This stems from the fact that improvement in health does not only enhances welfare but also output. Thus, as Ghana aspires to achieve higher income status there is the need to raise investment in health in order to raise the vitality and strength of the population to propel Ghana's growth. In addition to public health programmes, construction of new health facilities, training of healthcare personnel, and improved medical supplies in hospitals will help achieve this goal. Again, policy should aim at promoting immunisation programmes to reduce infant and under-five mortality. Overall, Ghana's healthcare system should be strengthened to respond to the health needs of the population. These measures will help improve life expectancy of the population.

Secondly, policies that aim at improving the educational levels of the population will help propel Ghana's long-term growth. In this respect, improving enrolment and completion rates in schools, at least to the secondary level, will boost long-term growth. The free distribution of uniforms and books, zero fees, prompt payment of educational workers' emoluments, improving educational infrastructure, e.g., classrooms, computer laboratories, and libraries will enhance teaching and learning while improving enrolment and completion rates. There should be strategies to retain skilled and educated labour in the country to propel growth. Thus, government must create the enabling environment to reduce brain-drain so as to realise the full benefits of educational investments.

Further, policymakers should improve the capital stock of the country to fasten the pace of growth and development. Thus, investment in infrastructure such as road networks, telecommunications, railway lines, and factories are necessary to fasten Ghana's growth and development. Public-Private Partnerships can be initiated in such sectors as transportation and manufacturing to boost the stock of physical capital.

International trade is also an important driver of Ghana's economic growth. In this regard, policy should aim at enhancing trade in goods and services. The export sector of the economy should be encouraged to promote local production. By this, the Exports Promotion Council should encourage and provide incentives, e.g., export subsidies, and concessionary loans, to local manufacturers. In doing this, government should not lose control over its economic management. Proper and adequate fiscal and monetary measures should be in place to maintain stability. These will help Ghana achieve its vision of higher income country.

The results of this study should be interpreted with some caution. The findings relate to the period under study based on the data used for Ghana. Though our study suggests that health, education, international trade and capital accumulation are robust determinants of economic growth in Ghana, we do not, in anyway, suggest that these are the only [important] determinants of economic growth. Other factors such as financial development, government expenditure, and foreign aid may also influence economic growth, either in the long-term or short-term. Again, different proxies for health status or health improvement exist. Future studies can use other measures of health to study the effect of health on economic growth while accounting for other factors that might influence growth.

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Competing Interest

The author declares to have no competing interest.

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