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Re-Examining the Impact of Public Health Expenditure on Longevity: The Critical Role of Human Capital

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Abstract

This study examines the impact of public health expenditure on life expectancy controlling for human capital. The ADF nonstationarity test and the ADRL bound test for cointegration were applied on annual based time series data from 1981-2019. Both the F- and t-statistic of the bound test for cointegration indicated long run relationship among the variables considered in the model. From the regression results, the lagged value of LE is positive and significant in explaining current year changes in LE. The lagged values of PHE and GDP also had positive and significant coefficients revealing similar effects on LE in the short run. HC also reveal a positive and significant impact positively on LE in the current year. However, the contribution of the variables considered in the model to life expectancy is rather marginal or weak. The ECT_{t-1} coefficient suggests that LE adjusts to long run equilibrium through the channels of lagged values of LE, PHE, GDP and HC at the speed of 5%. The coefficient is negative and statistically significant as required by economic theory. However, the ECT_{t-1} coefficient shows that the speed of adjustment to long run equilibrium due to short run distortions is quite slow. The study recommends measures to improve public health services coverage such as increased public health expenditure on health to the desired limit of 15% of the yearly budgets and enhanced human capital development

Key Words: life expectancy, Public Health Expenditure, Human Capital, Gross Domestic Product and Autoregressive Distributed Lags (ARDL) Model

JEL CODE: I12, H51, J24, P24, E22

1. Introduction

Globally, the well-being of a people is considered imperative to a nation's sustainable economic growth. Health is the general state of the mind and body and not just the absence of sickness, injuries, or disability (Yusuf, 2016). Good Health care and quality of life is affiliated to each other. That is, health and economic growth are correlated making it a fundamental

factor for sustainable economic growth. The country's economy is propelled by a healthy population. To understand the future generation's income, the life cycle model explains the affiliation between the citizen's health status, wealth and expenditure. On the other hand, a diminishing and unsustainable economy is seen when the quality of life and health status is poor but if otherwise, then a fueled upswing of the economic activities is seen (World Health Organization (WHO), 2020).

According to the WHO world health report, an agreement was made by Africa rulers in 2001 to focus on health expenditure to achieve the health Millennium Development Goals (MDGs) with the aim of raising the economies of Africa. Furthermore, 15% of the government's expenditure is to be allocated to the health sector to attain this goal by 2013 only five countries accomplished this target, namely Botswana, Rwanda, Zambia, Madagascar, and Togo. Nigeria could not meet up. Nevertheless, roll out of strategies and plans for an increase in health capital expenditure and economic growth was implemented by the governments. According to the study carried out by Oni (2014), health expenditure, and labor force productivity are paramount to the economic development of Nigeria. He noted however; that Nigeria made some positive gains in health expenditure from 1970 to 2010, but the results were inconsistent. According to the African Development Bank (AFDB) 2011; World Bank (2013) and The United Nations Economic Commission for Africa (UNECA) 2012, the health expenditure budgetary allocations as a percentage of the total budgets are 9.19, 7.63, 7.63, 7.42, 7.43, 6.48, and 8.17% respectively for the year 2008 to 2014. These proportions reveal the noncompliance of the Nigerian government to the several international requirements/ agreements concerning budgetary allocations to health.

Investment in human capital is important in influencing the health conditions of a society. Current investment in human capital increases health capital expenditure. This increases the availability of quality and affordable health care delivery to the people. It also encourages people to access care in order to promote their wellbeing. On the other hand, decreasing investments in human capital would possibly prompt a reduction in the knowledge of people about healthy lifestyle and disease prevention. Many studies have investigated the impact of human capital on health expenditure. Scheffler (2004), evaluated the relationship between health expenditure per capita and several socio-economic, demographic and lifestyle variables while Wakeel (2009), examined the concept of Human Capital and its role in national development with a view to re-echoing its importance in the economic development of Nigeria.

An average Nigerian is anticipated to live for about 55.2 years from birth. According to the WHO, this figure is significantly below the global average of 72 years and Africa's average of 61.2 years target of the Sustainable Development Goals (SDGs) cumulating in Nigeria being ranked 6th lowest in the world on the quality of life and life expectancy. It is also observed that the budget distribution of the country to the health industry is exceptionally small at a rate of $4.7 per individual compared to more than $1,000 per individual in high life expectancy nations. An elevated incidence of ailments such as Coronary Heart Disease, Tuberculosis, Influenza and Pneumonia, Stroke, Diarrhea diseases, Liver Disease, Malaria, Diabetes Mellitus, Road Traffic Accidents , HIV/AIDS, Kidney Disease, Cervical Cancer, Lung Disease, Breast Cancer, Prostate Cancer , Alzheimer & Dementia, Meningitis,

Hypertension, Birth Trauma, Low Birth Weight, Maternal Conditions, Violence, Congenital Anomalies, Other Injuries, Asthma, Falls, Measles, Peptic Ulcer Disease, Endocrine Disorders, Suicide, Peruses, Liver Cancer, Lymphomas, Drug Use, Parkinson's Disease, Inflammatory/Heart, Colon-Rectum Cancers, Ovary Cancer, Fires, Epilepsy, Poisonings, Pancreas Cancer, Stomach Cancer, Oral Cancer, Malnutrition, Skin Cancers, Drowning, Leukemia, Rheumatic Heart Disease, Tetanus have been ascribed to bad health spending results and lead to low life expectancy. Nigeria records the largest amount of tuberculosis fatalities in the globe and ranks fourth highest in terms of diarrhea. However, Nigeria's health spending pattern remains substantially small. For example, 4.6% of GDP was spent on health care in 1997. In 2005, the figure grew to 6.6% and subsequently dropped to 5.8% in 2009. The budgetary allocations to health as a percentage of the GDP for the years; 2013, 2017 and 2021 are 5.7%, 5.0% and 4.9% respectively. The expenditure on health as a percentage GDP is an indication of the nation's bad engagement during these periods to enhance health care and delivery (WHO 2018).

Studies such as Fernandes, 2020; Yaqub, Ojapinwa & Yussuff, 2012 have show that building a healthy population could be an asset to a country as it is paramount in building a sustainable economy. Human development is understood as an intergenerational process of human capital accumulation that is slowed down by market failures that can be strong enough to result in poverty traps. In turn, human development has a dynamic interaction with long-term economic growth. In this long-term context, it is easy to see that health and in particular, early child development plays a crucial role in human capital development and therefore in long-term economic growth. Human capital and its impact on economic growth and welfare are closely interrelated. If a country desires to move on the path of sustainable economic development, a fair amount of money should be spent on health care in the development process.

This study is therefore motivated against this background to investigate the place of macroeconomic factors in this intriguing matrix by re-examining the impact of public health expenditure (PHE), human capital development (HC) and gross domestic product (GDP) on life longevity proxied by life expectancy. Specifically, the study aims at re-examining the impact of public health expenditure on longevity: the critical role of Human Capital. The situation in Nigeria where most household health spending's catastrophic leaves much to be desired in the efforts leading to the attainment of the Universal Health Coverage (UHC) by 2030. Therefore, this study becomes very handy as the findings will provide better insights for policy makers to deepen the macroeconomic environment and strengthen policies that will further expand access to health services by all populations at a minimal cost to improve on life expectancy.

2. Brief Literature Review

The link between public expenditure and longevity using human capital as a parameter is situated in the theoretical nexus between public expenditure and longevity as captured by the theory of Government spending. It is a theory of the cost of providing goods and services through the public sector budget that will result in private sector expenditure. There are two

approaches to the questions of growth of government sector, namely the growth in absolute size of public expenditure, and the growth in government sector in relation to economic growth. According to Brown and Jackson public expenditures are classified in two board categories, namely, exhaustive public expenditure and transfer public expenditure. Exhaustive government expenditures are government's purchases of labour, consumables etc. (current goods and services) and capital goods and services (i.e. public sector investment in roads, schools, hospitals etc.) while the non-exhaustible involve transfer payments i.e. transfer of money to people (for instance, pensioners and the unemployed) and to firms (in the form of subsidies and grants). Our attention is however, limited to the first form of government expenditure.

Capital Development Theory: Human capital theory started in the 17th century. According to Kwon (2009), the origin of human capital goes back to the appearance of classical economics in 1776, and was thereafter developed into a scientific theory. After the materialization of that idea as a theory, Schultz (1961) recognized human capital as one of the essential factors for national economic development in the contemporary economy. With the appearance and advancement of human capital as an educational field, some researchers comprehensively attempted to explain how increased investment in human capital could add to socio-political expansion and freedom (Lazerson, 2004). The basic doctrine of the human capital development theory is that investment in human capital will lead to enhancement in the value of human capital and in turn yield better fiscal outputs. The theory has been criticized on the basis that the legitimacy of the theory is sometimes hard to confirm and paradoxical. Conventionally, economic strength was largely dependent on substantial physical assets such as land, factories and equipment. Labor was a compulsory element, but increases in the worth of the commerce came from investment in capital equipment. Regardless of the criticisms, contemporary economists appear to agree that investment in education and health care are the solution to improving human capital and eventual increase economic output.

Several studies have been conducted in the past few years in Nigeria by different scholars with the aim of drawing the attention of the government, the general public and private sector to the critical importance of increased health expenditure on health care delivery, health care Accessibility, health care affordability, health status and environment on the quality of life and sustainable economic growth. Alhassan (2021) carried out a study on the impact of life expectancy, death rate and public health expenditure on sustaining economic growth under COVID-19: Empirical evidence from Nigeria. The study relied on recent annual time-series data to conceptualize the hypothesized claim via Pesaran's Autoregressive Distributed Lag techniques. Empirical findings from the bounds test trace the long-run relationship between public health expenditure and economic growth over the study span. Although health expenditure is not significant, empirical results show that a 1% increase in life expectancy and death rate increases and decreases economic growth by 3.85 and 1.84%, respectively. This suggests the need for Health Policymakers in Nigeria to implement active strategies that reduce death rate, which is a blueprint for active engagement in the face of a global pandemic such as COVID-19.

Nwani & Kelikume (2019) using the Toda-Yamamoto granger causality technique investigated the causal relationship between health expenditure, health status and economic growth in Nigeria for the period 1981–2018. The estimated results reveal a negative non-interdependence between government health expenditure and economic growth in Nigeria. They therefore concluded that focusing on the link between health expenditure and economic growth was pointless. However, the classical linear regression technique employed by the researchers is adjudged unsuitable due to the nature of the complex relationship between the variables.

Effiong (2021) examined the effect of government health expenditure on the quality of life in Nigeria. The paper used secondary data from the Central Bank of Nigeria's statistical bulletin and the World Development Indicators for the period 1981 to 2018. The time series data were tested for unit root using the Augmented Dickey-Fuller test which revealed a mixed order of integration and as a result, the Autoregressive Distributed Lag (ARDL) model was employed as an estimation technique. The result from the ARDL bounds test depicted a clear presence of long run relationship between government expenditure on health and life expectancy. This necessitated the use of the ARDL error correction mechanism. The major finding of the study was that government expenditure on health had a significant positive effect on life expectancy in Nigeria within the study period, both in the short run and in the long run. The coefficient of the ECM (-0.5331) which is statistically significant at the 1% level means that 53.31% of the discrepancy between long run and short run life expectancy is corrected within a year. Consequently, the paper recommended that the government should apportion 15% of her total budget to the health sector in line with the 2001 WHO recommendation of the Abuja Declaration. Also, concerted efforts should be geared towards poverty reduction since the paper revealed a significant negative relationship between poverty and life expectancy in Nigeria.

Ogungbenle (2013) empirically analyze the relationship existing among life expectancy, public health spending and economic growth in Nigeria. A Vector Autoregressive (VAR) model approach was employed in analyzing the data. The results of the study revealed that there is no bidirectional causality between life expectancy and public health spending in Nigeria. In the same vein, the study also revealed that there is no bidirectional causality between life expectancy and economic growth in Nigeria. However, the study confirmed that there is bidirectional causality between public health spending and economic growth. Based on the findings of the study, it was recommended that for Nigeria to experience sustainable economic growth, it has become imperative for her to put in place measures that would boost the life expectancy of her citizenry by increasing her public health spending as this will serve as a panacea for her economic backwardness.

The effects of public financing of health expenditures, insurance coverage and other factors on health outcomes was examined by Berger & Messer (2002) with health production models estimated, using 1960-1992 data across 20 Organization for Economic Cooperation and Development (OECD) countries. They found that mortality rates depend on the mix of health care expenditures and the type of health coverage. In particular, increases in the household out of pocket expenditure on health are associated with increases in the mortality

rates. These authors therefore conclude that a country increases the level of their health expenditures they may want to avoid increasing the proportion of their expenditures that are publicly financed.

Seewananyana & Younger (2004) found that, in Uganda, increases in health care expenditures particularly on vaccinations, is expected to impact positively on infant mortality rate in Uganda by 2015. According to them, increasing vaccination rate to 100 percent would have the largest and probably most cost effective, impact, reducing infant mortality by 16 deaths per thousand births. Using demographic and health survey (DHS) data, Wang (2002) investigated the low-income countries both at the national level, and for rural and urban areas separately. He found that at the national level, public health expenditure significantly reduces child mortality. While Harttgen & Misselhorn (2006) found that access to health infrastructure is important for child mortality, socio-economic factors are often found to be good determinants of health outcomes (Notre & McKee, 2004 and Young, 2001).

Education as the proxy of human capital has a dynamic and complicated relationship with several components of well-being, including health. For instance, education affects health in adulthood; life expectancy affects educational investment in childhood; the health and education of parents—particularly mothers—affects both outcomes in their children. These relations like the income play an important role in developing countries (Barro & Lee 2013).

Kim & Lane (2013) studied 17 OECD countries with a mixed-effect model to critically evaluate the link connecting public health output, national health outcomes, and impact of recent changes in healthcare policy in the United States. The study focused on infant mortality rate and life expectancy at birth, the finding indicated negative and positive result accordingly, no link was found between government health expenditure and infant mortality rate meanwhile, an obvious link between government health expenditure and life expectancy at birth was seen. Doğan, Tülüce & Doğan (2014) also used the OECD countries to analyze health expenditure for the period of 1995–2011 using an Autoregressive Distributed lags (ARDL) methodology. The result proved positivity in the effect of age Dependency Ratio on health care expenditures but unexpected influence in a decrease in expenditure is seen in the increased population among young workers.

Good policies and institutions (as measured by the world bank's country policy and institutional assessment (CPIA) index) are important determinants of the impact of government health expenditures on outcomes, in particular, as the quantity of policies and institution improves (as the CPIA index rises), the impact of government health expenditures on maternal mortality, underweight children under-five and tuberculosis mortality also improves and is statistically significant (Wagstaff & Cleason 2004). However, they conclude that the impact of government expenditures on under-five mortality remains not significantly different from zero.

Day & Tousignant (2005) examined the relationship between health outcomes and health spending in Canada for the periods 1960-1997, 1950-1997 and 1926-1999 and concluded that although the causal relationship between the measure of the health status of the population and real per capita health expenditure were statistically significant, these relationships were not very strong. The authors indicated that their findings may be due to

model misspecification or may reflect the fact that at high level of population health, the return to increases in health spending is small.

There is a mutual interaction between a population's health level and its level of economic growth and development. Because outcomes from several studies have suggested that there has been a positive correlation between a worker's health status, productivity, and sustainable economic growth. This is also supported by Adeniyi & Abiodun (2011) as they cited Bloom, Canning & Sevilla (2001) in their study, who agreed with others on the positive and significant effect of health expenditure on economic growth. They, therefore, suggested that a one-year improvement in a population life expectancy contributes to a 4% increase in output. Maintaining a sustainable level of growth and development provides people significantly better nutrition and disease treatment opportunities along with wider access to preventive medical technology.

Lustig (2006), observed that health is responsible for approximately one-third of long term economic growth. He used data from Mexico covering a period of 1970 to 1975 and life expectancy and mortality rates for different age groups as health indicators. He considered health to be an asset with essential and instrumental value. Good health according to him is a source of well-being and highly valued throughout the world.

Scheffler (2004), argued that health may not be treated as output (life expectancy, adult survival rate, etc.) rather it needs to be treated as input (health expenditure). In doing this, Scheffler observed that the elasticity of health care spending with respect to GDP is greater than one, meaning that if GDP increases by 10% then healthcare spending goes up by more than 10%. Consequently, this study shows that developed countries spend more on health as compared to developing countries (Ogundipe & Lawal, 2011). Furthermore, Gallup, Sachs & Mellinger (1998), supported the positive relationship between health and economic growth. They find a strong relationship between initial levels of health and economic growth, using life expectancy at birth as their basic measure of the overall health of the population. They concluded that, improved health is associated with faster economic growth. Baldacci (2004), explored the role played by health expenditures and found that spending on health within a period affects growth within that same period.

In this study, we seek to examine the impact of public health expenditure on life expectancy while taking particular interest in the role played by improvements in human capital of life expectancy. The effects of improvements in human capital on life expectancy are an area that has not been widely researched in Nigeria. The study intends to use the Autoregressive Distributed Lags (ARDL) Methodology which is suitable for small samples and variables that are integrated of different orders especially where the dependent variable is stationary at levels. The ARDL also is believed to produce more robust results than the ordinary least squares method employed by some scholars.

3. Methodology

3.1 Type and Source of Data

This study is set to estimate the impact of public health expenditure (PHE) on longevity proxied by life expectancy (LE) while controlling for human capital (HC) and national output

(GDP). The study made use of secondary data whose manifestation has already occurred and cannot be manipulated by the researchers. The data covering the period 1981 – 2019 was sourced from the Central Bank of Nigeria (CBN) Statistical Bulletin, National Bureau of Statistics, CBN Bullion and World Bank Publications.

3.2 Model Specification

The researchers have built a model of life expectancy by adopting and modifying the model by Ogungbenle, et al. (2013), to address the specific objectives of this paper. The deterministic form of the model is therefore realized as;

LE = f (PHE, HC, GDP) ----------3.1

Where;
LE_t= Longevity which is proxied by Life Expectancy in Nigeria;
PHE_t = Public Health Expenditure;
HC_t= Human Capital in Nigeria;
GDP_t = Gross Domestic Product in Nigeria.

The econometric form of the model in equation 3.1 is specified as:
$LE_t = \Phi_t + \text{ﾑ}PHE_t + \text{ﾓ}HC_t + \psi GDP_t + \varepsilon_t$ ----------3.2

Where;
Φ_t is constant or intercept of the model;
ﾑ, ﾓ and ψ = coefficients of Public Health Expenditure, Human Capital and Gross Domestic Product respectively. The coefficients or regression parameters are used in determining the significance or otherwise of the effect of each independent variable on the variable of interest (longevity or Life Expectancy).
ε_t= Error term

3.3 Estimation Techniques

The following estimation procedure was used to arrive at the final results of the research.

Stationarity Test

In view of the fact that most macroeconomic series are inherently non stationary, it is important to carry out a stationarity test on the variables to forestall obtaining spurious regression results. Since robust estimates can only be obtained with series that are time invariant (series with constant mean, constant variance and covariance), the Augmented Dickey Fuller (ADF) Test will be used to test for unit root and to determine the order of integration of the series. The study will determine the unit root or otherwise of a series considering the critical values at 5% levels of significance.

Autoregressive Distributed Lags (ARDL) Model

Economic analyses often assume the existence of long run relationship between variables under consideration as stipulated by most economic theories. By this, they assume that the long run properties are intact or that the means and variances are constant and not time varying. However, most empirical researches have shown that the constancy of the means and variances are not satisfied in analyzing time series variables as most series are usually non-stationary and in most integrated of different orders.

The ARDL model is specified for variables that are integrated of different orders ie having a combination of variables integrated of order zero I(0) and those integrated of order one I(1). The I(0)'s represents level stationary variables while I(1)'s represent differenced stationary variables. It also includes the lagged values of the dependent variable, the current values and lagged values of the regressors as explanatory variables. These ensure that unbiased estimates of the long run relationship are obtained when the ARDL technique is used. The model also makes use of endogenous and exogenous variables, and is very appropriate for small sample sizes. The general form of the ARDL (p,q) model is specified as;

$$Y_t = \gamma_{0i} + \sum_{i=1}^{p} \delta Y_{t-1} + \sum_{i=0}^{q} \beta X_{t-1} + \varepsilon_{it} \quad \text{----------} \quad 3.3$$

Where $Y^i_t$is a vector and the variables in $(X^i_t)^i$ are allowed to be purely I(0) or I(1) or Co-integrated; and β and δ are coefficients; γ is the constant; i=1, …..,k; p, q are optimal lag orders; ε_{it} is a vector of the error terms assumed to be serially uncorrelated or independent.

To perform the bounds test for cointegration, the conditional ARDL (p,q_1,q_2,q_3) model in which the log of LE is a dependent variable in line with the objective of the research work will be specified as;

$$\Delta InLE_t = a_{01} + b_{11} InLE_{t-1} + b_{21} InPHE_{t-1} + b_{31} InHC_{t-1} + b_{41} InGDP_{t-1} + \sum^{p}_{i=1} a_{1i} \Delta InLE_{t-1}$$

$$\sum^{q}_{i=1} a_{2i} \Delta InPHE_{t-1} + \sum^{q}_{i=1} a_{3i} \Delta InHC_{t-1} + \sum^{q}_{i=1} a_{4i} \Delta InGDP_{t-1} + \delta_{it} \text{ ---3.4}$$

The bound test for cointegration will be carried out using equation 3.4. The F-statistic and the t-statistic will be used to test the Null hypothesis for no long run relationship or cointegration. If the F_{value} is less than the I(1) bound, the null hypothesis for no long run relationship cannot be rejected. However, if the F_{value} is greater than the I(1) bound, the null hypothesis for no long run relationship will be rejected.

Alternatively, the t-statistic can also be used. If the absolute value of the t-statistic is less than the I(1) bound, the null hypothesis for no long run relationship cannot be rejected. However, if the t-statistic value is greater than the I(1) bound, the null hypothesis of no long run relationship will be rejected.

If the Bound test for cointegration reveals that there is no long run relationship between the variables in the model as specified in equation 3.4, where longevity (proxied by life expectancy) is a dependent variable, the researchers will go ahead to estimate the ARDL (p, q_1, q_2, q_3) model as specified in equation 3.5.

$\Delta InLE_t = a_0 + \sum^{p}_{i=1} a_{1j} \Delta InLE_{t-1} + \sum^{q}_{i=1} a_{2j} \Delta InPHE_{t-1} + \sum^{q}_{i=1} a_{3j} \Delta InHC_{t-1} + \sum^{q}_{i=1} a_{4j} \Delta InGDP_{t-1} + \delta_{it}$ ---------- 3.5

Alternatively, if equation 3.4 returns a long run relationship, we shall proceed to estimate the error correction model as specified in 3.6;

$\Delta InLE_t = a_0 + \sum^{p}_{i=1} a_{1j} \Delta InLE_{t-1} + \sum^{q}_{i=1} a_{2j} \Delta InPHE_{t-1} + \sum^{q}_{i=1} a_{3j} \Delta InHC_{t-1} + \sum^{q}_{i=1} a_{4j} \Delta InGDP_{t-1} + \lambda ECT_{t-1} + \delta_{it}$ ---------- 3.6

The estimates obtained will be analyzed and conclusions and recommendations will be made based on the results.

4. Estimation and Analysis

ADF Unit Root Test

Due to the inherent non stationarity of most macroeconomic data, the series were subjected to unit root test using the Augmented Dickey-Fuller (ADF). The null hypothesis of unit root will not be rejected if the ADF statistics is less than the t-statistic of -2.957110, otherwise we reject the null and accept the alternative. The summary of the outputs are presented in the table 4.1.

Table 4.1: Summary of Unit Root Results

Variables	At Level	1st Difference	Critical value @ 5% level of significance	Order of Integra-tion	Decision
InLE	-22.36402	-28.90746	-2.957110	I(0)	Accept H_0
InPHE	-0.830822	-8.228565	-2.957110	I(1)	Reject H_0
InGDP	-0.143438	-3.268812	-2.957110	I(1)	Reject H_0
InHC	-1.478731	-2.967211	-2.957110	I(1)	Reject H_0

Source: Researcher's Computation using Eviews.

The results of the unit root as presented in the table 1 above, shows that the null hypothesis for unit root was accepted for the coefficient of longevity (InLE). This meant that LE is stationary at level or integrated of order zero I(0). However, the null hypothesis for unit root could not be rejected at levels for InPHE, InGDP and InHC. At first difference, the ADF test reveals that all series are stationary at 5% critical level of significance. It is concluded that PHE, GDP and HC are integrated of order one (I(1)). This result paves way for the investigation of the long run relationship using the autoregressive distributed lags model.

Bounds Test for Cointegration and the Long Run Estimates

The Bound test for cointegration was carried out with the view to check for the possibility of a long run relationship using the model in which the log of LE is a dependent variable. The model estimation was based on unrestricted constant and no trend. The F and t-statistic resulting from the estimation are tabulated in table 4.2.

Table 4.2: Bound Test for Cointegration

Dependent Variable	F-Statistic	t-Statistic	Coin-tegration	What next
$LnLE_t$	$F_{value} = 37.73$, $F_{value} = 3.77$		Yes	Estimate ECM/Levels
$LnLE_t$		$T_{value} = 9.02$, $t_{value} = 3.46$	Yes	Estimate ECM/Levels

Author's compilation as generated from e-views

F_{value} and T_{value} represent the computed F and t-statistic values while f_{value} and t_{value} are the cointegrated of order one I(1) bound values. Both the F and t-statistic computed values are greater that the I(1) bound values as seen in the table 4.2 and as such, the null hypothesis for no cointegration was reject. We therefore conclude that, there is a long run relationship (or the variables are cointegrated) between the variables when the log of LE is a dependent variable.

Since there is a long run relationship between the variables, we shall proceed to estimate the error correction model or the short run estimates. The short run estimates are presented in table 4.3.

Table 4.3: Error Correction Estimates

Variables	Coefficient	Standard error	t-statistic	Probability Values
C	0.2625	0.0194	13.5308	0.0000
LnLE(-1)	0.4639	0.0863	5.3327	0.0001
LnPHE(-1)	0.0009	8.37E-	10.2953	0.0000
LnGDP(-1)	0.0029	0.0010	2.9985	0.0095
LnHC	0.0499	0.0123	4.0483	0.0012
ECT(-1)	-0.0592	0.0044	-13.5381	0.0000

Author's compilation as generated from e-views

The result of the error correction model reveals that, the model has a positive and significant intercept. The lagged value of life expectancy is seen to be positive and significant in explaining current year changes in life expectancy. The lagged values of public health expenditure and gross domestic product also had a positive and significant effect on life expectancy in the short run. Human capital also impact positively on life expectancy in the current year. A 10% increase in lnLE(-1), lnPHE(-1), lnGDP(-1) and lnHC will cause life

expectancy in the current year to improve by 4.6, 0.009, 0.029, 0.499% respectively. However, the contribution of the variables considered in the model to life expectancy is rather marginal. The ECT_{t-1} coefficient of -0.0592 suggests that life expectancy adjusts to long run equilibrium through the channels of lagged values of life expectancy, public health expenditure, gross domestic product and human capital at the speed of 5%. The coefficient is negative and statistically significant as required by economic theory. However, the ECT_{t-1} coefficient shows that the speed of adjustment to long run equilibrium due to short run distortions is quite slow.

The p-values of the F-statictic, t-statistic and the likelihood ratio of the Ramsey regression specification error test were not significant. This shows that the model is free from misspecification errors. The F-statistic and observed R-square of the Breusch-Godfrey serial correlation LM test also had probability values above 0.05, meaning that the data is free from serial correlation. The test for heteroskedasticity also revealed that the data is free from heteroskedasticity.

5. Discussion of finding

The ADF result showed that where as longevity (life expectancy) was stationary at levels, public health expenditure (PHE), gross domestic product (GDP) and human capital (HC) were non stationary at level and became stationary after first difference. This paved way for the use of the ARDL model. The ADRL bound test revealed that the variables used in the model in which the log of LE was a dependent variable exhibited a long run relationship and as such it was only proper to estimate the error correction model (ECM). The ECM model showed that PHE, GDP and HC were all positively related and significant in explaining changes in the dependent variable (LE). A 10% increase in lnLE(-1), lnPHE(-1), lnGDP(-1) and lnHC will cause LE in the current year to improve by 4.6, 0.009, 0.029, 0.499% respectively. This finding is similar to that by Ogungbenle, et. al. (2013) and Effiong (2021). However, PHE, GDP and HC were not strong determinants in explaining changes in the dependent variable.

The ECM(-1) has a coefficient of -0.0592 which shows that it is correctly signed and statistically significant as required by economic theory. This suggests that, LE adjusts to long run equilibrium through the channels of lagged values of LE, PHE, GDP and HC at the speed of 5%. However, the ECT_{t-1} coefficient shows that the speed of adjustment to long run equilibrium due to short run distortions is quite slow.

The Ramsey regression specification error test, Breusch-Godfrey serial correlation LM test and the test for heteroskedasticity show that the model is free from misspecification errors, free from serial correlation and free from heteroskedasticity.

Conclusion and recommendations

Considering the results of the estimates, the study concludes that PHE does not have much impact on longevity or life expectancy. This is probably because public expenditure on health and health services coverage in Nigeria are so limited that majority of the citizens do not even go public health service providers but pay for health services from their pockets. This shows that maybe a variable like household out-of-pocket expenditure would have probably had greater impact on longevity in Nigeria. It therefore beholds on the government to increase her

public health spending to be able positively improve LE. It can also be seen that GDP weakly contributes to life expectancy. This is an indication that improvements in the Nigerian GDP do not translate in to better living standards for the citizens and hence does not improve on longevity. However, a weak population will also contribute weakly to economic growth. Policies must be put in place to improve the quality of life of the citizens and hence, life expectancy to be able to achieve sustained economic growth. Human capital development also weakly influences longevity in Nigeria. This may possibly be as a result of the low literacy level in the country. Illiteracy may even hinder people from finding and accessing available health facilities that will help in promoting longevity. Measures must be put in place to deliberately educate the Nigerian population especially the rural poor.

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