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DETERMINANTS OF LIFE EXPECTANCY IN NIGERIA: DOES AGRICULTURAL PRODUCTIVITY MATTER?

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ABSTRACT

The paper examines the effects of agricultural productivity and other economic factors on life expectancy in Nigeria. The ARDL approach to cointegration and error correction modelling is employed for analysis of annual time series data spanning the period from1981-2016. The study finds that improvement in agricultural productivity enhances life expectancy in the short in, but adversely affects it in the long run. It also finds that inflation and unemployment adversely affect life expectancy in the short- and long-run. The short-run effect of real per capita income is found to be negative (an indication of uneven distribution of income), while the long run effect is also negative, but statistically not significant. The effects of exchange rate and government recurrent education-expenditure on life expectancy are neither significant in the short- nor in the long-run. Health expenditure positively affects life expectancy in the short run and in the long run. Based on these findings, the study recommends that though agricultural productivity enhances life expectancy in the short run in Nigeria, yet it should be cautiously pursued in a way that it is not detrimental to the industrial (especially, manufacturing) sector as this could have adverse consequences for life expectancy in the long run. There is also need to raise awareness campaigns on proper nutrition to control intake of high calorie and high cholesterol foods as a result of expansion in food production arising from improvement in agricultural productivity. Efforts should also be made by the government to address the unemployment problem and bring inflation under control. In addition, there is need for government to increase budgetary allocation to the health sector.

Keywords: Life Expectancy, Life Span, Agricultural Productivity, Economic Development, Nigeria.

INTRODUCTION

Life expectancy is one of the indicators of quality of life and economic development (Hossain, 2003; Bilas, et al., 2014). It is also a key indicator of health outcome or health status. It refers to an individual's lifespan or the average number of years from birth an individual is expected to live or exist. All things being equal (baring accidental or sudden death, assassination, murder, suicide, etc.), the quality of life of individuals is reflected to a large extent in their life expectancies. This implies that the higher the quality of life, the higher life expectancy will be. Data from the World Bank's World Development Indicators (2019) reveals that life expectancy is higher in developed countries than in less developed countries. This may be attributed to improved living conditions in the developed countries. LDCs are characterized by low life expectancy, low access to portable water, low access to modern energy, inadequate food supplies, low level of per capita income and wide income inequality, low quality education, poor access to medical or healthcare facility, and in most cases high inflation which increases the cost of accessing basic amenities, low agricultural productivity, resulting to increase in cost of living and decrease in living standards. These and a host of other factors contribute to the low life expectancy in the LDCs. Thus, responsible governments of LDCs strive to improve life expectancies of their citizens considering its relevance to the economy as it guarantees availability of labour (or human capital) required for production of goods and services.

Life expectancy is affected by numerous factors including economic, political, social and environmental factors ranging from health status, poverty, income level, etc. and these have been examined by various researchers. However, the potential effect of agricultural productivity on life expectancy has not been investigated, to my knowledge. Agricultural productivity refers to output of agriculture per unit of factor inputs employed. Improvement in productivity of agriculture would engender expansion in food and other agricultural output (Wiebe, et al., 2001; Dethier, 2011). The increase in food output could enhance life expectancy as a result of increase in food consumption leading to healthier life, but if not cautiously embraced, the rise in food consumption could engender reduction in lifespan as a result increased intake of life-threatening calories or cholesterol which may trigger release of age-related pathologies or diseases (Mehta, 2001). The objective of this study is to investigate the determinants of life expectancy in Nigeria, focusing specially on the role of agricultural productivity.

The paper is organized as follows: The study has been introduced and motivated in this section. The next section – section 2 – contains a review the relevant literature. The gap in the literature is also identified. Section 3 contains the discussion on data and methodology. The empirical analysis (results and discussions) is presented in section 4. Section 5 concludes the paper with evidence-based recommendations for policy considerations.

Literature Review

The determinants of life expectancy have been investigated in various studies. These include Kabir (2018), Lim, et al. (2012), Bayati et al. (2013) and a host of others. Some of the studies are reviewed in this section some.

Kabir (2008) examined the socio-economic determinants of life expectancy in 91 developing countries grouped into high, medium and low life expectancy countries. The disaggregated probit regression was employed for the analysis. The study found that life expectancy was not significantly affected by most of the socioeconomic factors such as access to safe water, education, health expenditure, per capita income and urbanization. However, the study found that improvement in physician availability, improvement in adult literacy and reduction in undernourishment would engender improvement in life expectancy in developing countries.

Lin et al. (2012) investigated the socioeconomic and political factors affecting life expectancy in a sample of 112 LDCs over the 35 years period of 1970-2004. In doing this, the effects of four factors namely per capita income (the economic factor), political regime (the political factor), literacy and nutritional status (the social factors), on life expectancy were investigated using mixed linear models accounting for regional heterogeneous covariance estimated with maximum likelihood estimator. The results of the study showed that all the factors contributed to improving life expectancy, but at varying magnitudes over time. The effect of political regime was the lowest among all, but it became significant from the third year and rose continuously thereafter. The effects of other factors were strong at the outset, but diminished over time.

Bayati et al. (2013) examined the determinants of life expectancy in 21 countries in Eastern Mediterranean Region during the 1995-2007 period. The methodology involved the fixed effect model selected on the basis of result of the Hausman test. The study found that life expectancy in the region was significantly affected by per capita income, food availability, education, urbanization level and employment. Similarly, Gilligan and Skrepnek (2015) also examined the determinants of life expectancy in 21 Eastern Mediterranean Region during the 1995-2010 period. The methodology involved cluster analysis and econometric analysis of estimation of random-intercept model which combines fixed and random effects. The study found that life expectancy was positively and significantly affected by GDP, vaccination, urbanization, physician density, literacy and health expenditure.

Dim and Ezenekwe (2013) employed the OLS technique to examine the effect of agricultural output, agricultural expenditure and other variables on life expectancy in Nigeria during 1979-2010 period. The results indicated that agricultural production negatively and significantly affected life expectancy, while the effect of agricultural expenditure was not significant. Rainfall and industrial output were found to be positively and significantly related to life expectancy in the country.

Factors affecting life expectancy in 28 EU countries were examined in the study by Bilas et al. (2014). The study covered the period from 2001 to 2011. The Johansen cointegration approach was employed for the analysis. The study found that for each country, education attainment and GDP per capita were the significant factors affecting life expectancy in the EU. Other variables such as population growth, growth of GDP and education enrolment rate exerted no significant effect on life expectancy in the countries.

Sede and Ohemeng (2015) investigated the socio-economic determinants of life expectancy in Nigeria during the period from 1980-2011 using VECM analysis and Granger causality test. From the results of the VECM estimates it is deduced that life expectancy in the country can be reduced by improvement in government expenditure in health, reduction in unemployment rate and currency appreciation. The study also found that life expectancy in Nigeria is unaffected by education, per capita income. However, the Granger causality test result shows short run bidirectional causality between per capita income and life expectancy, and short run unidirectional causalities from government expenditure in health to life expectancy, from exchange rate to life expectancy and from life expectancy to education suggesting that age is not a barrier to education in the country.

Monsef and Mehrjardi (2015) investigated the factors affecting life expectancy in a sample of 136 countries during the period from 2002-2010. The study involved estimation of a fixed effect model using the GLS estimator. The results showed that life expectancy is adversely affected mainly by inflation and unemployment. Factors found to have positively and significantly affected life expectancy were urban population, gross capital formation and gross national income. Life expectancy was not significantly affected by CO2 emission.

Shahbaz et al. (2015) examined the determinants of life expectancy in Pakistan during 1972-2012 period. The ARDL approach to cointegration and the VECM Granger-causality test were employed for the analysis. The empirical evidence indicated that life expectancy in the country was positively and significantly affected by urbanisation, food supplies, and health expenditure, and was adversely affected by economic misery and illiteracy. The Granger-causality test indicated that the aforementioned variables affecting life expectancy also Granger-caused it.

Hassan et al. (2017) examined the socio-environmental determinants of life expectancy in 108 developing countries during the 2006-2010. In the study the effects of education (years of schooling), water coverage, sanitation facilities, health expenditure and GDP on life expectancy at birth were examined within a panel setting using pooled regression, fixed effect and random effect models. The results of the fixed effect model selected based on the outcome of the Hausman test, indicated that life expectancy was enhanced by GDP and education. The effect of education on life expectancy was larger and more significant. The effects of the other variables were not significant.

Ketenci and Murthy (2018) examined the determinants of life expectancy in the United States during the period 1960-2012 using cointegration and DOLS analysis. The study found that life expectancy is the country is positively and significantly affected by real per capita income and educational attainment.

Njiru and Letema (2018) investigated the effect of energy poverty on standard of living (taking life expectancy as a measure) in Kiriyanga County, Kenya using basic trend analysis and descriptive statistics. The analyses revealed that energy poverty impacted negatively on life expectancy and other indicators of standard of living such as health, calorific intake and literacy levels in the county.

Cervantes et al. (2019) investigated the socioeconomic determinants of life expectancy in 17 regions of Spain during 2006-2016 using the Dumitrescu-Hurlin approach to (panel) Granger-causality test. The study found that life expectancy in the regions was Granger-caused by per capita income and number of medical staff.

Etikan et al. (2019) examined the socioeconomic factors affecting life expectancy at birth in Nigeria during the period 2000-2015. The methodology involved OLS estimation of a multivariate linear regression model specified for the study. The evidence indicated that life expectancy was affected negatively and significantly by private expenditure in health, and positively and significantly by improved access to safe water and basic sanitation system. Further evidence from the study is that government expenditure in health positively affected life expectancy, but the effect was not significant.

Miladinov (2020) examined the socioeconomic determinants of life expectancy in five EU accession candidate countries during the period 1990-2017, using the full information maximum likelihood (FIML) estimator. The countries are Albania, Bosnia Macedonia, Montenegro, and Serbia. The study found that life expectancy in the countries was significantly affected by GDP per capita and infant mortality rate. While the effect of GDP per capita was positive, that of infant mortality was negative.

Attempts have been made by various researchers to identify factors affecting life expectancy. The factors identified in the literature include per capita income, exchange rate, health expenditure, inflation, unemployment, agricultural output, and so on, with varying levels of statistical significance and non-significance in some cases. To my knowledge, based on a wide search of the literature, agricultural productivity as potential determinant of life expectancy has not been investigated. This leaves a gap in the literature which this study intends to fill.

METHODOLOGY

The data on variables used for the study as well as the methodology involving the models and the estimation procedure employed for analysis of the data are presented in this section.

Data

Annual time series data for the period 1981 to 2016 were employed for the study. This scope was dictated by data availability as the last observation on agricultural total factor productivity from the source it was gotten was for 2016. Nigeria's data on life expectancy at birth (male and female combined), energy poverty, agricultural productivity, unemployment, per capita income, inflation, nominal exchange rate was employed for the study. Data on agricultural productivity was obtained from the USDA ERS (2019), while data on the other variables were obtained from the World Bank's World Development Indicator (2019).

Model and Methodology

The endogenous growth theory relating agricultural productivity to economic development developed by Matsuyama (1992) provides the theoretical framework for this study. The theory is relevant to this study considering that life expectancy is one of the indicators of development. The theory can therefore be used to explain the effect of agricultural productivity on life expectancy.

Matsuyama (1992) demonstrated that the effect of agricultural productivity on economic development depends on whether the economy is closed or open. The Matsuyama model predicts positive linkage between agricultural productivity and economic growth in a closed economy (as increase in agricultural productivity releases labour to the manufacturing sector, engendering increase in its output, and also causes an increase in food production). It also predicts a negative linkage between agricultural productivity and economic growth in a small open economy (especially where food is considered a luxury good), as improvement in agricultural productivity squeezes out the manufacturing sector causing a de-industrialization of the economy over time. Since Nigeria is an open economy, the effect of agricultural productivity on life expectancy could be adverse.

Following the Matsuyama model with some modification (using life expectancy as the indicator of economic development and incorporating other policy variables which serve as control variables), the model to investigate the effect of agricultural productivity on life expectancy in Nigeria is specified functionally as:

$$LEBT = f(AGTFP, RPCY, UNEMP, INFL, EXRT, EDEXP, HEEXP) \quad [1]$$

Where LEBT = Life expectancy at birth (male and female, total); AGTFP = Index of agricultural total factor productivity. This study uses the agricultural total factor productivity index computed by Economic Research Service (ERS) of the United States Department of Agriculture. The index takes into account the productivity of various factors (including land, machinery fertilisers, etc.) employed in agricultural production, hence it is called agricultural total factor productivity index; RPCY = Real GDP per capita; UNEMP = Unemployment rate; INFL = Inflation; EXRT = Nominal exchange rate; EDEXP = Government recurrent expenditure in education; HEEXP = Government recurrent expenditure in health. AGTFP is the explanatory variable of interest. Variables incorporated in the model as control variables were selected based on various theories and previous empirical studies.

The ARDL approach to cointegration and error correction modelling developed by Pesaran et al. (2001) was used for analysis of the data. The choice of this methodology was informed by its flexibility in application as it could be used in cases of I(0), I(1) variables or variables with mixed order of integration (mix of I(0) and I(1) and even fractionally integrated series, so long as none is integrated of order (I(2)). Apart from this, the approach can be applied in cases of small finite data size and it is designed to yield efficient and consistent long-run parameters with valid t-ratios in the presence of regressor endogeneity (Harris & Sollis, 2003).

Implementation of the method begins with application of the augmented Dickey-Fuller (ADF) and the Dickey-Fuller generalized least squares (DF-GLS) tests to test for unit root in the variables of the study so as to ascertain their stationarity properties and to be certain that none of them is I(2). If it is established that there is/are no I(2) variable(s) the cointegration test is performed to determine whether long run relationship exists between the dependent variable and the explanatory variables. This involves specifying and estimating an unrestricted error correction version an underlying ARDL model (UECM-ARDL) using the least squares estimator. The UECM-ARDL model specified for this study is:

$$\begin{aligned}\Delta \mathrm{LnLEBT}_t = \ & \gamma_0 + \sum_{j=1}^{p}\left(\delta_{1j}\Delta \mathrm{LnLEBT}_{t-j}\right) + \sum_{j=0}^{p}\left(\delta_{2j}\Delta \mathrm{LnAGTFP}_{t-j}\right) \\ & + \sum_{j=0}^{p}\left(\delta_{3j}\Delta \mathrm{LnRPCY}_{t-j}\right) + \sum_{j=0}^{p}\left(\delta_{4j}\Delta \mathrm{UNEMP}_{t-j}\right) + \sum_{j=0}^{p}\left(\delta_{5j}\Delta \mathrm{INF}_{t-j}\right) \\ & + \sum_{j=0}^{p}\left(\delta_{6j}\Delta \mathrm{LnEXRT}_{t-j}\right) \sum_{j=0}^{p}\left(\delta_{7j}\Delta \mathrm{LnEDEXP}_{t-j}\right) \\ & + \sum_{j=0}^{p}\left(\delta_{8j}\Delta \mathrm{LnHEEXP}_{t-j}\right) + \lambda_1 \mathrm{LnAGTFP}_{t-1} + \lambda_2 \mathrm{LnRPCY}_{t-1} \\ & + \lambda_3 \mathrm{UNEMP}_{t-1} + \lambda_4 \mathrm{INF}_{t-1} + \lambda_5 \mathrm{LnEXRT}_{t-1} + \lambda_6 \mathrm{LnEDEXP}_{t-1} \\ & + \lambda_7 \mathrm{LnHEEXP}_{t-1} + \mu_t \qquad [2]\end{aligned}$$

The δs correspond to short run relationships, while the λs correspond to long run relationships. Δ stands for first difference operator. μ is the error term.

The bounds test for cointegration involves application of the Wald's F-statistic to test the joint significance of equation 2. Pesaran et al. (2001) provides two sets of asymptotic critical values at various significance levels for the estimated F-statistic. One set are the lower critical bounds values which assume the variables are I(0), the other set are the upper critical bounds values which assume the variables are I(1). The F-statistic is compared with these bounds critical values to determine existence or otherwise of cointegration. The null hypothesis of no cointegration ($\gamma_1 = \gamma_2 = \gamma_3 = \ldots \gamma_6 = 0$) is tested against the alternation hypothesis of existence of cointegration

($\lambda_1 \neq \lambda_2 \neq \lambda_3 \neq \ldots\lambda_8 \neq 0$). If the F-statistic is greater than the upper bound critical value at a chosen level of statistical significance, then the null hypothesis of no cointegration is rejected, implying the alternative hypothesis holds, that is there is long run relationship between the variables. F-statistic less than the lower bounds critical value implies the null hypothesis cannot be rejected. F-statistic between the upper and lower bound critical values is inconclusive. Where cointegration is established, the short run (error correction) and the long run models are estimated. The error correction model is specified as:

$$\Delta LnLEBT_t = \beta_0 + \sum_{j=1}^{p}(\Gamma_{1j}\Delta LnLEBT_{t-j}) + \sum_{j=0}^{p}(\Gamma_{2j}\Delta AGTFP_{t-j}) + \sum_{j=0}^{p}(\Gamma_{3j}\Delta LnRPCY_{t-j}) + \sum_{j=0}^{p}(\Gamma_{4j}\Delta UNEMP_{t-j}) + \sum_{j=0}^{p}(\Gamma_{5j}\Delta INF_{t-j}) + \sum_{j=0}^{p}(\Gamma_{6j}LnEXRT_{t-j}) + \sum_{j=0}^{p}(\Gamma_{6j}LnEDEXP_{t-j}) + \sum_{j=0}^{p}(\Gamma_{6j}LnHEEXP_{t-j}) + \varphi ECT_{t-1} + \xi_t \quad [3]$$

The parameters Γs represent the short run effects of respective explanatory variable on the dependent variable. ECT is the error correction term derived as one-year lagged values of residuals derived from the ARDL-based long run model. Its coefficient is expected to be negatively signed and statistically significant to play the role of error correction in the model, that is to reconcile short run deviation with the long run relationship. The negative coefficient is a further indication of cointegration. Its absolute value measures the speed of adjustment to equilibrium. ξ is the error term.

The ARDL-based long run model is specified as:

$$LnLEBT = a_0 + a_1 LnAGTFP_t + a_2 LnRPCY_t + a_3 UNEMP_t + a_4 INFL_t + a_5 LnEXRT_t + a_6 LnEDEXP_t + a_7 LnHEEXP_t + \varepsilon_{1t} \quad [4]$$

$a_1 \ldots a_7$ represent long run coefficients. ε is the error term. The *a priori* expectations are:
$a_1 < 0$, $a_2 > 0$, $a_3 < 0$, $a_4 < 0$, $a_5 < 0$, $a_6 > 0$, $a_7 > 0$.

Based on the prediction of the Matsuyama model, the long run effect of agricultural productivity on life expectancy is expected to be negative considering that Nigeria's economy is a small open economy. Improvement in agricultural productivity engenders shifts of resources towards the agricultural sector and squeezes the industrial (manufacturing) sector leading to de-industrialisation which may adversely affect life expectancy in the long run (Matsuyama, 2012). At the micro-level, increase in food production resulting from improvement in agricultural productivity could engender uncontrolled increase in calorie intake with associated adverse effect (if the excess calories are not burnt through engagement in activities) which could cause reduction in life span (Mehta, 2001). All things being equal, and if income in evenly distributed (that is given that income inequality is low), then increase in per capita income would engender increase in life expectancy. Increase in unemployment (in the absence of remittances, unemployment benefits and other transfers) will adversely affect life expectancy. Increase in inflation raises living costs, lowers living standard and causes reduction in life expectancy. For a country that is highly import-dependent, currency depreciation (increase in the exchange rate of the domestic currency) will adversely affect importation of life-enhancing items such as drugs, and other final (consumer) goods which are not produced or readily available in the economy, leading to the increase in prices of the items which become unaffordable by majority of those who require them. The ultimate effect could be reduction in lifespan. Increase in government recurrent expenditures in education and health are expected to enhance life expectancy all things being equal as they contribute to human capital development which is a requirement for enhanced lifespan.

RESULTS AND DISCUSSION

The unit root test results involving the ADF and the DF-GLS tests are presented in Table 1.

Table 1. Unit Root Test

ADF Test							
Variables	**Levels**			**1st Difference**			**I(d)**
	ADF Stat	Critical Value (5%)	Inference	ADF Stat	Critical Value (5%)	Inference	
LnLEBT	-4.69	-3.54	S	-	-	-	0
LnAGTFP	-0.74	-3.55	NS	-8.09	-3.55	S	1
LnRPCY	-1.51	-3.54	NS	-3.74	-3.54	S	1
UNEMP	-3.33	-3.54	NS	-7.31	-3.54	S	1
INFL	-3.97	-3.54	S	-	-	-	0
LnEXRT	-1.41	-3.54	NS	-5.48	-3.54	S	1
LnEDEXP	-3.12	-3.54	NS	-5.76	-3.55	S	1
LnHEEXP	0.04	-3.55	NS	-5.29	-3.55	S	1
DF-GLS Test							
Variables	**Levels**			**1st Difference**			**I(d)**
	PP Stat	Critical Value (5%)	Inference	PP Stat	Critical Value (5%)	Inference	
LnLEBT	-4.06	-3.19	S	-	-	-	0

LnAGTFP	-0.99	-3.19	NS	-8.16	-3.19	S	1
LnRPCY	-1.50	-3.19	NS	-3.46	-3.19	S	1
UNEMP	-3.41	-3.19	S	-	-	-	0
INFL	-3.12	-3.19	NS	-5.51	-3.19	S	1
LnEXRT	-1.31	-3.19	NS	-5.51	-3.19	S	1
LnEDEXP	-3.25	-3.19	S	-	-	-	0
LnHEEXP	-2.26	-3.19	NS	-10.16	-3.19	S	1

I(d) represents order of integration

Source: Author's estimation using EVIEWS 9.

The unit root test results indicate that the variables are integrated of different orders. While some are stationary at level (that is integrated of order 0), others are stationary at first difference (integrated of order 1). In view of this, the Bounds test based on the UECM version of the ARRDL was employed to test for cointegration between the dependent variable and the explanatory variables. The result of the test is presented in Table 2.

Table 2: ARDL Bounds Test

Sample: 1983 2016		
Included observations: 34		
Null Hypothesis: No long-run relationships exist		
Test Statistic	Value	k
F-statistic	45.49820	7
Critical Value Bounds		
Significance	I0 (Lower) Bound	I1 (Upper) Bound
10%	2.03	3.13
5%	2.32	3.5
2.5%	2.6	3.84
1%	2.96	4.26

k represents number of explanatory variables.

Source: Author's estimation using EVIEWS 9

The estimated F-statistic is greater than the upper bound critical value even at the 1% significance level. Thus, the null hypothesis of no long run relationship is rejected at this level of significance. It can therefore be inferred that long run relationship exists between the variables. Since the variables are cointegrated, the short run (dynamic, error correction) and the long run models can be estimated.

Model Estimations

The result of estimation of the ECM is presented in Table 3.

Table 3: Error Correction Model

Dependent Variable: LOG(LEBT)			
Selected Model: ARDL(2, 2, 2, 2, 2, 1, 2, 2)			
Sample: 1981 2016			
Included observations: 34			
Variables	Coefficients	t-ratios	p-values
DLn(LEBT(-1))	0.934338	24.063479	0.0000
DLn(AGTFP)	0.003659	2.660091	0.0222
DLn(AGTFP(-1))	0.010986	6.281181	0.0001
DLn(RPCY)	-0.005999	-2.772861	0.0181
DLn(RPCY(-1))	-0.003254	-2.110835	0.0585
D(UNEMP)	-0.000034	-3.096334	0.0102
D(UNEMP(-1))	0.000033	2.303871	0.0417
D(INFL)	-0.000019	-3.871663	0.0026
D(INFL(-1))	0.000013	2.384861	0.0362
DLn(EXRT)	0.000116	0.537170	0.6018
DLn(EDEXP)	-0.000179	-0.828864	0.4248
DLn(EDEXP(-1))	0.000252	1.238754	0.2412
DLn(HEEXP)	0.000411	1.923756	0.0806
DLn(HEEXP(-1))	-0.000509	-2.201656	0.0499
CointEq(-1)	-0.020913	-2.329443	0.0399

*Cointeq = LOG(LEBT) - (-0.5348*LOG(AGTFP) - 0.1399*LOG(RPCY) - 0.0027*UNEMP - 0.0016*INFL + 0.0531*LOG(EXRT) - 0.0282*LOG(EDEXP) + 0.0685*LOG(HEEXP) + 7.1024)*

R^2 = 0.999; Adj. R^2 = 0.998; F-stat. = 874.99, p-value = 0.000; Durbin-Watson stat. = 1.779.

CointEq representes ECT in equation 3.

Source: Author's estimation using EVIEWS 9.

The results shows positive and highly significant relationship between previous year's LEBT (LEBT(-1)) and current LEBT. This suggests that all things being equal, life expectancy in a particular year in the country is dependent on life expectancy in the preceding year if driving or determining factors responsible for it the previous year persist, barring any unforeseen (negative) circumstances. Looking at the key explanatory variable of interest which is agricultural productivity, it can be observed that its coefficients – current and lagged – are positive and statistically significant at the 5% and the 1% level respectively. These imply that improvements in agricultural productivity would enhance life expectancy in the country in the short run.

Contrary to expectation, the relationship between (current and previous year's level of) per capita income and LEBT is negative and significant at the 2% and 5% level respectively. This could be an indication that income is not evenly distributed in the country; in other words, it could be a reflection of wide income inequality in the country (and higher poverty levels), policy somersault and other underlying anti-development factors affecting the development of the country. Hence increase in per capita income engenders decrease in life expectancy in the country in the short run.

The contemporaneous short run effect of unemployment on life expectancy is negative and significant at the 1% level. Thus, increase in unemployment in a particular year is associated with decrease in life expectancy same year. Though the lagged effect is positive and significant at the 5% level, the contemporaneous effect is larger and more significant, resulting in net decrease in life expectancy consequent on increase in unemployment rate in the country in the short run.
The contemporaneous short run effect of inflation on life expectancy is also negative and significant at 1% level, indicating that increase in inflation is associated with decrease in left expectancy in the short run. Though the lagged effect is positive and significant at the 5% level, yet the net effect is negative, considering that the contemporaneous negative effect is larger and more significant. This therefore implies that inflation adversely affects life expectancy in the country in the short run.
The short run effect of exchange rate and government recurrent expenditures on education are not significant. This implies that these variables are not key determinant of life expectancy in the short run in the country. The short run contemporaneous effect of health expenditure on life expectancy is positive and significant at the 10% level. Increase in health expenditure may engender improvement in life expectancy in same period it was implemented, though this effect may be adversely affected by the negative and significant lagged effect of government health expenditure on life expectancy in the country. This suggests that the productiveness of recurrent health expenditure as it relates to life expectancy is short-lived in the short run.

The error correction coefficient is negatively signed as expected and statistically significant at the 5% level. Thus, it will rightly play the role of error correction in the model, reconciling short run dynamics with equilibrium relationship. However, the speed of adjustment to equilibrium is quite low as reflected in the size of the error coefficient which indicates that 2.1% of short run deviation from equilibrium is corrected (adjusted) annually to restore equilibrium in the system. The negative sign on the error correction coefficient further confirms cointegration between the explanatory and the dependent variables.

The foregoing is an analysis of the short run (dynamic, temporary) relationships between life expectancy and its determinants. The estimated model showing the long run effects of agricultural productivity and other policy variables on life expectancy in Nigeria is presented in Table 5.

Table 4: Long Run Coefficients derived from ARDL(2, 2, 2, 2, 2, 1, 2, 2)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LOG(AGTFP)	-0.534773	0.232889	-2.296254	0.0423
LOG(RPCY)	-0.139904	0.153156	-0.913472	0.3806
UNEMP	-0.002742	0.001072	-2.559442	0.0265
INFL	-0.001620	0.000642	-2.525091	0.0282
LOG(EXRT)	0.053095	0.030873	1.719788	0.1134
LOG(EDEXP)	-0.028226	0.018380	-1.535640	0.1529
LOG(HEEXP)	0.068543	0.027364	2.504856	0.0293
C	7.102383	2.047465	3.468867	0.0053

Source: Author's estimation using EVIEWS 9

The result presented in Table 4 shows that improvement in agricultural productivity adversely affects life expectancy in the long run. This conforms to *a priori* expectation and may be attributed to the fact that improvement in agricultural total factor productivity could engender shift of productive factors from other sectors such as manufacturing (and solid minerals) to the agricultural sector causing a squeeze in those sectors which are key growth-drivers, income-generators and poverty-reducers, and engendering expansion of the agricultural sector further making the economy a primary commodity-driven economy characterized by low-wage employment (or high unemployment), higher poverty, low national income, reduction in capacity to access the basic necessities of life and lower life expectancy in the long run. At the micro-level, the negative effect of agricultural productivity on life expectancy could be attributed to increased, uncontrolled calorie intake resulting from expansion in food production – engendered by improvement in agricultural productivity – which could trigger age-related pathologies and reduction in lifespan, as argued by Mehta (2001).

The long run effect of per capita income on life expectancy is not statistically significant. Thus, per capita income is a not significant determinant of life expectancy in the country in the long run. Unemployment and inflation significantly reduce life expectancy in the long run in the country. These conform to *a priori* expectations. The observation with respect to unemployment is in sync with Bayati et al. (2013), Sede and Ohemeng (2015) and Monsef and Mehrjardi (2015) which also found negative effect of unemployment on life expectancy. The observation with respect to inflation is in agreement with Monsef and Mehrjardi (2015) which found that inflation adversely affected life expectancy.

As in the short run, exchange rate and government recurrent expenditure in education do not significantly affect life expectancy in the long run. The effect of government recurrent health expenditure on life expectancy is positive and statistically significant at the 5% level. This conforms to *a priori* expectation and is in agreement with evidence from previous studies including Shahbaz et al (2015), Gilligan and Skrepnek (2015) and Sede and Ohemeng (2015) which found that health expenditure contributes significantly to improvement in life expectancy.

Diagnostic Tests

Various diagnostic tests were carried out to determine the reliability of the results. The tests included the residual normality, the serial correlation, the heteroskedasticity and the RESET (regression equation specification error) tests. The tests were conducted at the 5% significance level. The results are summarized and presented in Table 5.

Table 5: Diagnostics

Test	Test stat	p-value
Residual Normality (Jaque-Bera)	1.2338	0.5396
Serial Correlation (Breusch-Godfrey LM test)	1.1212	0.3675
Heteroscedasticity (Breusch-Pagan-Godfrey)	1.1001	0.4521
Ramsey RESET	1.3904	0.2656

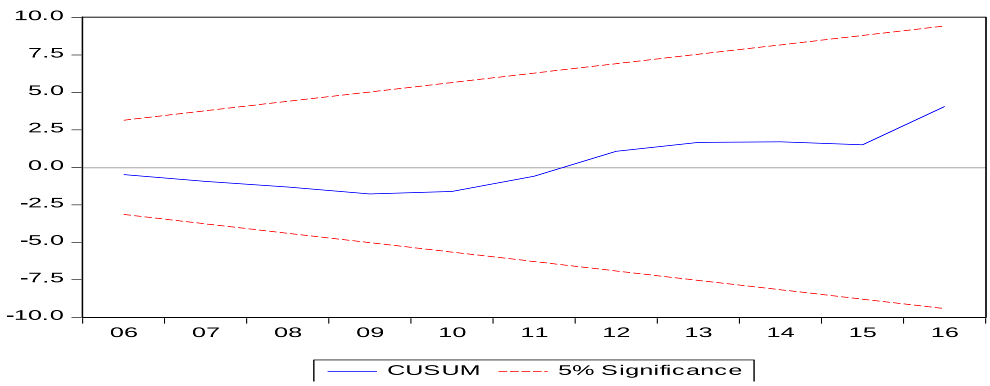
Source: Author's estimations using EVIEWS 9.

The p-value of the Jarque-Bera test for residual normality fails to rejects the null hypothesis of residual normality being greater than 0.05. Thus, the residuals of the model are normality distributed. The p-value of the test for serial correlation does not reject the null hypothesis of absence of serial correlation; there is no problem of serial correlation in the model. The p-value of the test for heteroscedasticity fails to reject the null hypothesis of no heteroscedastic error terms. Thus, the errors are homoscedastic. Finally, the RESET test indicates that there is no specification error in the regression equation (or model). This is indicated by the p-value of the F-test statistic which is greater 0.05.

Stability Test

The study relied on the plot of the cumulative sum of residuals (CUSUM) to test the stability of the underlying ARDL model. The test was developed by Brown, et al. (1975) to test the constancy of regression parameters over time. The result of the test is presented Figure 1.

Figure 1: CUSUM



Source: Authors results from EVIEWS 9

The CUSUM plot lies between the 5% significance bounds. It is therefore inferred that the model is stable. This enhances its usefulness for policy purposes.

CONCLUSION AND RECOMMENDATIONS

The determinants of life expectancy in Nigeria have been examined in this study. Special focus was on the role of agricultural productivity in life expectancy in the country. The study found that agricultural productivity does matter, as it enhances life expectancy in the short run, but adversely affects it in the long run. Unemployment and inflation were also found to adversely affect life expectancy in the short run and in the long run. The effect of per capita income on life expectancy was found to be negative (reflecting poverty in spite of growth; non-inclusive growth and unequal distribution of income or high-income inequality) in the short- and long-run, though the long run effect was not significant. Government recurrent expenditure in health was found to be positive and significant in the short run and also in the long run. The effects of exchange rate and government recurrent expenditure in education were found to be statistically not significant.

In light of the evidence, though improvement in agricultural productivity is desirable since it engenders improvement in life expectancy in the short run, it should be cautiously pursued considering that its long run effect could be adverse as it squeezes key sectors of the economy particularly the manufacturing sector which gets deprived of productive factors. The consequence of this that the economy will get more agrarian, and growth, employment and output will be adversely affected. Moreover, at the micro-level, improvement in agricultural productivity could lead to increase in food production and consumption which if not controlled leads to high calorie intake and if this is not burned off through engagement in activities, the consequences on health and lifespan could be adverse. Emphasis should therefore be on improving industrial sector productivity. There is also need to create awareness programmes and campaigns on proper nutrition to prevent adverse effect of high calorie and cholesterol intake. It is also recommended that government increases it recurrent expenditure in healthcare services in the country and make frantic effort through implementation of programmes and policies to reduce unemployment and inflation in the country.

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