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DETERMINANTS OF LIFE EXPECTANCY IN NIGERIA: AN AUTOREGRESSIVE DISTRIBUTED LAG APPROACH

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Abstract: Nigeria's life expectancy in 2018 was an average of 54.33 years, followed by Sierra Leone (54.31 years), Chad (53.97 years). and Lesotho (53.70 years). It isbelow the Sub-Saharan African region average of 61.27 years and 72.56 years globally (WorldBank Data, 2019). This study investigates the determinants of life expectancy in Nigeria from 1981 to 2017. Adopting the autoregressive distributed lag (ARDL) estimation technique, the study found that Real GDP per capita (Rgdppc), inflation rate (infr) at lags 1 and 2, Imports (lag 1), and government consumption expenditure (GCE) at lag 1 are positively related to life expectancy in the short run, whereas current inflation rate, imports, household consumption expenditure (HCE), HCE (lag 1), GCE, exchange rate (EXR) and EXR (lag 1) are inversely related to life expectancy. The long-run results indicate that while real GDP per capita, HCE and EXR impacted positively on life expectancy, inflation rate, Imports, and GCE impacted negatively on life expectancy. The study concludes that the composite factors of real GDP per capita, inflation, imports, HCE, GCE and EXR are strong determinants of life expectancy at birth. The study, therefore, recommends that growth of real GDP per capita should be prioritized with judicious and productive government expenditures while implementing a strong deterrent policy on the exchange rate, inflation, and imports.

Keywords: Life expectancy, determinants, real GDP per capita, ARDL, Nigeria.

Introduction

The World Health Organization (WHO) in its 2017 report observed that life expectancy at birth has improved within the last two decades globally, from 65.5 years in 2000 to 72.0 years in 2016. This is about a 6.4% increase which is observed to be the fastest life expectancy growth since the 1960s (WHO, 2016). As the global life expectancy improves, there continues to be a wide gap between the life expectancy rate of the African region and the developed European region. While Africa's life expectancy rate at birth stood at approximately 61.2 years, that of the European region stood at 77.5 years (WHO, 2016). Also, within the African region, Nigeria still lags and remains the fourth-lowest country in life expectancy at 53.95 years, followed by Sierra Leone (53.895 years), Chad (53.712 years), and Lesotho (52.947 years). Although life expectancy in Nigeria has increased from 45.33 years in 1980 to 53.95 years in 2017, it is still very low compared to the average life expectancy of 61.2 years in Sub-Saharan Africa (World Bank, 2018). This low life expectancy rate at birth has implications for Nigeria in that productive resources are lost at their prime and their contributions to GDP can no longer be counted.

According to WHO, life expectancy at birth is the average number of years that a newborn could expect to live if he or she were to pass through life exposed to the sex- and age-specific death rates prevailing at the time of his or her birth, for a specific year, in a given country, territory, or geographic area. It reflects the overall mortality level of a population. It summarizes the mortality pattern that prevails across all age groups – children and adolescents, adults, and the elderly (WHO, 2020). The Organization for Economic Cooperation and Development (OECD) defines life expectancy at birth as to how long, on average, a newborn

can expect to live, if current death rates do not change (OECD, 2020). Thus life expectancy is a measure of the length and quality of life a person is expected to live within a geographical area given that the factors affecting longevity do not change. Life expectancy at birth is therefore a measure of the health of a population and a reflection of the socio-economic conditions prevailing among a population in a particular area. It is the most widely used indicator of population health (Sharma, 2018). There exists a set of socioeconomic indicators concerning life expectancy (Cervantes *et al.* 2019). Life expectancy has significant implications for individuals and the entire aggregate human behavior, affecting fertility behavior, economic growth, human capital investment, intergenerational transfers, and even incentives for pension benefits (Jie, *et al.,* 2001; Courtney *et al.,* 2002). It also implies public finance (Granstein & Kanganovich, 2004). Alluding to the significance of life expectancy, it is very crucial to developing countries striving to achieve socio-economic progress through significant investments in the social sectors like health, education, sanitation, environmental management and sustainability, and social safety nets (Kabir, 2008). It is an important synthetic indicator for assessing the economic and social development of a country or a region (Bilas, Frank, & Bosnjak, 2014). It is the integrated survivorship of the population across all ages (Missov, 2013). With reference to Nigeria, as in other developing countries, variations in morbidity and mortality have been associated with a wide variety of measures of socioeconomic status including per capita GDP, fertility rate, adult illiteracy rate, per capita calorie intake, health care expenditure, access to potable drinking water, urban inhabitants, unemployment rate and the nominal exchange rate (Sede & Ohemeng, 2015). Although the link between life expectancy and income, for instance, has been demonstrated in several statistical studies, it is not just the aggregate increase in income that increases life expectancy at birth rate, but the reduction in poverty that results from the income growth (Biciunaite, 2014). Income growth acts positively to reduce hunger, provide accommodation in clean environments, access to healthcare, education, and healthy nutritious meals which engenders good health and longevity. Life expectancy as a measure, therefore, reflects not just the overall health or mortality of a population but also provides an insight into the social and economic conditions that interplay or exist to affect longevity within a region. It is a barometer for a healthy socio-economic system.

The cliche, that health is wealth underscores the importance of a healthy nation and the length of life (life expectancy) a nation's citizens stand to enjoy. Several factors can affect life expectancy at birth which many studies suggest could be: social, economic, biological, medical, political, and environmental (Chang *et al*., 2011; Lee *et al*., 2012; Bilas, *et al.*, 2014; Levine *et al*., 2016). These factors could also be grouped into demand-side factors and supply-side factors. Nevertheless, it is expected that the life expectancy rate for any nation should be high enough to guarantee sustainable growth and development. The third goal of the sustainable development goals is to ensure healthy lives and promote wellbeing for all ages (UNDP 2020). This goal has 13 features, all of which touches on reducing death of all types by reducing the causes of such deaths. The idea is that if people can be made to live longer, then the life expectancy rate will increase and if the life expectancy rate increases then the economy can be sustained. The sustenance of the economy is possible since people with an increased life expectancy rate can supply more of their labour services to participate in every economic opportunity. The questions this study seeks to ask is: what factors determine the life expectancy rate at birth in Nigeria? Are there more demand factors than there are supply factors as determinants? How can the life expectancy rate of Nigeria be increased? These questions are important because "the disparity in life expectancy is believed to have its roots in differential socio-economic backgrounds of different social groups [and] …one of the principal goals of every government is to

lengthen the life expectancy of its population by reducing its mortality rate to its minimum possible level" (Bilas *et al.*, 2014)

The remainder of the section of this study is structured as follows: Section 2 deals with the materials and methods which reviews the relevant literature, past and present, on the determinants of life expectancy around the globe and in Nigeria. This section also looks at the research methodology, data and estimation technique. Section 3 presents the data analysis and estimation of the results as well as the discussion of results. It also gives a summary of major findings, recommendations, and the conclusion.

Materials and Method

The concept of life expectancy refers to what the length or span of life should be. Thus, it refers to the average lifespan of individuals in a society given their peculiarities. The World Health Organization (WHO) defines life expectancy at birth as a reflection of the overall mortality level of a population. It is therefore a measure of the quality and quantity of life a person enjoys. From the literature there exist theories that explain the determinants of life expectancy from the medical perspective (Charlesworth, 2001; Rice & Fineman 2004; Christensen *et al.,* 2006; Tetz & Tetz 2018). Some theories explain how people respond to health-related issues based on their perception of the health-related threat or their socio-economic conditions. This research will examine three of these theories. First is the Health Belief Model (HBM), a model of health behavior theory. It is a psychological model that attempts to explain and predict health-seeking behaviors. The HBM was developed in the early 1950s by social scientists at the U.S. Public Health Service to understand the failure of people to adopt disease prevention strategies or screening tests for the early detection of disease (LaMorte, 2019). Thus, the social psychologists (Hochbaum, Rosenstock, & Kegels) wanted to explain why some people do not use certain health services. The model postulates that health-seeking behaviors are influenced by a persons' perception of a threat posed by a health problem and the value associated with actions aimed at reducing the threat. It provides a way to understand and predict how individuals will behave concerning their health and how they will comply with health care therapies. This model however does not explain the cause or source of the threat but addresses the relationship between a person's beliefs and behaviors towards perceived threats to their health. Thus, a person can determine how his life or health will turn out depending on his behavior towards taking necessary precautions to improve his/her health. Put simply, one's healthy state is a function of his perception and behavior to threats posed by health problems. This perception will ultimately influence the individual's behavior and determine longevity for the individual. This behavior which is informed by perception eventually determines health outcomes. Therefore, this model implies that health outcome is a function of health-seeking behaviors. The second is the theory of social suffering (Kleinman, 1997). According to him "Social suffering" takes in the human consequences of war, famine, depression, disease, torture - the whole assemblage of human problems that result from what political, economic, and institutional power does to people - and also human responses to social problems as they are influenced by those forms of power. This theory provides the framework that holds four potentially useful implications for health, 1) this theory holds that socio-economic and socio-political forces can at times cause disease as it is the case with the structural violence of deep poverty creating the conditions for diseases to flourish, become chronic and resistant to antibiotics, 2) social institutions such as healthcare bureaucracies that are developed to respond to suffering can make the suffering worse, 3) social suffering conveys the idea that the pain and suffering associated with health conditions affect caregivers and relatives as well and 4) the theory of social suffering has shown that ill health or diseases are a social problem due to its ravaging effect on the social status and behavior of the affected and the relatives/

caregivers. It has broken down the distinction between health problems and social problems in that where poverty, broken families and violence thrive there exist such hazards as depression, suicide, post-traumatic stress disorders, and drug misuse. To a great extent, this theory asserts health outcomes are a function of the level of social suffering inherent in a given society. Thirdly and lastly is the theory of Bio-power (Michel, 1990). This theory holds that where the authority uses its political power to regulate the population, it has great implications for health. As such when countries regulate the population of their citizenry, it engenders a safer environment for health such that public health is guaranteed with much ease. Thus, health outcomes are a function of government regulatory action on the population.

On the empirical lane, there are several factors adduced to affect health outcomes in general and life expectancy in particular. A study of 28 European countries to investigate the determinants of life expectancy at birth in the European Union (EU) countries from 2001 to 2011, using the Johansen cointegration test on a panel data, found that GDP per capita and level of education attained together explain between 72.6 and 82.6% of differences in life expectancy at birth among the EU countries (Bilas *et al.,* 2014). Thus, their findings show that GDP per capita is a significant determinant of life expectancy. This is certain because a high level of GDP per capita implies that people have high income that makes healthcare affordable and accessible. Also, they found that the level of education can increase life expectancy. Again this is possible because when the level of education increases the level of awareness, exposure, and consciousness that heightens the need to live better lives and take care of one's health also increases. However, population growth, GDP growth rate, and education enrolment rate had no significant effect on the life expectancy rate of the selected countries (Bilas *et al.,* 2014). Another research conducted on the socio-economic determinants of life expectancy in Nigeria, covering the period 1980 - 2011 and employing five explanatory variables namely GDP per capita, nominal exchange rate, secondary school enrollment rate, public health expenditure, and unemployment rate, found that government expenditure on health, per capita income, and education were not significant explainers of health outcomes, life expectancy in particular (Sede & Ohemeng, 2015). They used the VAR and VECM frameworks to draw their conclusions. However, not minimizing the importance of government expenditure on health, they recommended that such expenditures be made more qualitative. GDP per capita and level of education are important determinants of life expectancy to the extent that there is a positive correlation between life expectancy and GDP per capita and between life expectancy and the level of education (Bilas *et al.,* 2014; Sede & Ohemeng, 2015). A study of the socio-environmental determinants of life expectancy in 108 developing countries was carried out, covering the period 2006 - 2010 and using variables such as education (years of schooling), water coverage, sanitation facilities, health expenditure, and GDP. The technique of estimation involved pooled regression, fixed effect, and random effect models and the result showed that education and GDP were strong socio-environmental determinants of life expectancy in Nigeria (Hassan *et al.* 2017). Also, an investigation into the socioeconomic determinants of life expectancy in Iran using Iranian time series data on variables such as GDP per capita, number of doctors per 10,000 population, degree of urbanization, food availability, CO2 emission, total fertility rate, inflation rate, and literacy rate found that GDP per capita, ratio of doctors to 10,000 population, food availability, literacy rate, and total fertility are significant determinants of life expectancy in Iran (Delavari *et al.,* 2016). They applied diagnostic tests of Augmented Dickey-Fuller (ADF), Banergy, Dolado, and Master (BDM) tests, Engle-Granger causality, cointegration, and the ordinary least-square (OLS) method of estimation, using Stata version 12 software, to reach their conclusion. They concluded that to improve life expectancy in Iran, factors outside the health sector are critical. From their findings,

Delavari *et al.* also observed that GDP per capita and education (literacy level) is an integral determinant of life expectancy. This agrees with the findings of Bilas *et al.* 2014; Sede and Ohemeng, 2015. In another comparative study of the risk factors that affect or cause shorter life expectancy among 15 European countries, it was discovered that income level, education, and gender among other factors are significant risk factors causing inequality in the level of life expectancy among the selected 15 European countries (Mackenbach *et al.,* 2019). The authors obtained register-based mortality data and survey-based risk factor data for all these countries and examined them based on gender and education. The risk factors included a father with a manual occupation, low income, few social contacts, smoking, high alcohol consumption, high bodyweight, low physical exercise, and low fruit and vegetable consumption. They computed partial life expectancy for those between 35 years and 80 years based on gender and education and found that there exists a substantial gap in life expectancy between males and females and between the highly educated and those with low education. Other factors such as smoking, low income, and heavy body weight also contributed to the inequality in life expectancy between men and women within the region. They concluded that Smoking, low income, and high body weight are critical factors to consider to reduce the inequality in life expectancy in those countries. They noted that to achieve a substantial reduction of inequalities in life expectancy, strong policy action on a broad range of health determinants is required. It is worthy to note that again income and education are significant factors here, lending support to Bilas *et al.* 2014; Sede and Ohemeng, 2015; Delavari *et al.* 2019. Another study examined the relationship between socioeconomic development and life expectancy among the five accession countries (Macedonia, Serbia, Bosnia and Herzegovina, Montenegro, and Albania) in the EU. Using the aggregate times series pool data and the Full Information Maximum Likelihood (FIML) estimation method, the study found that socioeconomic development is a prerequisite for the longevity or otherwise obtained among the accession candidate countries (Miladinov, G. 2020). He used GDP per capita and infant mortality as proxies for socioeconomic development and concluded that countries with higher GDP per capita and lower infant mortality rates have higher levels of life expectancy at birth. This, according to him, explains why the countries with higher life expectancy rates have higher GDP per capita as shown in the Human Development Index (HDI) ranking. Again GDP per capita is a significant determinant of life expectancy and this agrees with the findings of Bilas *et al.* 2014; Sede and Ohemeng, 2015; Hassan *et al.* 2017; Ketenci and Murthy, 2018; Cerventes *et al.* 2019: Delavari *et al.* 2019. The link between life expectancy and economic growth has also been explored with statistical outcomes. There is two-way causation, as increased income leads to better access to health and longer life, healthy people increase their productivity leading to economic growth with more investment in health technology for more enhanced living (Gurler & Ozsoy, 2019). This does not agree with earlier findings that higher life expectancy is associated with low per capita GDP (Hansen and Lonstrup, 2015).

On the other hand, a study of the relationship between public health expenditure and health outcomes in Nigeria, using the ARDL approach found that public health expenditure was negatively related to life expectancy (Onwube *et al.,* 2019). This finding lends support to the argument that public health expenditure can be rendered insignificant when health infrastructures are largely underdeveloped, the poverty rate is high, institutional inefficiency exists and good governance is not entrenched (Bokhari, *et al.,* 2007; Rajkumar & Swaroop, 2007; Riman & Akpan, 2010; Sede & Ohemeng, 2015) but contradicts other studies (Akinkugbe & Afeikhena, 2006; Anyanwu & Erhijakpor, 2009). Overall, GDP per capita, level of education attained, institutional efficiencies, poverty reduction, government health expenditure among others are seen to improve health and contribute to increased life expectancy. Health improvement has been also

linked to other factors such as globalization and rapid economic growth (Philip, 2005). This study is aimed at investigating the factors that determine life expectancy in Nigeria

Theoretical Framework and Methodology

From the theories analyzed for this study we can deduce that the quality and quantity (length) of life a person enjoys, measured by life expectancy, is a function of three composite factors which can be categorized as behavioral, socio-economic, and political. Thus, the tripod factors of behavioral, socio-economic and political factors can combine to determine the life expectancy rate. However, for this research, we will concentrate on the socio-economic and political factors since we are not able to proxy the behavioral factors. A model of this relationship can be expressed mathematically in the form

$$lifE = f(sce, pol) \quad \ldots\ldots\ldots\ldots (1)$$

Where *lifE* = life expectancy; *sce* = socio-economic factors; *pol* = political factors

The socio-economic factors can be situated at the individual level to assess the average quality and quantity of life lived by people. The socio-economic factors might include income level, employment status, macroeconomic variables such as inflation, imports, real GDP, and exchange rate among others. The effect of the socio-economic factors will be reflected on the expenditure pattern of the individuals of the society. At the government or political level, life expectancy is influenced by the extent to which the government can use its powers to harness the resources of the state, put them to good use by providing basic social services of health, education, and security. It also includes protecting members of society from external aggression socially and economically. The level of health outcomes in society, therefore, becomes a function of the overall government expenditure (health expenditure inclusive). Equation (1) can, therefore, be disaggregated and expressed in the linear regression form following the pattern of Bilas *et al.* (2014), but with a departure in the technique of estimation, the period of study, and the variables applied. The period of study is 1980 to 2017 while the sample area is Nigeria, using data on selected variables as explained in Table 1. This period was chosen to allow for a more robust result and proper analysis. The variables were equally selected in line with theory and in harmony with earlier research. Equation (1) can be expressed to capture all the expected explanatory variables as indicated in Equations (2) below:

$$lifE = f(rgdppc, \inf r, imp, hc \exp, gc \exp, exr) \quad \ldots\ldots. (2)$$

In the simple mathematical form, Equation (2) is expressed as shown in Equation (3) below:

$$\ln lifE = \beta_0 + \beta_1 \ln RGDPPC + \beta_2 \inf r + \beta_3 \ln import + \beta_4 \ln HCexp + \beta_5 GCexp + \beta_6 EXR \quad \ldots\ldots\ldots\ldots (3)$$

The explicit econometric expression of Equation (3) is given in Equation (4) below:

$$\ln lifE = \beta_0 + \beta_1 \ln RGDPPC - \beta_2 \inf r - \beta_3 \ln import + \beta_4 \ln HCexp + \beta_5 GCexp + \beta_6 EXR + \varepsilon_i \quad \ldots\ldots\ldots\ldots (4)$$

Equation (2) is the decomposition of Equation (1) expressed in the functional form which tells us that life expectancy is a function of multiple variables such as real GDP, inflation, imports, household consumption expenditure pattern, government consumption expenditure, and exchange rate. Equation (3) is the mathematical form expressed as a linear regression model. To estimate our model, equation (3) must be transformed and expressed in the econometric form indicating the stochastic term. Equation (4) is the model to be estimated having expressed it in the indeterministic form, and "ln" indicates variables in the natural log form. The explanatory variables are stated with their a priori expected signs. Thus, we expect that real GDP, household consumption expenditure, government consumption expenditure and exchange rate will turn out with positive relationships while inflation and imports will turn out with negative relationships.

The variables are defined in Table 1, below.

Table 1: Variable definition, data sources, and descriptive statistics

Variable	Definition
LifE	Life expectancy at birth, total (years)
Rgdppc	GDP per capita (constant 2010 US$)
Infr	Inflation rate, consumer prices (annual %)
Imports	Imports of goods and services (per capita constant 2010 US$)
HCExp	Household final consumption expenditure (per capita constant 2010 US$)
GCExp	General government final consumption expenditure (Per capita constant 2010 US$)
EXR	Official exchange rate (LCU per US$, period average)

Data Source: World Development Indicators, World Bank.

The model adopted for this study is the autoregressive distributed lag (ARDL) or Bounds testing approach to co-integration, proposed by Pesaran *et al*. (2001) to investigate the log-linear models. Studies have shown that the ARDL approach offers some desirable statistical advantages over other co-integration techniques. While other co-integration techniques require all the variables to be integrated of the same order, ARDL test procedure provides valid results whether the variables are integrated at order zero i.e [I(0)] or integrated at order one i.e [I(1)] or mutually co-integrated. It also allows for simultaneous testing of the long and short-run relationships between the variables in a time series model and provides very efficient and consistent test results in small and large sample sizes (see Pesaran *et al*., 2001). The ARDL model is shown below:

$$\Delta y_t = \beta_0 + \varphi y_{t-1} + \delta x_{t-1} + \sum_{i=1}^{p} \pi_i \Delta y_{t-i} + \sum_{j=0}^{q} \gamma_j \Delta x_{t-j} + \emptyset v_t + u_t \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (5)$$

Where β_0 is the drift; φy and δx are long run multipliers; lagged values of Δy_t (Δy_{t-i}),current and lagged values of Δx_t are the short run dynamics; v_t is the vector of explanatory variables; Δ indicates series first difference and u_t is the error term. The presence of long-run cointegration can be examined by the Wald test (F-test) which was proposed by Pesaran *et al.* (2001). The Wald test's null hypothesis of no cointegration between the selected variables is accepted if $\rho = \beta = 0$. To this end, the Wald test provides the calculated F-statistic which will be compared with the upper and lower critical bounds. If the F-statistic of the Wald test is greater than the upper bound, we reject the null hypothesis and confirm the presence of a long-run relationship between y_t and the explanatory variables.

Results and Discussions

Before the estimation, the unit root test of stationarity is carried out and the result is presented in Table 2.

The result shows that some of the selected variables are stationary at level; that is I(0) while some are stationary at the first difference,

that is I(1). This informed the adoption of the ARDL estimation technique. The result of the ARDL bounds test to co-integration is reported in Table 3.

The result in Table 3 indicates rejection of the null hypothesis of no long-run relationships as the F-statistic values of 46.55 is greater than the critical upper (I1) bounds value of 3.28 at a 5% level of significance. That means there exists a long-run relationship between life expectancy and the composite explanatory variables. The ARDL short-run and long-run results are presented in Table 4.

From the estimated result in Table 4, Real GDP per capita (RGDPPC) showed a positive relationship; as a unit increase in Rgdppc raises life expectancy by 0.0005% and 0.10% in both periods respectively indicating that economies that experience real growth will have high life expectancy rates. This finding agrees with that of others (Bilas *et al.,* 2014; Sede & Ohemeng, 2015). However, real growth is very slow and insignificant in the short-run for Nigeria, which explains why the country's life expectancy rate at birth is relatively poor. Also, inflation is inversely related to life expectancy as a unit increase in inflation reduces life expectancy

Table 2: Augmented Dickey-Fuller unit root test of stationarity result

Variables	At level	At First Difference	Result
	t-Statistic	t-Statistic	
LifE	-1.1206 [1]	-4.0170 [1] ***	I(1)
Rgdppc	-0.8520 [2]**	-3.7667 [0] ***	I(0)
Infr	-3.2986[0]*	-5.9064[0] ***	I(0)
Imports	-2.7195[0]	-4.9278[0] ***	I(1)
HCExp	-1.1569[0]	-6.6952[0] ***	I(1)
GCExp	-0.8747[0]	-6.0988[0] ***	I(1)
EXR	-1.8805[0]	-5.1135[0] ***	I(1)

Source: Computed by the authors using eviews
Note: Lag length in [ ]. *, ** and *** indicates significance at 1%, 5% and 10% respectively.

Table 3: Result of ARDL bounds test to cointegration

F-Bounds Test		Null Hypothesis: No Levels Relationship		
Test Statistic	Value	Signif.	I(0)	I(1)
			Asymptotic: n=1000	
F-statistic	46.55082	10%	1.99	2.94
k	6	5%	2.27	3.28
		2.5%	2.55	3.61
		1%	2.88	3.99
Actual Sample Size	35		Finite Sample: n=35	
		10%	2.254	3.388
		5%	2.685	3.96
		1%	3.713	5.326

Source: Computed by the authors using eviews

Table 4: ARDL short run and long run results (dependent variable: LifE)

	Short-run	**Result**		
Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(lnLifE(-1))	1.291637	0.039209	32.942602	0.0000
D(lnLifE(-2))	-0.248271	0.042109	-5.895873	0.0001
D(lnRgdppc)	0.000528	0.000383	1.379849	0.1928
D(lnInfr)	-0.000286	0.000022	-12.726569	0.0000
D(lnInfr(-1))	0.000277	0.000022	12.741392	0.0000
D(lnInfr(-2))	0.000110	0.000017	6.684846	0.0000
D(lnImport)	-0.000709	0.000058	-12.161586	0.0000
D(lnImport(-1))	0.000098	0.000055	1.779097	0.1005
D(lnHCExp)	-0.000051	0.000103	-0.495160	0.6294
D(lnHCExp(-1))	-0.000211	0.000091	-2.312701	0.0393
D(lnGCExp)	-0.000186	0.000029	-6.511154	0.0000
D(lnGCExp(-1))	0.000091	0.000033	2.767177	0.0171
D(lnEXR)	-0.000366	0.000042	-8.725452	0.0000
D(lnEXR(-1))	-0.000655	0.000055	-11.919435	0.0000
CointEq(-1)	-0.020116	0.001041	-19.329870	0.0000
	Long run	result		
Variable	Coefficient	Std. Error	t-Statistic	Prob.
lnRgdppc	0.100954	0.023056	4.378582	0.0009
lninfr	-0.034493	0.005914	-5.832961	0.0001
lnimport	-0.068840	0.004762	-14.455056	0.0000
lnHCE	0.021552	0.014641	1.472108	0.1667
lnGCE	-0.024102	0.005043	-4.779458	0.0004
lnEXR	0.017021	0.002713	6.273139	0.0000
C	3.487327	0.119951	29.072964	0.0000
R-squared	0.999993	F-statistic	228913.2	
Adjusted R-squared	0.999989	Prob(F-statistic)	0.000000	
Durbin-Watson stat	1.958593			

Source: Computed by the authors using eviews

by 0.0002% and 0.03% in both periods respectively; implying that a high inflation rate leads to low life expectancy at birth. This is also a grim reality for Nigeria as inflation continues to rise, reducing the value of money and making the cost of living very high. This has negative implications for the life expectancy rate since it will make health care services unaffordable for the majority of Nigerians who are very poor. Household consumption expenditure (HCExp) representing the average consumption level and pattern of a family is negatively related to life expectancy at birth in the short-run but positively related in the long-run. Numerically, a unit increase in HCExp reduces life expectancy by 0.00005% and 0.0002% at the current and previous period (lag 1) respectively but raises life expectancy by 0.02% in the long-run. This means that families that earn a reasonably high income and spend such income to provide

its essential needs will have a higher life expectancy at birth in the long-run. Although the relationship is weak, it underscores the need for household income levels to be reasonably high to guarantee a pattern of consumption that satisfies the basic needs of health, food, shelter, clothing, and education among others. Concerning exchange rate, the result showed that there exists a negative relationship between exchange rate and life expectancy at birth in the short-run and a positive relationship in the long-run. This means that, in the short run, as the exchange rate continues to rise, life expectancy continues to fall. A unit increase in EXR reduces life expectancy by 0.0003% and 0.0006% at current and previous periods (lag 1) respectively. This short-run negative relationship agrees with other findings that the two immediate past periods of the exchange rate and unemployment affected life expectancy at birth negatively (Sede & Ohemeng, 2015). Again, since Nigeria is an import-dependent economy, depending on the rest of the world for her needs, including health care, it will be increasingly expensive for Nigerians to afford their health needs in the short run in addition to the widespread poverty. However, in the long run, the exchange rate takes a positive value to imply that a higher exchange rate will lead to higher life expectancy at birth. Thus, a unit increase in EXR increases life expectancy by 0.01% in the long-run. From the result, we also observed that imports in the long-run and current imports in the short-run are inversely related to life expectancy at birth though it made an insignificant positive impact at lag 1 in the short-run. A unit increase in imports reduces life expectancy by 0.0007% and 0.068% in the current short-run and long-run respectively but raises life expectancy by 0.00009% at lag 1 in the short-run. This suggests that the higher the level of the country's imports, the lower the life expectancy at birth. Nigeria has a history of importing all sorts of items that have slowed the pace of industrial and economic growth and thereby reduced the rate of life expectancy at birth. On the other hand, government consumption expenditure (GCExp), a proxy for government health expenditure, is negatively related to life expectancy rate at birth in the current short-run and long-run respectively but positively related to life expectancy at lag 1 in the short-run. A unit increase in GCExp reduces life expectancy by 0.0005% and 0.02% in the current short-run and long-run periods respectively but raises life expectancy by 0.00009% at lag 1 in the short-run. This is the only variable that did not conform to *a priori* expectation. However, it is very possible that while government expenditure increases, life expectancy will be very low. This can happen where more than 2/3 of the government budget is spent on recurrent expenditure and non-productive projects. This will negatively impact the health outcomes of the country as is the reality with Nigeria today. The results further show that the short-run lagged values of life expectancy (lag 1 and lag 2) impacted significantly both positively and negatively respectively on the current value of life expectancy. The error correction term, which shows the speed at which life expectancy adjusts from short-run disequilibrium to long-run and vice versa, is negative and significant. It shows that 0.02 (20%) of the disequilibrium is corrected annually. The R^2 of 0.99 indicates that the explanatory variables of the model jointly explain 99% changes in Life expectancy whereas the F-statistic probability value of 0.000000 shows that the overall model is significant in determining life expectancy in Nigeria.

Diagnostic Tests

The results of the diagnostic tests which include a test of serial correlation, heteroskedasticity, normality, and CUSUM and CUSUM of Squares test of stability are presented in this sub-section as follows:

Test of Serial Correlation and Heteroskedasticity

Table 5 shows tests of serial correlation and heteroskedasticity results. The results indicate the absence of serial correlation and heteroskedasticity as the probability values of both tests are greater than 0.05 (or 5%).

Test of Normality and Stability

Figure 1 shows the result of the normality test which shows whether the residual of the model is normally distributed. We notice that for a normally distributed observation, the skewness should be zero and the kurtosis should be equal to three. These are all true for the estimated model (skewness = 0.25, kurtosis = 3.40) indicating that the residuals of the estimated model are normally distributed and their mean value is a true representation of the population. The Jarque-Bera statistic of 0.60 also confirms the normality of the residuals since the computed statistic is very much close to zero. Besides, the probability of obtaining a Jarque-Bera statistic as high as 0.60 is 74%. Therefore, the null hypothesis that the residuals of the model are normally distributed cannot be rejected. On the other hand, Figure 2 shows the parameter stability test using the CUSUM and CUSUM Square criteria. The figure shows that the parameter estimates are stable and the model can be relied upon when interpreted for policy. This conclusion is drawn from the fact that.

Conclusion and Recommendations

Using ARDL bounds testing approach and annual time series data for the period 1981 – 2017, this study investigates the determinants of life expectancy in Nigeria. The Augmented Dickey-Fuller (ADF) unit root test indicates that some variables are integrated of order 1 [I(1)] while others are integrated at order zero [I(0)].

Table 5: Tests of serial correlation and heteroskedasticity results

Breusch-Godfrey Serial Correlation LM Test			
F-statistic	0.007144	Prob. F	0.9335
Obs*R-squared	0.012498	Prob. Chi-Square	0.9110
Heteroskedasticity test: Arch			
F-statistic	0.134671	Prob. F	0.7161
Obs*R-squared	0.142739	Prob. Chi-Square	0.7056

Source: Computed by the authors using eviews.

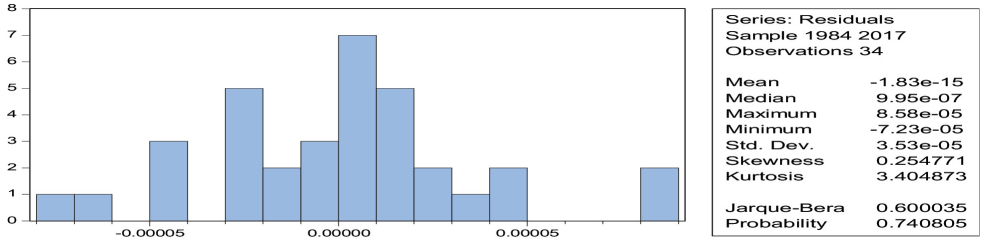

Figure 1: Jarque-Bera normality test

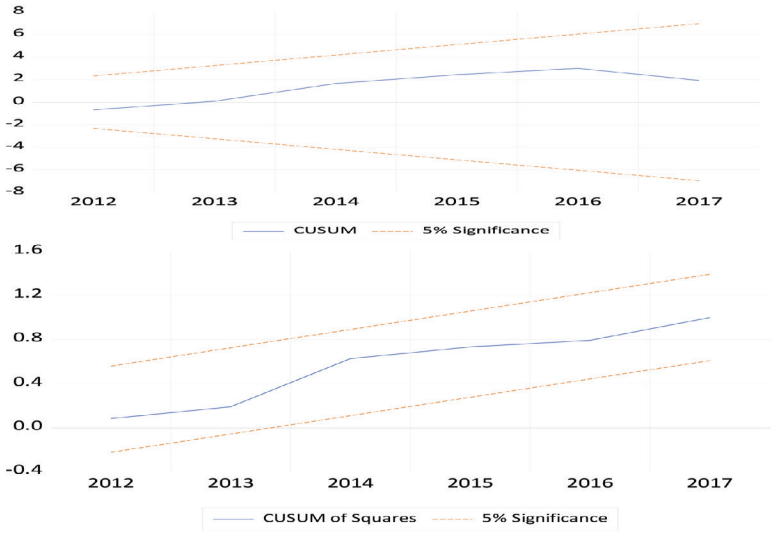

Figure 2: CUSUM and CUSUM of squares tests of stability

The bounds test to co-integration result provides evidence of a long-run relationship between the variables. The short-run results reveal that RGDPPC, Infr (at lags 1 and 2), Imports (at lag 1), and GCExp (at lag 1) are positively related to life expectancy whereas current Infr, current Imports, current HCExp, previous HCExp (i.e. HCExp at lag 1), current GCExp, current EXR and EXR at lag 1 are inversely related to life expectancy. The long-run results indicate that while RGDPPC, HCExp, and EXR impacted positively on life expectancy, Infr, Imports and GCExp impacted negatively on life expectancy. The study, therefore, concludes that life expectancy inertia, RGDPPC, Infr, Imports, HCExp, GCExp, and EXR are significant determinants of life expectancy in Nigeria. Following this conclusion and the major findings from the study the following recommendations are made:

i) Since real GDP per capita is positively related to life expectancy in Nigeria, priority must be given to the fundamentals of GDP growth which will translate into increased income per capita that will enhance individual's access to and affordability of basic needs including health needs. This implies that emphasis is placed on real growth as against nominal growth.

ii) To achieve a high life expectancy at birth in Nigeria, the macroeconomic variables of the Exchange rate and inflation must be checked via implementable fiscal and monetary policies designed to regulate the volatility in the exchange rate and to peg inflation at a low single-digit to avoid its corrosive effect on the value of income, prices, output, employment, and the overall living standard.

iii) The Nigerian government must restrict imports of non-essentials and pave the way for the adoption of an import substitution strategy.

iv) To achieve a high level of life expectancy at birth, government consumption expenditure must be restructured to allow for more capital expenditures as against the current trend of 2/3 recurrent expenditure of the budget and must be designed to support the nation's infrastructural development gap in health, education, power, roads, communication, and other basic amenities. Such expenditures must be transparent, inclusive, and holistic.

Conclusively, the study agrees with the findings of others (Bilas *et al.,* 2014; Sede & Ohemeng, 2015), to posit that real GDP per capita is a strong positive determinant of life expectancy. The exchange rate impacts negatively on life expectancy in the short run but turns positive in the long run which agrees with Sede and Ohemeng, 2015. As composite factors, government expenditure, household consumption expenditure, Imports, inflation, and exchange rate all determine life expectancy in Nigeria both in the short and long run. Thus, the monetary and fiscal authority must work unanimously to guarantee a high level of life expectancy at birth. This research is limited by the fact that the variables employed for the analysis are socio-economic variables only and does not consider the behavioral attributes of individuals. A more comprehensive study will include behavioral and biological factors to fully capture the determinants of life expectancy in Nigeria. However, beyond the findings of Bilas *et al.,* 2014; Sede and Ohemeng, 2015, this research has shown that external factors such as imports can impact life expectancy which has a composite determining factor. Imports can impact life expectancy in various ways. It can impact directly through the effect of imported consumption items (food, drug, etc.) on longevity. Or via the cost implication of obtaining such imported goods domestically, when it carts away money that will be used for other needs. A detailed study of the transmission mechanism of the impact of imports on life expectancy is yet another limitation of this study and could be a basis for future research.

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