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Longevity in Nigeria: What and what Really Matters?

Adedayo Oluseun Adedeji
Department of Economics, Accounting and Finance, Bells University of Technology, Ota, Nigeria
Email: dayose2002@gmail.com

Abstract
Studies have shown that improvement in longevity would spur labour productivity, income, savings and economic growth. Therefore, the effort to sustain and further raise the growth of Nigerian economy needed not to overlook the possible gains from rising longevity. This study investigated the determinants of average longevity of Nigerians using secondary data spanning from 1995 to 2012. Adopting the Augmented Dickey-Fuller (ADF) unit root test and Error-Correction Modelling (ECM) technique, the results revealed that increase in food availability, basic education enrolments, access to sanitation facilities and improved water sources promoted longevity, while carbon dioxide (CO_2) emission cut longevity short. Population density also had positive effect on longevity, but not statistically significant. Thus, environmental policy aimed at reducing the emission of CO_2 will be of vital value in promoting longevity. Also, efforts of both the public and private sectors toward advancement in universal basic education, food production, provision of more sanitation facilities and making subsidised qualitative healthcare services accessible to the very poor and low income earners, are highly required.
Keywords: longevity, Nigeria, determinants, unit root test, error-correction model

1. Introduction

Human health is as important as the existence of human race and how long an individual can live is a function of many influences. Longevity[1], the extent of survival or how long an individual is expected to live, given that the prevailing health condition persisted, varies across individuals. Similarly, average longevity varies across countries, regions and continents due to a number of social, economic and environmental factors. Although, empirical studies have shown that improvement in longevity have associated benefits in spurring labour productivity (Knowles and Owen, 1997; Rivera and Currais, 1999 and Adedeji, 2014), income (Chakraborty, 2004), savings (Bloom *et al*, 2002) and growth of the economy (Arora, 2001; Aghion, Howitt and Murtin, 2010), what composition of socioeconomic and environmental factors are required to improve the degree of longevity, is still under debate.

The few empirical studies that examined the determinants of longevity are with mixed results, thus giving room for further investigation. For instance, the study by Shaw *et al* (2005) on the analysis of determinants of longevity for 29 developed countries (that is, OECD countries; Organisation for Economic Cooperation and Development), using ordinary least square (OLS) and residual maximum likelihood in estimating mixed model with countries random effect, found pharmaceutical consumption, reduction in tobacco consumption, and increase in fruit and vegetable consumption to be positively associated with longevity. While the study by Bilas, Franc and Bosnjak (2014) on 28 European Union Countries using panel data that spanned between 2001 and 2011, found that Gross Domestic Product (GDP) per capita and the attained level of education explained the bulk of differences in longevity.

Similarly, Lin *et al* (2012) investigated the contribution of political and socioeconomic factors to the increase in longevity in 119 Less Developed Countries (LDCs) using data from 1970 to 2007. Adopting linear mixed model, the study found that democratic politics had relatively small positive effect on longevity compared to economic growth, educational environment and nutritional status. Also, Bayati, Akbarian and Kavosi (2013) estimated a health production function for East Mediterranean Region using Grossman theoretical model. The study used panel data spanning from 1995 to 2007 for 21 countries and adopted fixed-effect-model. The authors found that income per capita, education index, food availability, level of urbanization and employment ratio influenced longevity. The study by Kabir (2008) examined the determinants of longevity in 91 developing countries, using multiple regression and probit framework for data analysis. He found none of per capita income, education, health expenditure, access to safe water and urbanization to be statistically significant.

Furthermore, Fayissa and Gutema (2005) examined the determinants of longevity in sub-Saharan Africa (SSA) using Grossman (1972) theoretical model. Applying the two-way random-effect model with data spanning from 1990 to 2000 for a cross-section of 33 SSA countries, the study found decrease in illiteracy rate and increase in food availability to be associated positively with longevity. In another study carried out by Jaba, Balan and Robu (2014), the relationship between longevity and health expenditures was examined using panel data that spanned between 1995 and 2010 for 175 countries. The findings from the work highlighted a

[1] Longevity in this study is life expectancy at birth. Most empirical studies reviewed discussed life expectancy at birth which is reffered to as longevity in this work. In some studies it was examined as health, health status or health outcome.

statistically significant relationship between health expenditure and longevity. The authors further found country-specific effects to be statistically significant, revealing the existence of vital differences among countries of the world. In a country-specific study by Halicioglu (2010), the determinants of longevity in Turkey were investigated. Using secondary data that spanned between 1965 and 2005 and adopting Autoregressive Distributed Lagged (ARDL) method for data analysis, the study found that food availability and health expenditure positively associated with longevity, while smoking negatively influenced longevity.

From the literature, it is evident that there are variations in the findings, suggesting that the factors that matter to improve longevity in the developed countries might not count for developing countries. Besides, their choices of socioeconomic and environmental factors vary and with different interpretations. Also, most of the empirical studies are cross-country focused (Shaw *et al,* 2005; Fayissa and Gutema, 2005; Kabir, 2008; Lin *et al,* 2012; Bayati, Akbarian and Kavosi, 2013; Bilas, Franc and Bosnjak, 2014; and Jaba, Balan and Robu, 2014) which could not account for the uniqueness in the effects of the identified factors on longevity in each country. Thus, formulating appropriate and workable country-specific policy will necessitate country-specific studies as buttressed by Jaba, Balan and Robu (2014). Although, there are country-specific studies of which the study on Turkey by Halicioglu (2010) is one, a study that examined the socioeconomic and environmental determinants of average longevity of Nigerians is sparse, hence this study.

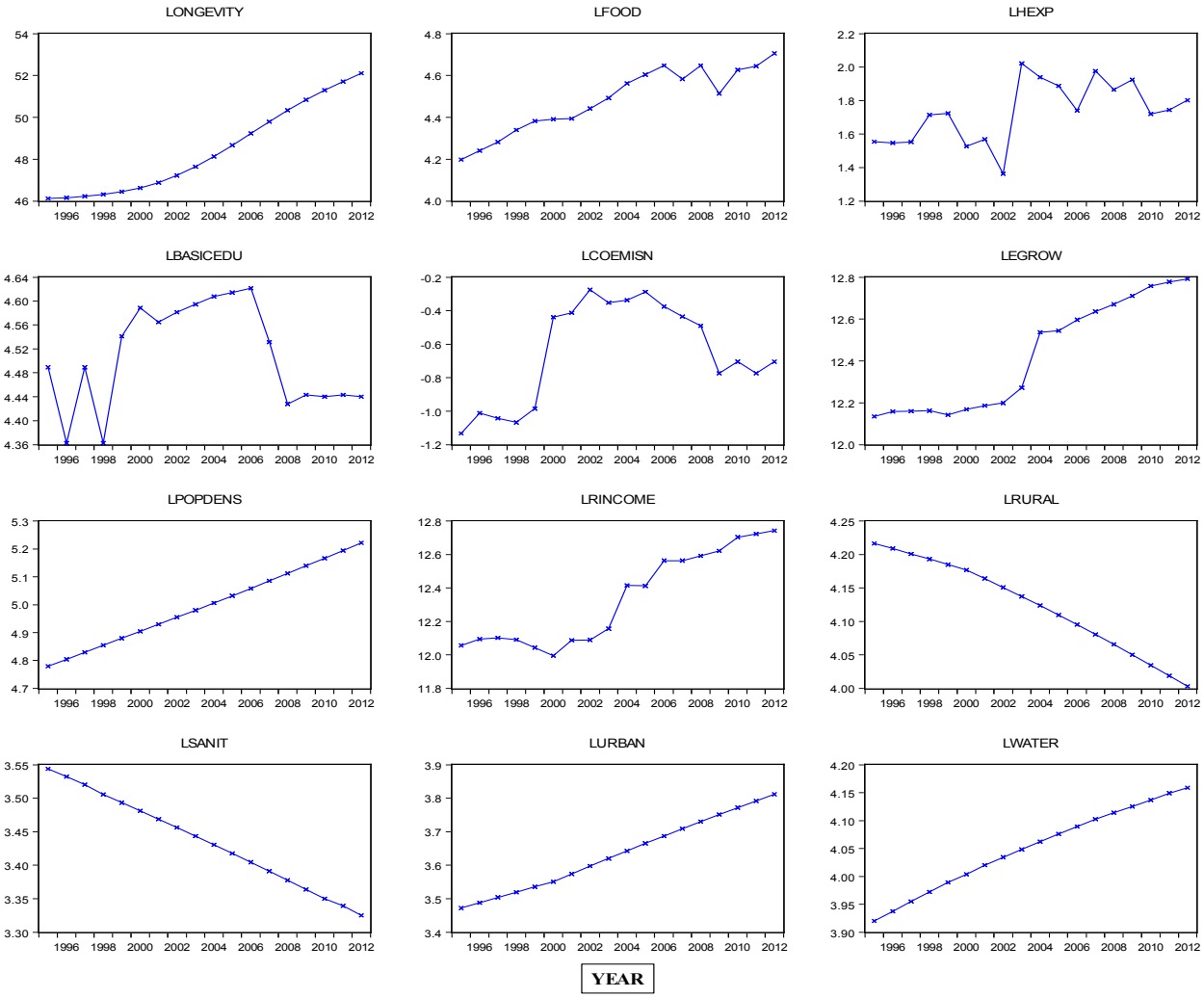
In addition, this study employed more possible factors, like population density and basic education (primary schooling), which have not been investigated in other studies, but may be vital due to the nature of Nigerian culture and settlements. In the Nigerian culture, for instance, communal effort and neighbourhood relationships are encouraged. In the process of interacting, basic and traditional knowledge are spilled-over about healthy living which is capable of improving longevity. Also, in compliance with the Millenium Development Goals (MDGs), Nigeria implemented the Universal Basic Education (UBE) policy which has led to increase in primary school gross enrollment ratio over the years (WDI, 2014). Then, has the increase in primary schooling significantly influenced longevity in Nigeria?

In addition to this introduction section, sections 2 and 3 present a brief overview of longevity, socioeconomic and environmental factors, and methodology adopted in this study respectively. In sections 4 and 5, the empirical results, conclusion and policy recommendations are discussed.

2. A Brief Overview of Longevity, Socioeconomic and Environmental Factors in Nigeria

Nigeria is a country endowed with both material and human resources. However, the resources required to sustain and improve the health status of over 150 million people appear to be a challenge. However, with the National Health Insurance Scheme and the contributory effort of the private sector and international organization, and the activities of the three tiers of government towards improving the health and longevity of Nigerians, seems to be yielding. Figure 1 shows that, longevity rose slightly from 46 years in 1995 to about 47 years in 2002, after which it steadily and sharply rose to 52 years in 2012.

Although rising, the average longevity of Nigerians compares low with some other countries in sub-Saharan Africa (SSA). For instance, longevity in 2012 for countries like Namibia, Gabon, Rwanda and Senegal was 63 years, while that of Benin Republic and Cape Verde were 59 and 75 years respectively (WDI, 2014). Then, considering some socioeconomic and environmental factors that can influence the degree of longevity in Nigeria may lend some wisdom for policy and research purposes.



NB: *LFOOD*=food availability, *LHEXP*=total health expenditure, *LCOEMISN*=carbon dioxide emission, *LSANIT*=percentage of the population with access to sanitation facilities, *LPOPDENS*=population density, *LURBAN*=population of urban centres, *LRURAL*=population of rural settlement, *LBASICEDU*=primary school enrolment rate, *LEGROW*=economic growth, *LRINCOME*=gross national income, *LWATER*=percentage of the population that can access clean/ treated water.

Figure 1: Trend of Longevity and its possible Determinant Factors in Nigeria

Looking further into the nature of trends of the selected socioeconomic and environmental factors as shown in Figure 1, the population density (*LPOPDENS*) was rising, the percentage of the population that could gain access to sanitation facilities kept falling, thus opening up the possibilities of diseases outbreak and death, and thereby negatively affecting the average longevity.

Similarly, the ever growing population of urban centres (*LURBAN*) at the expense of rural settlement (*LRURAL*) appeared not to be favoured by the highly unstable and relatively downward trended total health expenditure. This is an indication of inadequate provision of both preventive and curative health services and family planning, and the emergency aid designated for health. This seems to be the situation among the SSA countries at large (Fayissa and Gutema, 2005).

However, the universal basic education policy appeared to have lead to a substantial rise in primary school enrolment rate (*LBASICEDU*) between the year 2000 and 2005. The Nigerian growing economy (*LEGROW*) and the rising income (*LRINCOME*) was supported by increasing food availability (*LFOOD*) and the percentage of the population that can access clean/ treated water (*LWATER*). One of the side-effect of a growing population is increase in carbon dioxide emission which was the major cause of global warming and climate change. This is capable of leading to extension in the ranges of disease vectors. All these have implications for longevity.

3. Research Methodology

3.1 Model Specification

To determine the major factors that influenced longevity in Nigeria, a health production function in which longevity is endogenized is formulated taking after the work of Halicioglu (2010). This modelling approach was also used by Shaw *et al* (2005), Fayissa and Gutema (2005) and Kabir (2008). The modelling method originally came up from Grossman (1972) theoretical model which treated social, economic and environmental factors as inputs of the production system. The major advantage of estimating an aggregate health production function is that, the estimates effect of various inputs into longevity can be obtained (Thornton, 2002; and Fayissa and Gutema, 2005).

In addition, studies have found some factors relevant in explaining the changes in human health which may have implications for longevity Some of these factors include improved nutrition/food availability (Fayissa and Gutema, 2005; and Halicioglu, 2010), access to clean water and sanitation (Gulis, 2000; and Cultler and Miller, 2005), urban/rural area (Kabir, 2008), education (Fayissa and Gutema, 2005; and Riscci and Zachariadis, 2007) and GDP per capita (Canning, 2010). The variables highlighted are either classified as social, economic and environmental factors. The model assumed constant returns to each factor. It is implicitly specified as follows;

$$LONG_t = f(X_t, Y_t, Z_t) \quad \ldots\ldots 1$$

Where *LONG* = longevity; life expectancy at birth

X = social factor; education (*BASICEDU*) was measured by gross primary school enrolment. This will reflect the longevity implication of Universal Basic Education (UBE) for Nigeria;

Y = vector of economic factors; real income (*RINCOME*) or per capita GDP (*EGROW*), health expenditure (*HEXP*) and food availability (*FOOD*);

Z = vector of environmental factors; urbanization (*URBAN*), rural population (*RURAL),* carbon dioxide emission (*COEMISN*), access to clean water (*WATER*), population density (*POPDENS*) and sanitation (*SANIT*)

t = periods of time.

Explicitly, equation 1 could be stated thus;

$$LONG_t = X_t^a Y_t^b Z_t^c, \qquad such\ that\ a + b + c = 1 \quad \ldots\ldots 2$$

Where *a, b* and *c* are vectors of parameters for social, economic and environmental factors respectively. By linearizing equation 2 using natural logarithm, we have;

$$\ln LONG_t = w + a \ln X_t + b \ln Y_t + c \ln Z_t + e_t \quad \ldots\ldots 3$$

Where *t* is the time period, e_t is serially uncorrelated error term and *w* is the intercept. Inserting all the variables in equation 3, we then obtain;

$$LONGEVITY_t = \omega + a_1 BASICEDU_t + b_1 RINCOME_t + + b_2 EGROW_t + b_3 HEXP_t + b_4 FOOD_t + c_1 URBAN_t + c_2 RURAL_t + c_3 COEMISN_t + c_4 WATER_t + c_5 POPDENS_t + c_6 SANIT_t + e_t \quad \ldots\ldots 4$$

All variables are in natural logarithm form and Table 1 shows the apriori expectation, which is the theoretical/conceptual position on the expected impact of the exogenous variables on the endogenized longevity. To give more information on the expected nature of relationship of the regressors with endogenized longevity, the factors are categorized as follow;

Environmental Factors:

Urbanization: In the case of urbanization, the sign can be positive due to the concentration of infrastructure like health facilities, educational institutions, and better roads among others in urban centre or negative due to pollution, congestion and other associated problem of overcrowding.

Rural population: This is expected to impact negatively on longevity. This is because most of the rural settlements in Nigeria lack qualitative health and educational institutions with their required facilities. Most of the roads are not tarred, the villages are not electrified and the few with electrification are not having regular electricity supply.

Access to clean/treated water and sanitation facilities: The percentage of the population that have access to clean or treated water will likely reflect on the population health outcomes. Similarly, the percentage of people that have access to adequate excreta disposal facilities, such that human, animal, and insect are prevented from contacting with excreta will erase the possibility of diseases outbreak which is capable of cutting the life span short. Thus, as the percentage of the population that gained access to clean water and sanitation facilities increase, the tendency for the outbreak of disease will reduce and average longevity will increase.

The density of the population: The density of the population describes the pattern of settlement of the people on land area per square kilometre of a country. The involvement of population density stem from the fact that as the population grows, the rate of settlement of households on land area will increase. Overtime, this may lead to congestion, inadequate infrastructure and food shortage, therefore, negatively impacting on longevity. On the other hand, due to cultural ties among Nigerians, offering local assistance to sick neighbour to recover may result

to positive influence of population density on longevity.

Carbon dioxide emission: Carbon dioxide emission build-up causes global warming and, consequently, climate change. Climate Change is the increase in the average temperature of the earth's surface air and oceans. Thus, carbon dioxide is the main cause of climate change. While every living thing produces CO_2 naturally, human activities, combustion of fossil fuels and deforestation, have caused the concentration of atmospheric carbon dioxide to increase by about 35%[1]. It is expected that global warming exacerbate the intensity of extreme weather events, and affect the amount and pattern of global precipitation, changes in agricultural yields, trade routes, glacier retreat, species extinctions and extension in the ranges of disease vectors, capable of cutting longevity short.

Economic Factors

Food availability: The need for food cannot be overemphasised. The availability of nutritious edible food, especially in developing countries and particularly in Nigeria, will be of vital ingredient for healthy living and prolonged life span. Thus, food availability is expected to impact positively on longevity.

The growth of the economy: Increase in the volume of Gross Domestic Product (GDP) per capita implies the rise in availability of services, agricultural produce, manufactured goods among others, which are capable of increasing the standard of living and consequently, promote longevity. On the contrary, increase in the volume of economic activities of the people will increase the carbon dioxide emission rate, translate into global warming and its vices, thereby impeding longevity. Hence, economic growth can impact either positively or negatively on longevity.

Income level: High income earners are in better position to afford quality health care services as it is usually expensive for a low income earner. Similarly, high income earning country will be able to provide the required equipment, personnel and environment for qualitative health care services delivery at a subsidised rate to the public. This will promote the degree of longevity. Hence, positive impact is expected with increase in income level.

Health expenditure: Health expenditure is the sum of public and private health expenditures taken as a ratio of total population. It covers the provision of health services (preventive and curative), family planning activities, nutrition activities, and emergency aid designated for health. This does not include provision of water and sanitation. It is expected to positively impact on longevity.

Social Factor

Basic education: It has been popularly identified in the literature both theoretically and empirically, that education is a necessary resource for higher productivity and increased income earning. Therefore, with high income, payment for qualitative healthcare will be affordable. Also, it is expected that an educated person will be hygienic and value a neat environment. All these are capable of positively influencing longevity. Thus, basic education is expected to positively influence longevity.

Table 1: Apriori Expectation of the Impact of Exogenous variables on Longevity

LONGEVITY	*COEMISN* (-)	*HEXP* (+)	*EGROW* (+ or -)
	RURAL (-)	*POPDENS* (+ or -)	*RINCOME* (+)
	FOOD (+)	*WATER* (+)	*SANIT* (+)
	BASICEDU (+)	*URBAN* (+ or -)	

NB: All the variables are as described earlier and the signs in parentheses represent the apriori expectation relative to longevity

3.2 Method of Analysis

The first step before the specified model can be estimated is to examine the stationary or otherwise of the data. This is done by testing for the existence of unit root process in the series of each variable of interest. There are numerous unit root tests techniques, but the Augmented Dickey-Fuller version is popularly used in empirical studies in economics. If the data for the variables are stationary at levels, then the variables are integrated of order zero, I(0), and we can adopt the ordinary least square (OLS) method as the estimation technique. On the other hand, if variables are integrated of order one, I(1), testing for the existence of long-run in the relationship between the dependent variable and the Regressors become inevitable. In this kind of study in which determining the determinants of longevity is the focus, the Error-Correction Modelling (ECM) procedure can be followed if the variables are not of the same order of integration (see Nwachukwu and Egwaikhide, 2007)

1 This information was obtained from UNIGLOBE webpage. This is a brief report on the effect of carbon dioxide emission. http://www.uniglobetravel.mu/AccessCorporateTravel/GreenTravel/CO_2EmissionsEffects.aspx

3.3 Data Measurement and Sources

The data for this work are sourced from World Development Indicators (WDI) online database[1] published by World Bank organization and accessed in 2014. Longevity (*LONGEVITY)* is measured as life expectancy at birth. It is an overall indicator of mortality and an important indicator of health status in a country. Economic growth (*EGROW*) is the real gross domestic product (GDP) per capita. It is the purchasing power parity converted GDP chain per capita at 2005 constant prices. Real income (*RINCOME*) is the Gross National Income (GNI) divided by midyear population. Urbanization rate (*URBAN*) is the urban population as a percentage of total population. CO_2 emissions (*COEMISN*) are carbon dioxide produced during consumption of solid, liquid, and gas fuels and gas flaring. Health expenditure per capita (*HEXP*) is the sum of public and private health expenditures as a ratio of total population.

Also, Rural Population (*RURAL*) refers to the difference between total population and urban population. Population density (*POPDENS*) is midyear population divided by land area in square kilometres. Clean water (*WATER*) is the percentage of the population with reasonable access to an adequate amount of water from an improved source, while sanitation (*SANIT*) is the percentage of the population with at least adequate access to excreta disposal facilities. Food availability (*FOOD*) is the food production index which covered food crops that are edible and contained nutrients. Primary Education (*BASICEDU*) is the gross primary school enrolment ratio[2] which is the ratio of total enrolment in primary school, regardless of age, to the population of the age group that officially corresponds to the level of primary education.

4 Empirical Results

4.1 Descriptive Summary of the Data

The first issue considered is the descriptive statistics of the data and the inference on the normality assumption of the distribution of the selected sample. The descriptive analysis of the data gives a brief overview of the mean, median, standard deviation, minimum and maximum values; the normality inference is drawn using the kurtosis, skewness and Jarque-Bera statistic. Table 2 provides the report on both the descriptive and inferential nature of the data.

As revealed in Table 2, all the series displayed high level of consistency as the mean and median values are within the range of minimum and maximum values of the series. Also, the standard deviation (S.D) which measures the level of variation or degrees of dispersion of each series from its mean values are generally low. Thus, nearly all the series indicated very low overall variation in the series of each variable.

For the inference on the normality assumption, each of the skewness and kurtosis statistics is not the end tool in itself for testing the normality of a probability distribution of a series. Jarque-Bera statistic is computed using the skewness and kurtosis coefficients for the purpose of testing the normality assumption. The essence of testing for normality or asymptotic property of a series is informed by the assumption of series normality distribution by other test statistics like χ^2, t and F, among others, which are popularly used in estimation of econometric models. From Table 2, the probability values of the Jarque-Bera statistics revealed that all the series satisfied the normally distribution assumption at 5% level of significance.

1 Address of the database, http://databank.worldbank.org/data/home.aspx
[2] Few missing data were interpolated using simple average

Table 2: Descriptive Statistics and Normality Inference of the Data

	RURAL	*LPROD*	*EGROW*	*SANIT*	*HEXP*	*FOOD*	BEDU
Mean	4.123	8.390	12.422	3.436	1.732	4.483	4.508
Median	4.131	8.447	12.404	3.437	1.732	4.503	4.510
Maximum	4.216	8.790	12.792	3.544	2.021	4.706	4.622
Minimum	4.003	8.059	12.134	3.325	1.364	4.198	4.363
Std. Dev.	0.069	0.269	0.264	0.069	0.184	0.156	0.086
Skewness	-0.273	-0.019	0.152	-0.030	-0.186	-0.332	-0.228
Kurtosis	1.780	1.432	1.268	1.790	2.122	1.880	1.770
Jarque-Bera	1.340*	1.846*	2.319*	1.101*	0.682*	1.272*	1.291*
Probability	0.512	0.397	0.314	0.577	0.711	0.529	0.525
Observations	18	18	18	18	18	18	18

	WATER	*POPDENS*	*RINCOME*	*LONGEVITY*	*COEMISN*	*URBAN*
Mean	4.050	4.996	12.336	3.879	-0.645	3.635
Median	4.055	4.993	12.284	3.869	-0.598	3.632
Maximum	4.159	5.222	12.742	3.953	-0.275	3.812
Minimum	3.920	4.780	11.996	3.831	-1.133	3.472
Std. Dev.	0.075	0.139	0.279	0.043	0.301	0.111
Skewness	-0.196	0.051	0.209	0.407	-0.322	0.092
Kurtosis	1.834	1.805	1.341	1.677	1.579	1.693
Jarque-Bera	1.135*	1.079*	2.195*	1.809*	1.826*	1.306*
Probability	0.567	0.583	0.334	0.405	0.401	0.521
Observations	18	18	18	18	18	18

Note: Jarque-Bera statistic follows a χ^2 distribution and the acceptance of the null hypothesis that variables are normally distributed at 5% level of significance is denoted by *.

4.2 Unit Root Test

A unit root process is a highly persistent time series process where the current value comprises of the last period's value and a dependent disturbance. There are numerous unit root tests for investigating the stationary or otherwise of the data. Most of the empirical studies in economics, which tested for the existence of unit root process, adopted Augmented Dickey-Fuller (ADF) test. The ADF test is asymptotically valid in the presence of a moving average (MA) component, provided that sufficient lagged difference terms are included in the test regression (Said and Dickey, 1984). This study adopted the ADF test for unit root investigation allowing for intercept, and intercept with trend respectively. The results are shown in Table 3.

As shown in Table 3, using 5 percent level of significance, when intercept is included, variables like real income (*RINCOME*) and access to clean water (*WATER*) are stationary at levels, carbon dioxide (CO_2) emission (*COEMISN*), economic growth (*EGROW*), health expenditure (*HEXP*), basic education (*BASICEDU*), food availability (*FOOD*) and access to sanitation facilities are stationary at first difference, while rural (*RURAL*) and urban (*URBAN*) population are stationary at second difference. However, when both intercept and trend are included and 5 percent level of significance was considered, some of the variables sustained their order of integration while it changes in some others, as shown in Table 3.

Table 3: Results of Augmented Dickey-Fuller Unit Root Test Results

Variables	ADF (Max. Lag of 3)						Order of Integration	
	LEVEL		First Difference		Second Difference			
	With C	With C and T	With C	With C and T	With C	With C and T	With C	With C and T
RINCOME	0.013 (0.95)	-3.902* (0.04)	-4.018* (0.01)	-4.060* (0.03)	...	...	I(0)	I(1)
WATER	-5.866* (0.00)	-1.389 (0.82)	...	...	...	...	I(0)	...
COEMISN	-1.787 (0.37)	-1.165 (0.89)	-3.517* (0.02)	-3.820* (0.04)	...	...	I(1)	I(1)
EGROW	-0.043 (0.94)	-1.972 (0.58)	-3.422* (0.03)	-3.336 (0.10)	...	...	I(1)	...
BEDU	-1.904 (0.32)	-1.823 (0.65)	-6.267* (0.00)	-6.896* (0.00)	...	...	I(1)	I(1)
HEXP	-2.697 (0.10)	-3.230 (0.11)	-5.755* (0.00)	-5.604* (0.00)	...	...	I(1)	I(1)
FOOD	-1.370 (0.57)	-2.494 (0.33)	-3.530* (0.03)	-3.567 (0.07)	...	...	I(1)	I(1)
SANIT	1.154 (1.00)	-2.437 (0.35)	-5.034* (0.00)	-5.133* (0.01)	....	...	I(1)	I(1)
LONGEVITY	0.653 (0.99)	-4.860* (0.01)	-2.651 (0.11)	-10.571* (0.00)	-4.970* (0.00)	-5.230* (0.01)	I(2)	I(0)
RURAL	0.598 (0.99)	-3.185 (0.12)	-1.194 (0.65)	-1.528 (0.78)	-3.868* (0.01)	-5.537* (0.01)	I(2)	I(2)
URBAN	-0.171 (0.93)	-3.276 (0.11)	-1.724 (0.40)	-1.315 (0.85)	-3.730* (0.02)	-4.368* (0.03)	I(2)	I(2)
POPDENS	...	-2.081 (0.51)	-1.491 (0.51)	-4.726* (0.01)	-2.227 (0.21)	-1.431 (0.80)	...	I(1)

NB: 'C' and 'T' represent intercept and trend respectively. In parentheses are the probabilities of the unit root results. The asterisks (*) show the result of unit root tests for which the series is stationary at the significance level of 5% and below.

4.3 Discussion of findings on the Determinants of Longevity in Nigeria

To determining the major factors that spur longevity in Nigeria, Error-Correction Modelling (ECM) procedure was adopted. The ECM series represent the residual generated by first using OLS to estimate equation 4 with variables in levels. ECM was used due to the differences in the order of integration of the variable and the interest of the study was to obtain the determinants. The result of the unit root test was incorporated into equation 4 with the lag-length chosen using the result of Akaike Information Criterion, Schwarz Criterion and Hannan-Quinn Criterion. After obtaining the over-parametized regression estimates[1], the models were down sized by removing some of the non-statistically significant variables. This process continues until the coefficient of the ECM became statistically significant. These lead to obtaining parsimonious regression results, which are presented in Tables 4 and 5. Table 4 presents the results of the estimated model with intercept, while Table 5 shows the results of the estimated model with the inclusion of intercept and trend.

[1] The over-parametized regression estimates results can be made available on request

Table 4: Parsimonious Regression Results on Determinants of Longevity (Trend not included)

Dependent Variable: $D(LONGEVITY, 2)$ Method: Least Squares Sample (adjusted): 1998 2012			
Variable	**Coefficient**	**t-statistic**	**Probability**
C	-0.0105	-2.8667	0.1032
$D(BASICEDU)$	0.0239	7.2183**	0.0187
$D(COEMISN)$	-0.0450	-6.7099**	0.0215
$D(RURAL, 2)$	-4.6373	-6.5860**	0.0223
$D(SANIT)$	3.6980	6.5340**	0.0226
$D(WATER)$	-5.6556	-6.4370**	0.0233
$D(BASICEDU(-1))$	0.0888	6.7035**	0.0215
$D(COEMISN(-1))$	-0.0177	-5.6491**	0.0299
$D(RURAL(-1),2)$	0.4217	3.4954	0.0730
$D(SANIT(-1))$	-3.0797	-5.7471**	0.0290
$D(WATER(-1))$	6.6862	6.7589**	0.0212
$D(EGROW(-1))$	0.0147	6.9660**	0.0200
$D(ECM(-1))$	-0.3269	-4.5650**	0.0448
R-squared	0.9123	AIC	-14.2102
Adjusted R-squared	0.7458	SC	-13.5965
F-statistic	21.343	HQC	-14.2167
Prob(F-statistic)	0.0456	DWS	2.1193

NB: ** *in the results indicate 5% level of significance. AIC, SC, HQC and DWS represent the Akaike Information Criterion, Schwarz Criterion, Hannan-Quinn Criterion and Durbin-Watson statistic respectively.*

From both tables, in all the estimated models, the approximate R^2 value of 0.91 in Table 4 and 0.94 in Table 5 suggest that over 90% of variation in longevity are explained by the independent variables put together. Also, the statistically significant F-statistic at $P<0.05$ imply that all the independent variables put together significantly explaining the behaviour of longevity in Nigeria.

Also, in the two tables, Tables 4 and 5, the Hannan-Quinn, Schwarz and Akaike Information Criteria, which are for model selection, are at their minima values and error-correction terms are negative and significant at 5 percent as expected (Nwachukwu and Egwaikhide, 2007).

The approximate Durbin Watson statistic value of 2 suggested the absence of any severe series correlation. However, with the inclusion of the lagged variables, further diagnostic tests were conducted; Histogram and Normality, Breusch-Godfrey Serial Correlation LM, ARCH Heteroskedasticity and CUSUM square model stability tests. The results of the diagnostic tests are reported in the appendixes. For the regression results in Table 4, the diagnostic tests are reported in appendix A, while that of the regression results in Table 5 are shown in appendix B. From the two appendices, the Jarque-Bera statistics in the histogram and normality tests are not significant at 5 percent, implying that the residuals are normally distributed. Also, the serial correlation LM tests results revealed that the null hypothesis of no serial correlation up to lag order one is accepted at 5 percent. Similarly, the heteroskedasticity tests results showed that the null hypothesis of homoskedasticity is accepted at 5 percent critical value, while the CUSUM squares of tests for model stability suggested that the parameters and the residual variances are stable, since the CUSUM square line movement is within the critical lines.

From Tables 4 and 5, it is clear that basic education consistently matter for improvement in longevity at 5 percent level of significance. Even the results from the lagged value of basic education also support this position. Thus, the coefficients of basic education elasticity of longevity are 0.024 and 0.010 from Table 4 and 5 respectively. This is an indication that the universal basic education policy is actually worthwhile for Nigeria, when improvement in longevity is desired. This buttressed the finding by Fayissa and Gutema (2005), that education matter for longevity.

Table 5: Parsimonious Regression Results on Determinants of Longevity (Trend included)

Dependent Variable: $D(LONGEVITY)$ Method: Least Squares Sample (adjusted): 1997 2012			
Variable	**Coefficient**	**t-statistic**	**Probability**
C	0.0069	4.7436**	0.0417
$D(BASICEDU)$	0.0098	6.0005**	0.0267
$D(COEMISN)$	-0.0053	-5.4038**	0.0326
$D(FOOD)$	0.0216	10.8459**	0.0084
$D(RINCOME)$	-0.0271	-12.4300**	0.0064
$D(RURAL,2)$	-46.127	-30.2290**	0.0011
$D(SANIT)$	1.0695	9.2516**	0.0115
$D(URBAN,2)$	-23.620	-31.1980**	0.0010
$D(HEXP)$	-0.0007	-2.2563	0.1527
$D(POPDENS)$	1.4964	2.5822	0.1229
$D(BASICEDU(-1))$	0.0102	5.7415**	0.0290
$D(COEMISN(-1))$	-0.0192	-13.4109**	0.0055
$D(FOOD(-1))$	0.0219	11.5811**	0.0074
$D(ECM(-1))$	1.2191	16.6063**	0.0036
$@TREND(1995)$	-0.0004	-11.4297**	0.0076
R-squared	0.9416	AIC	-14.571
Adjusted R-squared	0.8168	SC	-13.895
F-statistic	361.47	HQC	-14.536
Prob(F-statistic)	0.0028	DWS	2.0496

NB: *** in the results indicate 5% level of significance. AIC, SC, HQC and DWS represent the Akaike Information Criterion, Schwarz Criterion, Hannan-Quinn Criterion and Durbin-Watson statistic respectively.*

Similarly, from Tables 4 and 5, increase in the percentage of population's access to sanitation facilities significantly improve longevity at the probability of less than 5 percent (P<0.05). The coefficients of sanitation facilities elasticities of longevity [$D(LONGEVITY)/D(SANIT) = 3.698$ and 1.070 in tables 4 and 5 respectively] revealed that longevity is highly elastic to the increase in the provision and population access to sanitation facilities. This result is also in accordance with the report by Cultler and Miller (2005).

Considering further from Tables 4 and 5, carbon dioxide (CO_2) emission consistently had significant[1] negative effect on longevity. This is according to the expectation of this study. The coefficients of CO_2 emission elasticity of longevity are 0.045 and 0.005 from Tables 4 and 5 respectively. This implies that any environmental policy aimed at reducing the emission of CO_2 will be of vital value in promoting longevity. Similarly, both rural and urban populations negatively and significantly affect longevity. This may not be unconnected with the fact that, rural settlements in Nigeria lack adequate qualitative health and educational institutions with their required facilities. Most of the roads are not tarred, the villages are not sufficiently electrified and the few with electrification are not having regular electricity supply. Also, the urban centres are filled with pollution, congestion and other associated problem of overcrowding.

Furthermore, food availability also matter for longevity as revealed in Table 5. Both the current and lagged food availability variables showed that the degrees of responsiveness of longevity to food availability are positive and fairly inelastic [$D(LONGEVITY)/D(FOOD) = 0.022$]. This result buttressed the earlier findings (Fayissa and Gutema, 2005; and Halicioglu, 2010).

In addition, health expenditure, which comprises of both private and public health expenditure and entailed the provision of preventive and curative health services, family planning activities and emergency aid designated for health, was not in accordance with the expectation. The result from Table 5 showed that health expenditure had a significant negative effect on longevity. This implies high level of instability or reduction in health expenditure, to provide facilities for qualitative health care services, as against the continuous increase in the demand for good health care services. Also, the density of the population was promoting longevity, but it was not statistically significant, as shown in Table 5. From Table 4, one year lagged value of the growth of the economy significantly promotes longevity. This means that the growth of domestic productivity led to an improved lifespan in Nigeria. However, in Table 5, the per capita income had a negative and statistically

1 In this study, only 5 percent level of significance is considered appropriate and reported in all the discussion of findings. This is majorly, the position in social science researches.

significant effect on longevity. This shows that the increase in income was not sufficiently shared out into increasing quality and quantity of healthcare personnel and provision of more social infrastructure.

5 Conclusion and Policy Recommendations

This study has investigated the determinants of longevity in Nigeria for the scope of 1995 to 2012, taking after the theoretical model of Grossman (1972) and as adopted by earlier studies (Fayissa and Gutema, 2005; and Halicioglu, 2010), using environmental and socioeconomic factors as determinants. Data were primarily sourced from World Development Indicators (WDI), an online databank published by World Bank, and analysed using Error-Correction Mechanism (ECM).

The results revealed that increase in basic education, food availability, access of the population to sanitation facilities and decrease in carbon dioxide emission per capita raised longevity. In a bid to pursue the MDGs, Nigeria implemented the Universal Basic Education (UBE) policy which led to increase in the gross primary school enrolment ratio. Basic education in Nigeria has led to improved longevity through human capital development and enlightenment to live a hygienic life. In addition, an attempt to eradicate hunger, as proposed in the MDGs, is to promote the availability of nutritious food. In Nigeria, increase in food availability has significantly improved the degree of longevity. Furthermore, the percentage of the population that can access sanitation facilities matters to improve longevity in Nigeria. On the contrary, if the sanitation infrastructures are inadequate, such will likely lead to food and water contamination and out-break of diseases, as insect, animal and people come in contact with excreta. Also, an increase in CO_2 emission will lead to global warming, change in the pattern of global precipitation, changes in agricultural yields, species extinctions and extension in the ranges of disease vectors.

Unfortunately, health expenditure had a significant negative effect on longevity, buttressing the finding by Fayissa and Gutema (2005). This is possibly a reflection of high level of instability or reduction in health expenditure, to provide facilities for qualitative health care services, thus, not meeting up with the continuous increase in the demand for good health care services in the country. Also, the rising income per capita did not improve longevity. This is an indication of the fact that, increases in income are not used to provide more social infrastructure to meet up with the increasing demand for them. Furthermore, both rural settlement size and urbanization had significant negative effects on longevity. This is also an indication of lack of qualitative health and educational institutions, poor roads network and inadequate electrification in the rural area, while most of the settlements in urban centres are congested, filled with pollution and other associated problem of overcrowding.

As an implication for the government and private sector, it can be inferred from the findings of this study that the Universal Basic Education (UBE) is worthwhile, promoting food production is a necessity, providing more sanitation facilities in both the public places by the government and private organization by employers are required. Also, the health care services systems need an overhauling to make accessible and cheap to the poor and low income Nigerians. More healthcare facilities are needed across the six geopolitical zones of Nigeria. In addition, environmental protection policy needs to be geared toward the reduction of carbon dioxide emission.

For individuals and households, it is important to consume not just edible, but nutritious foods which are capable of supplying the necessary nutrients for healthy living. Also, getting educated with basic information, regardless of age will likely help in living hygienic life. In addition, adequate excreta disposal facilities that could effectively prevent animal, insect and people from having contact with excreta are to be provided in every house. Similarly, adequate clean water from public tap, tube well or borehole and protected well or spring and rain water, should be the water intake for the households. All these efforts will improve the individuals' lifespan in the households.

This study concluded that increase in income does not automatically improve longevity, but that such increases should transform into provision of more social infrastructure like basic schools, healthcare and sanitation facilities, and clean water in addition to food availability.

Area for further investigation in determining the degree of longevity could include primary data studies aimed at unravelling other factors that are cultural, hereditary and spiritual in nature, which are capable of improving longevity in Nigeria.

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APPENDIXES

APPENDIX A

Diagnostics Test Results for the Parsimonious Model Estimated and shown in Table 4

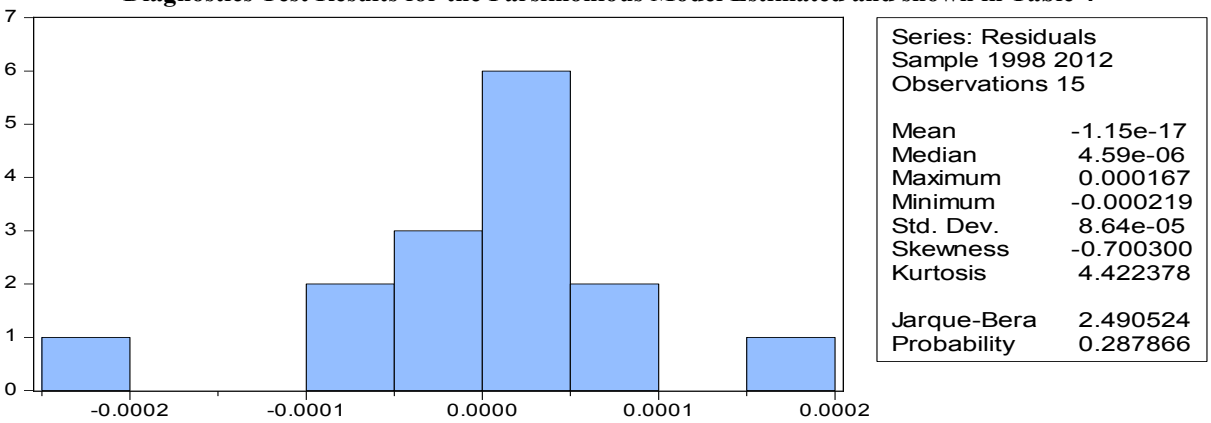

Figure A1: Histogram and Normality Test

Table A1: Breusch-Godfrey Serial Correlation LM Test:

F-statistic	1.041422	Prob. F(1,1)	0.4935
Obs*R-squared	3.652181	Prob. Chi-Square(1)	0.2057

Table A2: Heteroskedasticity Test: ARCH

F-statistic	0.450858	Prob. F(1,12)	0.5146
Obs*R-squared	0.506954	Prob. Chi-Square(1)	0.4765

Figure A2: Test for Model Stability

APPENDIX B

Diagnostics Test Results for the Parsimonious Model Estimated and shown in Table 5

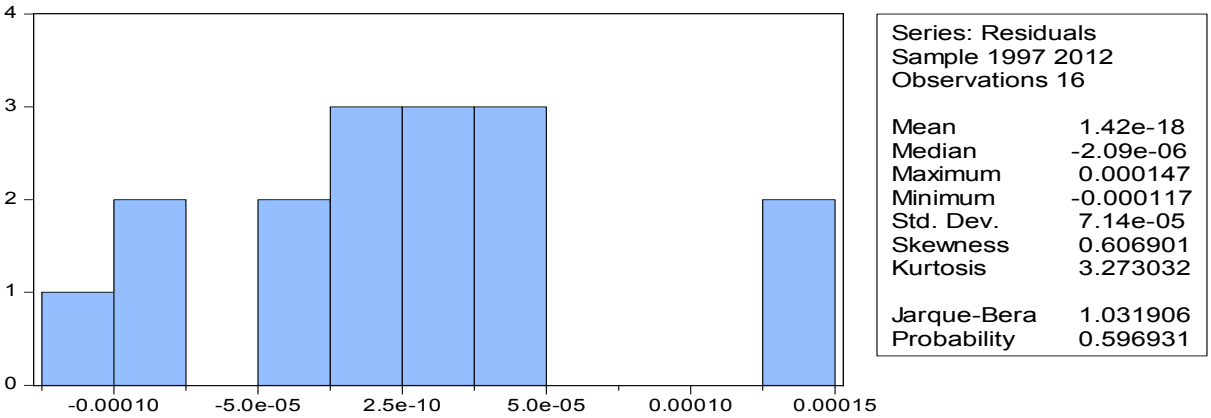

Figure B1: Histogram and Normality Test

Table B1: Breusch-Godfrey Serial Correlation LM Test:

F-statistic	8.682970	Prob. F(1,1)	0.2083
Obs*R-squared	11.34761	Prob. Chi-Square(1)	0.0572

Table B2: Heteroskedasticity Test: ARCH

F-statistic	0.109535	Prob. F(1,13)	0.7459
Obs*R-squared	0.125331	Prob. Chi-Square(1)	0.7233

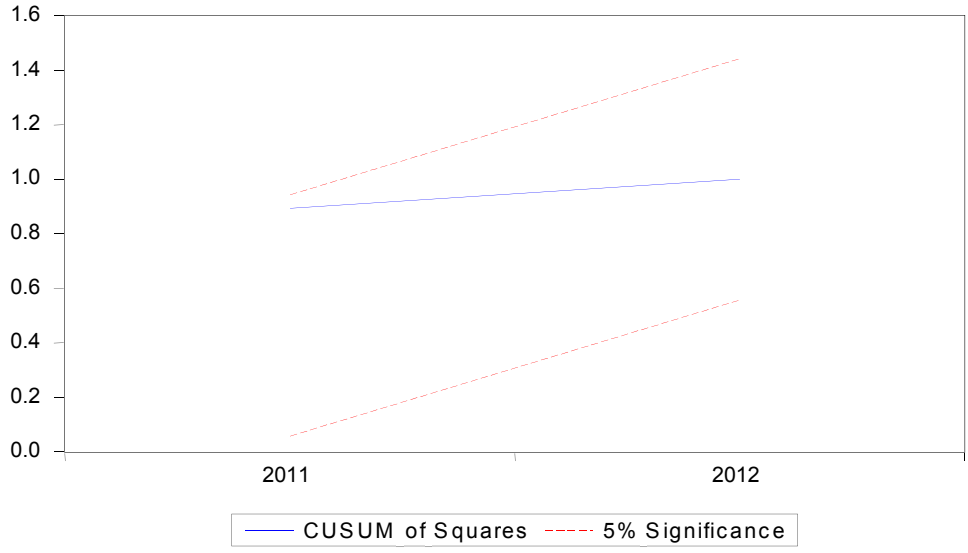

Figure B2: Test for Model Stability

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