Urbanization, CO\textsubscript{2} Emission and Longevity: The West African Experience

Olalekan Dimeji Bamiteko\textsuperscript{*}, Kazeem Bello Ajide

Department of Economics, University of Lagos, Akoka, Nigeria

Email address:
olalekanbamiteko@gmail.com (O. D. Bamiteko), Kazeemajide@gmail.com (K. B. Ajide)

\textsuperscript{*}Corresponding author

To cite this article:
Olalekan Dimeji Bamiteko, Kazeem Bello Ajide. Urbanization, CO\textsubscript{2} Emission and Longevity: The West African Experience. \textit{International Journal of Environmental Monitoring and Analysis}. Vol. 9, No. 2, 2021, pp. 29-39. doi: 10.11648/j.ijema.20210902.11

Abstract: This study considered the dynamic relationship between urbanization and CO\textsubscript{2} emission on longevity in West African countries. The importance of urbanization to developing countries cannot be overemphasized; but it comes with a cost (CO\textsubscript{2} emission). Hence the need to observe the effect of CO\textsubscript{2} emission on longevity becomes necessary. This study incorporated the theory of health production into Environmental Kuznets Curve (EKC) and explored the Fully Modified (FM) and Dynamic Ordinary Least Square (DOLS) methods to conduct the social scientific enquiry. The outcomes of the panel co-integration analysis are confirmed using the Pooled Mean Group (PMG) estimator to reaffirm the results of this study. The estimated coefficient for FMOLS presents urbanization (1.538) with CO\textsubscript{2} emission (-11.38) and DOLS reaffirmed urbanization (1.126) with CO\textsubscript{2} (-18.10) at 1% significant respectively. PMG indicated that the confirmatory test of a priori expectation is correct. The result showed that CO\textsubscript{2} emission and urbanization had negative and positive significant effect on longevity respectively. Therefore, the study re-validates that at long run the threshold for CO\textsubscript{2} emission must be established as developing countries especially West African countries yearn for development. The study concluded that in ECOWAS countries, urbanization spur longevity while CO\textsubscript{2} emission retards it.

Keywords: Urbanization, CO\textsubscript{2} Emission, Longevity, West African Countries, Fully Modified Ordinary Least Square

1. Introduction

Overtime different reports show that the rate of World urban population needs immediate attention especially in Africa. The world urbanization by UN DESA’s population division projected that by 2045 world population will surpass 6 billion and most of the population growth will take place in developing countries especially Africa [18, 19, 20, 44]. Another UN report launched in 2014 claims that world population could add another 2.5 billion people to urban population by 2050 and close to 90% of this projection will take place in Africa [46].

From the recent case and report on Africa’s cities on urbanization, African cities have failed to keep step with the rapid growth in population by investing in infrastructural development [16]. Urbanization, which refers to the gradual increase in the proportion of people living in urban areas, has been on the increase in recent times. This is because urbanization affords the people opportunities like getting jobs (different from the agrarian jobs in the rural areas), access to better health care, increased productivity and better education; to mention a few [21].

Also, urbanization has a close link to economic growth, innovations and efficient use of resources [23]. United Nations Population Fund projected that by 2030, the world population of urban dwellers will swell to about 5 billion. While much of this urbanization will unfold in Africa and Asia; bringing huge social, economic and environmental transformations [47]. West African countries are not left out as countries are becoming urbanized yet all the countries in the region are rated by Human Development Index (HDI, 2016) as low income countries except Cape Verde, Gambia and Ghana which are medium income countries; the pertinent question is that does urbanization have an effect on the environment in this region? As beneficial as urbanization is, it also comes with its cost; large amount of industrial
activities, transportation, and destruction of the ecosystem coupled with household consumption of fossil fuels can increase the CO$_2$ emission which is a major component of Green House Gases.

CO$_2$ emission can pose a threat to human health directly through pollution and indirectly by depleting the ozone layer which causes harsh weather that reduced the agricultural production which in turn lead to food scarcity that can impair human health, hence longevity [27]. Also, urbanization may increase urban poverty; as many rural dwellers move to urban centers, they may not be able to meet up with urban cost of living which makes majority found themselves living in slum and find it hard to access basic necessities of life. In addition, urban lifestyle of traffic jams, noise pollution, increase working hours, reduction in leisure and sleeping hours may all contribute to reduction in health quality which as a result has an effect on longevity.

Even though it has been argued that CO$_2$ emission is more and has a negative impact on urbanization and health in developed countries than developing countries [6]; low income countries may not be associated with high industrialization, CO$_2$ emission in such countries may be accounted for by disruption of the ecosystem (expansion in urban centers can cause deforestation and reduction in plants that can help absorb CO$_2$ emission), use of unclean energy for domestic purpose, emission associated with aged vehicles, use of other machines like generators etc. Also, increase in urban slums as one of the types of urbanization can lead to poor disposal of waste, overcrowded apartments and unclean energy use which can increase CO$_2$ emission [12]. Although, urban slum dominance is associated with lower carbon intensity of well-being if compared with level of urbanization determine by the percentage of urban population with access to certain social amenities; such improved water and sanitation [12].

From the foregoing, the challenges that come with urbanization centre mostly on environmental quality change as indicated by Environmental Kuznet Curve [6]. The UN reports equally listed certain challenges such as housing, transportation infrastructural needs and other basic services like education and health care. Kamp et al urbanization moves with urban lifestyle that cannot be separated from social economic pollution which has positive or negative effect on CO$_2$ emission such as increase in industrial activities, increase in transportation and disruption of ecosystem which will have effect on the health quality of the people [27]. The impact of CO$_2$ could be mental or physical on health quality of the people which has been left unattended to by most studies especially in West Africa. Longevity could be used to measure the actual effect of CO$_2$ on health quality. It on this premise, that this study envisaged that urbanization and CO$_2$ emission may have effect on longevity in West African countries. The main objective of this study is to find out the level of impact created by urbanization and CO$_2$ emission on longevity in ECOWAS countries. This is pertinent because the issues pertaining to longevity, pollution gasses as well as urbanization are policy issues crucial to ECOWAS countries when the union’s mission and objectives are considered.

This study used the panel data analysis for fifteen ECOWAS countries to examine the relationship among CO$_2$ Emission, Urbanization and Longevity. The author employs Fully Modified Ordinary Least Square (FMOLS) and Dynamic Ordinary Least Squared (DOLS) methods by Pedroni to establish the dynamic relationship between urbanization and CO$_2$ emission on longevity in ECOWAS countries and if EKC hypothesis hold in West Africa [42, 43]. Studies of Jude et al and Mesagan et al have used these panel cointegration estimation methods to examine fundamental and conditional variables on different grounds in relation to environmental quality [26, 36]. In this study author conducts a confirmatory test of the panel coefficients results to ascertain and lay to rest the assumptions of heterogeneity and homogeneity correction errors in his work using the Pooled Mean Group (PMG) estimation by Im et al for long run and short run coefficients analysis [22]. The study found that CO$_2$ emission has an inverse effect on longevity while urbanization had a positive effect on longevity.

The outline of this paper is as follows. The review of related literature in section 2 and adapted conceptual framework with research methodology is in chapter 3. Section 4 presents the empirical modification of the study. Section 5 covers summary, conclusion and policy recommendations.

2. Review of Related Literature

Urbanization have been examined in relation to other fundamental and conditional variables as its affect economic growth and development [8, 24, 35, 36]. This obviously supports the position of World Bank; no country has grown to middle income without industrializing and urbanizing [55]. None has grown to high income without vibrant cities. The rush to cities in developing countries seems chaotic, but it is necessary [55]. Conversely, other related studies examined environmental quality in relation to urbanization as an indicator for economic development [30, 23].

Grossman et al concluded that the absence of evidence showing the existence of causality relation between the gradual environmental degradation with the growth of the country [14], contrary to the results of Shairk saying that CO$_2$ emissions are increasing in parallel with economic growth [48]. Stern showed that CO$_2$ emissions began to decrease when the economy reach a well-defined income threshold while the results of Akbostanci et al do not comply with the principles of the hypothesis (EKC) [54, 1]. Martinez et al showed that CO$_2$ emissions and income level are negatively related in low-income countries, but they are positively related in high-income countries [32]. These studies’ results are divergent and often contradictory. Also, in the majority of cases, researchers have failed, to confirm the existence of a typical Kuznets curve, an inverted U-shaped curve [23].

Few other studies take different positions on the relationship of causality between growth and energy of
consumption. The works of Asafu-Adjaye, Glasure, Yang, Soytas et al., Morimoto et al., Altinay et al. and Narayan et al. have converged to the existence of a causal relation between the two variables (energy consumption and growth) [3, 11, 56, 51, 38, 4, 39]. Other research has found a unidirectional causal relation as shown by the works of Narayan et al or a two-way direction found by Masih et al and Oh et al [39, 33, 41]. Conversely, Soytas et al showed the absence of causality relationship between growth and carbon emissions [52, 53]. Unlike the works of Shahbaz et al., Halicioglu and Akpan et al. found a causality relation between all those variables [49, 17, 2]. The majority of these works focused on the trade-off which usually occurs between economic growth and the CO₂ emission.

Sharif confirmed in his work the existence of a set of unidirectional causality relations in the short term (from economic growth, trade openness and CO₂ emissions; from economic growth to the consumption of energy; from trade openness to economic growth; from urbanization to economic growth and from trade openness to urbanization) [50]. This work takes a closer shape to this study, but did not consider longevity which is important to the study. Although the studies that have examined the impact of urbanization, CO₂ emissions on the well-being in West Africa are relatively rare, we can consider the studies of Georgescu-Roegen and Meadows et al that showed the economic activity generates necessarily the accumulation of the CO₂ emissions [10 and 35]. As consequence, this will cause environmental degradation and decreased the social-welfare. Eric examined the interactions between welfare and environmental degradation and concluded that environmental problems can threaten the social well-being [9]. Christophe et al showed that life expectancy would increase up to 22 months if the major European cities can reduce air pollution [7]. Also, Chen et al showed the existence of negative correlation between longevity and the environmental degradation [57]. UNEP's report on the future of the global environment "environment for development" (GEO-4) showed that air pollution adversely affects the well-being in almost all regions of the world. WHO estimated that over one billion people in Asian countries are exposed to air pollutants.

The positions of UNEP and WHO laid the foundation for the study of Issaoui et al. investigated the impact of CO₂ emissions on per capita growth, energy consumption, life expectancy and urbanization in Middle East and North African (MENA) countries (Algeria, Bahrain, Egypt, Emirates Arab, Jordan, Saudi Arab, Morocco, Qatar, Tunisia and Yemen) from 1990 to 2010 [23]. The empirical results covered two-time horizons: the short and long term. Indeed, in the short-term authors pointed out that the CO₂ emission is explained by energy consumption and economic growth per capita which exert positive and significant effects for all countries in the sample. Also, that the CO₂ emission is always positively influenced by energy consumption and negatively influenced by life expectancy. The study used two approaches to deal with a single model; it explained the relationship between CO₂ emission and a vector of variables involving economic growth, energy consumption (first approach), urbanization and life expectancy (second approach). The study actually supports the research work and the key variables in this study. Despite it was a panel data used but it is for a period lesser than 5 years and not for West African countries. This shows the exclusivity of this study. Empirical literature on the relationship between environmental indicators and economic growth are limited, especially in relation to West African countries. Of importance is the fact that their results are mixed [40]. This confirmed the positions of different theoretical explanations advanced by studies earlier reviewed in this section. In another study, Joseph observed that there is a strong positive relationship and sensitivity of climate change to growth in some selected West Africa countries using a panel cointegration method over the period 1970-2006; an assessment of the EKC [25]. The result revealed that pooled ordinary least square is in consonance with EKC, while the fixed effects results were at variance with the applicability of EKC in West Africa. He considered the enactment of different policy options as a necessary condition to ensure efficiency in energy use and reduction in carbon emissions. This outcome will trigger the need to confirm the applicability of EKC in West African countries using considered variables on the targeted variable in this study. Another similar study, Usenobong et al. Examined economic growth and environmental degradation in Nigeria using the autoregressive distributed lag model [45]. The results indicated an N-shape relationship between economic growth and environmental degradation. The authors recommended that policy measures to cater for environmental preservation be adopted irrespective of the country’s level of income.

Obviously, most of the studies that examine the relationship between environmental quality and fundamental variables show unpredictable nature and highly sensitive with mixed results as earlier observed. In addition, no previous studies to best of author’s knowledge had examined the key variables within ECOWAS as being considered in this study. Leila et al examined Africa’s urban population growth: trends and projections [30]. The authors observed that urban growth is often correlated with adverse environmental effects, concentrating pollution and harming health using crowded cities like Makoko, a street in Lagos South West, Nigeria as a case study. The study is one of the closest studies to this research work.

Making inferences from the ECOWAS perspective, this research paper probes the effect of urbanization, CO₂ emission on longevity in members’ countries. The methods of panel analysis used in this paper is motivated by Mesagan et al. that used FMOLS and DOLS to examine how the level emission is positively and significantly determine by electricity consumption and growth while capital investment reduces the level of emission significantly in Brazil, Russia, India, China and South African (BRICS) [36]. This is extremely relevant for policy decision as it relates to environmental quality and health policies in the wake of the disastrous global warming. To the best of author’s knowledge, this paper represents the first strand of study on effect of urbanization,
CO₂ emission and longevity in the West Africa context. It is on this background that the main objective is to empirically examine the effect of urbanization and CO₂ emission on longevity in ECOWAS countries. This study uses the panel data analysis, FMOLS, DOLS and PMG to test the effect of urbanization and CO₂ emission on longevity for ECOWAS countries. The study concludes that in ECOWAS countries, urbanisation spur longevity while CO₂ emission retards it. As a policy recommendation, it suggests that efforts should be made by policymakers and governments to determine how to regulate rural-urban migration with necessary projects and policies to achieve healthier environment for the regional states. This will enhance its environment in the quest to competing favourably in the globe.

3. Framework Works and Research Methodology

3.1. Conceptual Framework

A review of relevant literature, Leidelmijer et al revealed that no generally accepted conceptual framework in relation to well-being has been developed or any coherent system to measure and properly evaluate aspects of, and trends in, environmental quality [29]. The concepts of urban environmental quality and related terms such as livability, quality of life and sustainability enjoy great public popularity and form a central issue in research-programmes, policy making, and urban development or at least they do so in terms of the appearance of these terms in the respective literatures. However, the manifestation and context in which environmental quality is used in research and policymaking is seldom uniform.

The starting point is the conceptual framework of Mitchell as shown in figure 1; who viewed quality of life (a measure of health outcomes) as the contribution of joint decisions, actions and policies made by different sectors of the economy [37]. The relevance of this to the study is that physical environment (climate and pollution) as well as natural environment has impact on health outcomes. For this study, longevity is the study’s health outcomes; hence, the study follows the work of Mitchell in order to establish a conceptual framework for this study [37].

3.2. Research Methodology

The theoretical framework of Grossman laid the foundation for the empirical research position of this study, which is an extension of grossman’s earlier work [15, 13]. A theory of health production function of Mathew et al. [34]. Therefore, this study assumes thus:

$$H_{it} = f(URBAN_{it}, CO_2_{it})$$  \hspace{1cm} (1)

Health outcomes represent \(H\) with longevity (LIFEXP), CO₂ emission (CO₂) and urbanisation (URBAN). Conversely, one of the key propositions of this study is that CO₂ retards longevity as urbanization spurs it positively in West African countries. EKC hypothesis would be employed like other studies, Joseph assessed EKC hypothesis in some selected West African countries over the period 1970-2006 and observed that there is a strong positive relationship and sensitivity of climate change to growth using a panel [25].

Taking a cue from the empirical study of Mesagan et al., where the authors, examined the role of electricity consumption and growth in the abatement of carbon emission in BRIC from 1992 to 2014 [36]. The need to test the assumption of the EKC hypothesis in ECOWAS region would not be out of place considering the relationship of the presented variables. Therefore, this study adapts the model and proposes:
(H) = β₀ + β₁Y_{it} + β₂Y^2_{it} + ε_{it} \tag{2}

EKC hypothesis usually specified as a quadratic function as it proposes that at early stage urbanization, output positively impacts longevity and at long run begins to be negative due to CO₂. Therefore, incorporating Grossman theory of health production, equation 1 into EKC hypothesis, equation 2 with the choice variables [15]. It becomes:

\[(\text{LIFEXP}) = \beta_0 + \beta_1 \text{URBAN}_{it} + \beta_2 \text{CO}_2_{it} \tag{3}\]

Considering, equation 3 \(\beta_0\) is the intercept term, while \(\beta_1\) and \(\beta_2\) are coefficients of explanatory variables as defined. The EKC hypothesis holds in West African countries if \(\beta_1 > 0\) and \(\beta_2 < 0\), using the variables. The author’s expectation is that CO₂ emission will have negative effect on longevity while urbanization will have positive impact on longevity. Thus, equation 3 is analysed by this study.

Panel data is used for the analysis; extract data from World Development Indicators (WDI 2016) of World Bank for the 15 West African countries with years spanning from 1990 to 2015. Data employed are Longevity measured by life expectancy (LIFEXP) at birth, total (year), CO₂ is measured by CO₂ emissions (metric tons per capita) and Urbanization measured by Urban population (% of total) the percentage of urban population relatively to the overall population.

This study examination of the relationship between longevity, urbanization and CO₂ is conducted in stages. First author considers the presence of unit root and non-stationarity within variables for both heterogeneous and homogenous process. This is to test for the order of integration and establish stationarity of the variables [28, 26]. Second, author conducts panel cointegration test to ascertain if long-run relationship exists among variables, within group and between-group tests are explored. Thereafter, author estimates long-run coefficients

\[\hat{\beta}_{\text{GFM}} = N^{-1} \sum_{i=1}^{N}(\sum_{t=1}^{T}\tilde{x}_{it})^{-2} - \frac{\sum_{t=1}^{T}b_{\text{FMI}}}{\sum_{t=1}^{T}b_{\text{FMI}}} \tag{6}\]

The group FMOLS estimator is \(\hat{\beta}_{\text{GFM}}\) also known as the between dimension estimator. It further explains the average of all coefficients of the regressors in the model.

Where: \(\text{LIFEXP}_{it} = (\text{LIFEXP}_{it} - \text{LIFEXP}_{it}) - \frac{\hat{\beta}_{\text{GFM}}}{\hat{\beta}_{\text{GFM}}} \Delta X_{it}\)

and \(\hat{\beta}_{\text{FMI}} = \sum_{t=1}^{T}b_{\text{FMI}} - \frac{\sum_{t=1}^{T}b_{\text{FMI}}}{\sum_{t=1}^{T}b_{\text{FMI}}} \tag{5}\)

Author identifies the between-dimension estimator using \(\hat{\beta}_{\text{GFM}} = N^{-1} \sum_{i=1}^{N} \hat{\beta}_{\text{FMI}}\) note that conventionally \(\hat{\beta}_{\text{FMI}}\) is FMOLS estimator which is applied to ith panel member. Whereas, the \(t\) statistics for the between-dimension is given as \(t_{\text{GFM}} = N^{-\frac{1}{2}} \sum_{t=1}^{T}b_{\text{FMI}}\) while \(t_{\text{FMI}} = (b_{\text{FMI}} - b_0)\left(\hat{\beta}_{\text{FMI}} - \frac{1}{\hat{\beta}_{\text{GFM}}} \sum_{t=1}^{T}(x_{it} - \bar{x}_{it})^2\right)^{-\frac{1}{2}}\)

Next equation author presents the between-dimension group mean panel for the DOLS estimator. This becomes necessary because Kao et al and Jude et al showed that OLS and FMOLS present certain level of bias and DOLS estimator appear to be better than both estimators [28]. Then it becomes important for us to use DOLS to control the endogeneity feedback and obtain the unbiased estimator of using FMOLS and DOLS (42 and 43) ordinary least square methods to establish the propose position and use the PMG of Im et al. as a confirmatory method to ascertain the FMOLS and DOLS results in this study [22].

The PMG and DOLS will assist to correct the endogeneity errors and serial correlation associated with regular pooled OLS in the while long run relationships correction. While PMG is adapted to take the cointegration pattern of a simple Autoregressive Distributed Lag (ARDL) model in large and panel individual effects; it allows the speed of adjustment and error variances to vary across countries, but the long run coefficients to remain homogenous. On this note, FMOLS and DOLS are presented thus:

\[\text{LIFEXP}_{it} = \alpha_i + \beta_iX_{it} + \mu_{it} \tag{4}\]

LIFEXP remains as specified earlier, \(X_{it}\) is the vector for urbanization and CO₂ emission which are the explanatory variables and \(\mu\) is the error term. It means that \(\text{LIFEXP}_{it}\) and \(X_{it}\) are cointegrated with slopes \(\beta_i\) this cointegration may be homogenous or heterogeneous across countries. Once the stationary vector of residuals is estimated from the cointegrating regression and the difference in \(x\) with \(\varepsilon_{it} = (\hat{\mu}_{it}\Delta X_{it})\) and able to show the long run covariance matrix for the vector process with \(\sigma_i = \ln T \to \infty\)

\[n_i = \lim T \to \infty E[T^{-1}\sum_{t=1}^{T}\varepsilon_{it}^2] \tag{5}\]

Therefore, it is possible to have \(n_i = n_i + \sigma_i + \sigma_i^2\) which \(n_i^2\) the contemporaneous covariance and \(\sigma_i\) is the weighted sum of auto covariance. As earlier mentioned (42 and 43) the between- dimension, group mean panel FMOLS estimator is therefore presented as:

The long run parameters. The DOLS use of parametric adjustment to correct errors is performed by estimator by including the past and future values of regressors at first difference. To obtain DOLS in the study the next equation is stated thus:

\[\text{LIFEXP}_{it} = \beta_{0i} + \beta_1X_{it} + \sum_{k=-k}^{k}\mu_{it} \tag{7}\]

The study obtains the group mean panel DOLS estimator from Eq. 7 and specified as:

\[\hat{\beta}_{\text{GOLS}} = N^{-1} \sum_{i=1}^{N}(\sum_{t=1}^{T}z_{it}^2)(\sum_{t=1}^{T}z_{it}\text{LIFEXP}_{it}) \tag{8}\]

Whereas is \(Z_{it} = (\tilde{x}_{it} - \bar{x}_{it} \Delta k_{it} \ldots \Delta k_{it+k})\) note that \(Z_{it}\) is the \(2(k+1) \times 1\) vector of regressors and LIFEXP is the transferred variable of longevity. The between-dimension estimator is then presented as \(\hat{\beta}_{\text{GOLS}} = N^{-1} \sum_{i=1}^{N}\beta_{\text{GOLS}}\) where \(\beta_{\text{GOLS}}\) is the conventional dynamic OLS estimator that is applied to the ith panel member. It is derived by obtaining the average of all coefficients of the independent variables. Then if we take \(\theta_2^2 = \lim T \to \infty E[T^{-1}\sum_{t=1}^{T}\varepsilon_{it}^2] \tag{5}\)
\[ \Delta \text{LIFEXP}_{it} = \varphi_i \text{LIFEXP}_{it-1} + \beta_i \text{X}_{it} + \sum_{j=1}^{p-1} \omega_{ij} \Delta \text{LIFEXP}_{it-j} + \sum_{j=0}^{q} \delta_{ij} \Delta \text{X}_{it-j} + \mu_{it} + \varepsilon_{it}, \]

where \( \varphi_i \leq 0, \beta_i \geq 0 \), and \( \omega_{ij}, \delta_{ij} \) are the coefficients of the lagged dependent variables and lagged explanatory variables, respectively.

The PMG developed by Im et al. is a general framework that adapts the assumptions of Autoregressive Distributed Lag (ARDL) to investigate the dynamic of long run and short run coefficients, equally known as ARDL Bound test [22]. The ARDL (p, q, q, ..., q) model, then the proposed PMG for the study adapt from pesaran bound test is

\[ \text{LIFEXP}_{it} = \sum_{j=1}^{p} \omega_{ij} \text{X}_{it-j} + \sum_{j=0}^{q} \delta_{ij} \Delta \text{X}_{it-j} + \mu_{it} + \varepsilon_{it}, \]

where the countries are specified by \( i = 1, 2, ..., N \) while \( t = 1, 2, ..., T \) to represent different time periods, \( \mu_{it} \) is the fixed effect, \( \omega_{ij} \) is the coefficient of the lagged dependent variables and \( \delta_{ij} \) represents the coefficient vectors. Therefore, the re-parameterization of eq. (10) appears thus:

\[ \text{LIFEXP}_{it} = - \frac{\beta_i}{\varphi_i} (\text{X}_{it} + n_{it}), \]

where \( n_{it} \) is a stationary process and the long-run coefficients \( \theta_i = - \frac{\beta_i}{\varphi_i} = \emptyset \) which are the same across the countries.

### Table 1. Panel Unit root.

| Variables | Heterogeneous unit root process | Homogenous unit root process |
|-----------|---------------------------------|----------------------------|
|           | Level ADF | PP Fisher | IPS | Level ADF | PP Fisher | IPS | Breitung | LLC | Breitung | LLC |
| LIFEXP    | 148.9***  | 6.42      | 10.31*** | 206.0*** | 27.9      | 14.10 | 2.09     | 114.0** | 17.7*** | 46.7 |
| URBAN1.9E | 1.9E      | 48.28**   | 33.2   | 3950*** | 3950***   | 82.79** | -14.92  | 41.21   | -3.30*** | -73.20*** |
| CO2       | 14.95     | 13.60     | 1.08   | 141.9*** | 159.0***  | -10.48*** | -3.22   | -1.99**  | -15.42*** | 13.06*** |

ADF, PP, IPS: LLC Levin, Lin and Chu

*** 1% significant; ** 5% significant

### Table 2. Pedroni residual cointegration test.

|               | Between-dimension | Within-dimension |
|---------------|-------------------|-----------------|
|               | Statistic         | Weighted        | Statistic |
| Group rho     | -0.36             | 4.63***         | 4.63***   |
| Group PP      | -3.30***          | -2.09***        | -2.09***  |
| Group ADF     | -3.62***          | -3.97***        | -3.97***  |

|               | Statistical       | Statistical     |
|---------------|-------------------|-----------------|
|               | Weighted          | Unweighted      |
| Group rho     | 4.63***           | 4.63***         |
| Group PP      | -2.09***          | -2.09***        |
| Group ADF     | -3.97***          | -3.97***        |

**** Represent 1% and 5% significance level, respectively

### 4. Data and Empirical Result

#### 4.1. Panel Non-Stationary Result

Considering the result in table 1, it shows that at level the null hypothesis holds for both heterogeneous and homogenous unit root process as well as apply to most variables then, the author accept that variables are not stationary at level. And further consider at first difference and observed that all the variables are stationary. Therefore, reject the null hypothesis of unit root and accept the alternative hypothesis of no unit root in the variables. To this end, the stationary at first difference is upheld in this study.
dimension column and estimates that pool the autoregressive coefficient across the different countries in the within-dimension column of the panel. Ten out of eleven statistics tests accept alternative hypothesis and reject null hypothesis of no cointegration at the conventional size of 1% and 5% respectively. Therefore, this study holds that there is a long run relationship between the considered variables.

**Table 3. Johansen fisher panel Cointegration test.**

| Hypothesised no. of CE (s) | Fisher stat. (trace test) | Fisher stat (max-eigen test) |
|---------------------------|--------------------------|-----------------------------|
| None                      | 311.5***                 | 276.3***                    |
| At most 1                 | 244.3***                 | 133.5***                    |
| At most 2                 | 205.4***                 | 205.4***                    |

Furthermore, to add more credence to author’s stand, tables 3 and 4 are presented as it represents Johansen Fisher panel and Kao residual cointegration tests respectively. Both tests are statistically significant and show that there is long run relationship amid the variables. These have reaffirmed author’s position that null hypothesis of no cointegration should be rejected and concludes that longevity; urbanization and CO$_2$ emission are cointegrated. Therefore, longevity in West African countries depends on urbanization and CO$_2$ emission. To this end, the coefficients of these variables at long run relationship need to be estimated using the panel cointegration methods of FMOLS and DOLS.

**Table 4. Kao residual cointegration test.**

| Variable | ADF | *** 1% significance level |
|----------|-----|---------------------------|
|          | -12.71*** |                           |

**Table 5. Fmols Result of Lifexp in West Africa**

| Variable | Coefficient of determination |
|----------|------------------------------|
| Urban    | CO$_2$ R$^2$ Adj. R$^2$      |
| FMOLS panel | 1.538 (285.3) *** | -11.38 (-19.49) *** | 0.744 | 0.743 |
| Benin     | 1.53 (70.39) ***       | -11.38 (-4.809) *** | 0.744 | 0.731 |
| Burkina Faso | 4.546 (5.116) *** | -391.9 (-2.190) * | -3.966 | -4.202 |
| Cabo Verde | 1.58 (45.26) ***       | -30.33 (-9.821) *** | -0.256 | -0.316 |
| Cote D’Ivoire | 0.693 (7.231) *** | 44.28 (4.161) *** | -3.042 | -3.235 |
| Gambia    | 0.267 (0.547)          | 184.1 (1.748) *     | -1.443 | -1.560 |
| Ghana     | 1.900 (6.291) ***      | -76.61 (-2.06) *    | -8.801 | -9.268 |
| Guinea    | 1.568 (13.00) ***      | 18.32 (0.803)       | 0.199 | 0.162 |
| Guinea Bissau | 0.613 (5.104) *** | 193.2 (60.4) *** | -2.948 | -3.136 |
| Liberia   | 0.712 (4.892) ***      | 117.6 (3.012) **    | -0.229 | -0.287 |
| Mali      | 1.316 (5.040) ***      | 181.1 (1.450)       | -0.067 | -0.118 |
| Niger     | 3.534 (20.51) ***      | -74.49 (-2.030) *   | 0.618 | 0.600 |
| Nigeria   | 1.284 (7.411) ***      | 0.762 (0.067)       | -2.601 | -2.773 |
| Senegal   | 1.278 (33.45) ***      | 16.90 (3.496) ***   | 0.863 | 0.857 |
| Sierra Leone | 0.912 (4.935) *** | 66.04 (1.277)       | 0.661 | 0.645 |
| Togo      | 1.987 (9.313) ***      | -44.70 (-1.712)     | -5.118 | -5.410 |

| Variable | Coefficient of determination |
|----------|------------------------------|
| Urban    | CO$_2$ R$^2$ Adj. R$^2$      |
| DOLS panel | 1.126 (12.53) *** | -18.10 (-7.89) *** | 0.892 | 0.848 |
| Benin     | 1.126 (2.325) **        | -18.10 (-2.03) *   | 0.892 | 0.834 |
| Burkina Faso | 5.556 (5.378) *** | -366.0 (-1.942) * | -0.293 | -0.989 |
| Cabo Verde | 1.420 (16.87) ***      | -25.26 (-7.245) ***| 0.779 | 0.661 |
| Cote D’Ivoire | 1.359 (6.773) *** | 12.01 (1.035)      | 0.329 | -0.031 |
| Gambia    | 0.811 (5.022) ***       | -5.177 (-0.142)    | 0.941 | 0.909 |
| Ghana     | 1.017 (7.216) ***       | -46.09 (-2.976) ***| 0.751 | 0.617 |
| Guinea    | 2.078 (40.92) ***       | 19.26 (3.003) **    | 0.974 | 0.960 |
| Guinea Bissau | 0.095 (0.927) | 66.96 (2.473) **   | 0.57 | 0.34 |
| Liberia   | 0.885 (6.143) ***       | 77.81 (2.043) *     | 0.802 | 0.696 |
| Mali      | 2.046 (34.80) ***       | 455.9 (15.810) ***  | 0.968 | 0.952 |
| Niger     | 3.999 (26.72) ***       | -136.4 (-5.625) *** | 0.944 | 0.914 |
| Nigeria   | 1.827 (21.37) ***       | 31.93 (5.180) ***   | 0.636 | 0.440 |
| Senegal   | 1.310 (34.85) ***       | 4.463 (1.142)       | 0.986 | 0.979 |
| Sierra Leone | 0.935 (2.8011) *       | 46.70 (59.04)       | 0.939 | 0.907 |
| Togo      | -0.921 (-1.461)        | 7.262 (0.365)       | 0.43 | 0.13 |

**** And * represent 1%, 5% and 10% significance level, respectively.
4.3. Panel Cointegration Estimates

In this study, the author considers the panel cointegration estimates by using the fully modified and dynamic OLS as presented in tables 5 and 6 respectively. The FMOLS and DOLS considered the coefficients of longevity, urbanization and CO₂ emission for individual countries and for the group panel model.

In Table 5, the FMOLS reveal that urbanization is significant at 1% and impact positively on longevity in West Africa countries, this is in conformity with a priori expectation. Since, urbanization drives is part of transitional process from traditional economic to developed ones. The rate of urbanization is significant and has a positive impact on longevity in West African Countries. Therefore, it should be maintained and sustained.

Conversely, the table further presents that CO₂ emission has inverse relationship with longevity and poses negative impact on health quality of West Africans. This position shows that it is statistically significant at 1% with negative impact; which is also in conformity with a prior expectation. Several studies like Mitchell, Mesagan et al and Givens have confirmed that CO₂ emission is negatively significant as the drive for development begins in most developing countries and create threshold for developed countries; [37, 36 and 12]. The FMOLS panel result indicates achieve 1% increase in longevity at long-run, urbanization will be at the aggregate level 1.538 and accompanied with a negative effect of 11.38 in West Africa.

Invariably, urbanization is coming with an accompanying cost effects, as this study present CO₂ as a cost that retards urbanization in West Africa. The EKC assumptions is that, as development takes it ground and begins to impact positively on structurally wellbeing of developing countries; there comes its negative implication on environment quality of countries at the long run. From the FMOL result it is obvious that the EKC proposition holds considering the coefficients of urbanization with a positive sign and CO₂ emission with a negative steering towards longevity in West African Countries.

The country-specific result of FMOLS further confirm that the position in this study holds in some countries like Benin, Burkina Faso, Cabo Verde, Ghana, Niger, Togo and others has one variation with this study’s expectation as regards CO₂ emission. This study assumes that situations differ as there could be certain exogenous factors that are conditional to the considered variables in these countries. The result of Gambia shows otherwise with urbanization not significant and CO₂ emission significant at 10% both positive; it is in total variation with author’s expectations. Also, FMOLS at country-specific considering Givens study that identify types of urbanization across 78 countries and reveal that urbanization are associated with lower carbon intensity of wellbeing [12]. Therefore, urbanization and CO₂ emission have not taken it proper position in some country in West Africa.

The dynamic long run relationships of these variables are considered using the DOLS in table 6 confirmed a priori expectations of this study. The group panel result present urbanization has significant and positively related to longevity while, CO₂ emission is significant but contributes negatively to longevity in ECOWAS countries. This follows suit and gives credence to the earlier result obtained in FMOLS. The DOLS result also upholds the EKC hypothesis considering the relationship between urbanization and CO₂ emission on longevity in West African countries.

Furthermore, the country-specific result of DOLS follow same pattern of FMOLS result as presented earlier except Togo that shows a total variation form the study’s position with urbanization with a negative impact on longevity, while CO₂ emission impact positively on longevity. Surprisingly, the DOLS of Gambia shows that urban is 0.811 at 1% significant impact to longevity but CO is negative with no significant impact. It points in the same direction that urbanization drives development in most West African countries with significant impact on longevity, while CO₂ will retard the gains negatively at the long run.

To add more credence to FMOLS and DOLS positions in the study, eliminate observe non-stationary issue at level and at first difference of among considered variables. This study also confirms that the Pedroni’s residual cointegration test between dimensions of Group rho test is not significant and accept null hypothesis while other reject it. Therefore, the author decides to confirm the position of the study using PMG long run coefficient test.

Table 7. PMG Result of Lifexp in West Africa.

| Variable | Long-Run Co-efficient | CO₂       |
|----------|------------------------|-----------|
| Urban    | 1.748 (284.4) ***      | -6.020 (-40.16) *** |

***Represents 1% significance level.

Table 7, PMG result reveals that earlier results of FMOLS and DOLS are correct and a prior expectation stand. Therefore, as a matter of policy implication it is necessary to create a check and balance on the drive for development through urbanization of cites considering the negative impact among West African countries.

5. Summary, Conclusion and Policy Recommendation

This study has examined the dynamic relationship between urbanization and CO₂ emission on longevity for West African countries. It considers the period spanning from 1990 to 2015 based on durability of data. Data was sourced from WDI 2016 and the conceptual framework takes it root from Mitchell’s work [37]. The study used the theoretical framework from Grossman and incorporate Mesagan et al the of health production into the EKC proposition (laid the foundation for the methodology used in this study) [15, 36]. The methods employed are applied in 3 stages; the panel unit root test and the Peroni residual cointegration test with
Johnsen Fisher and Kao residual cointegration gave the confirmation test in this study. Secondly, the FMOLS and DOLS estimation are performed and lastly, the PMG estimation method.

The aim of this study is to examine the dynamic relationship between urbanization and CO₂ emission on longevity considering the West African experience; to find out the level of impact created by urbanization and CO₂ emission on longevity in West African countries, to examine if there is dynamic relationship between urbanization and CO₂ emissions as most developing countries yearn for development and considering their impact on longevity and confirm if the assumption of EKC hypothesis hold in West African countries.

In order to achieve this, the study employed three variables which are urbanization proxy as Urban; Carbon emission is CO₂ and longevity proxy as life expectancy (LIFEEXP). The empirical findings in this study reveal that all variables are stationary at first difference and not at level considering the homogenous and heterogeneous process of unit root test. Then the existence of long run relationship among variables were confirmed using Pedroni residual cointegration test for between and within dimensions, while Johannsen Fishor and Kao residual cointegration presented further confirmation. These variables are cointegrated and have long run relationship; this confirms the existence of long run relationship between urbanization and CO₂ emission with longevity in West African countries. It suggests that longevity in West African counties has certain level of dependence on urbanization and CO₂ emission.

The level of impact created by urbanization and CO₂ emission on longevity in West Africa was confirmed through the FMOLS and DOLS. The panel results reveal that both variables are statistically significant and have certain level of impact on longevity in West African countries and EKC hypothesis holds in West Africa but on country basis it takes a different stand in some countries.

However, urbanization impact positively while CO₂ emission impact negatively on health quality among West Africans. The estimated coefficient for FMOLS presents urbanization (1.538) with CO₂ emission (-11.38) and DOLS reaffirms urbanization (1.126) with CO₂ (-18.10) at 1% significant respectively. PMG indicates that the confirmatory test of this study’s a priori expectation is correct. The result showed that CO₂ emission had negative but significant effect on longevity while urbanisation had a positive and significant effect on longevity. The study concludes that in ECOWAS countries, urbanisation spur longevity while CO₂ emission retards it.

Since this study has found that urbanization led to longevity in ECOWAS countries and there is potential for growth rate of urbanization in the region to continue, as shown by the trend of growth rate of urbanization. Therefore, the study recommends that more programmes and policies in ECOWAS countries should be geared towards laying good foundation in the unceasing increase and yarning for urbanization. Also, efforts should be made by policy makers in ECOWAS countries to reduce CO₂ emission to the minimum as it has negative impact on longevity according to the findings of this study.

Furthermore, in order to achieve healthier environment in the regional states and enhance its environment in the quest to competing favorably in the globe it would be logical that these countries invest in improving living conditions and reducing CO₂ emissions as long as life expectancy is negatively correlated to CO₂ emissions. As a policy recommendation, it is suggested that efforts should be made by policymakers and governments on how to mediate the rate of urban growth with necessary projects. Finally, for further studies, the need to establish urbanization threshold as a measure for CO₂ emission in West Africa will add credit to this study.

References
[1] Akbostanci, E., turut, asik, S., tunc, G. I. (2006). The relationship between income andenvironment in Turkey: is there an environmental Kuznets curve: International conference in economics-turkish. Economic association Sept 11-13.
[2] Akpan et al (2012) Economic Growth and Environmental Degradation in Nigeria.
[3] Asafu-Adjeaye, J. (2000). The relationship between energy consumption, energy prices and economic growth: time series evidence from Asian developing countries. Energy Economics, 22, 615–625.
[4] Altinay, G., Karagol, E., (2005). Electricity Consumption and Economic Growth: Evidence from Turkey. Energy Economics, 27, 849-856.
[5] Bangake, C., & Eggoh, J. C. (2011). The Feldstein-Horioka puzzle in African countries: A panel cointegration analysis. Economic Modelling, 28, 939–947.
[6] Barido, D. and Marshall, J. (2014). Relationship between Urbanization and CO2 Emissions Depends on Income Level and Policy. Environmental Science and Technology.
[7] Christophe Declercq et al (2011) Impact sanitaire de la pollution atmosphérique dans neuf villes françaises. Résultats du projet Aphekom — Institut de veille sanitaire.
[8] David Satterthwaite, Gordon McGranahan, and Cecilia Tacoli (2010) Urbanization and its implications for food and farming: The Royal Society.
[9] Eric Lambin, (2009), Une écologie du bonheurp. 267.
[10] Georgescu-Roegen (1971), the Entropy Law and the Economic Process, Cambridge, Mass, Harvard University Press, pp. XVIII + 450.
[11] Glasure, Y. U., 2002. Energy and national income in Korea: Further evidence on the role of omitted variables. Energy Economics 24, 355-365.
[12] Givens, J. (2015). Urbanization, Slum, and the Carbon Intensity of Well-being: Implications for Sustainable Development. Human Ecology Review, 22 (1), 107-128 Retrieved from http://www.Jstor.org stable/2487515.
[13] Grossman, M (1972). On the Concept of Health Capital and the Demand for Health. Journal of Political Economy, 80: 223-255.

[14] Grossman G. et Krueger A. (1995), Economic Growth and the Environment, Quarterly Journal of Economics, 112, p. 353-377.

[15] Grossman M (1999). The Human Capital Model of Demand for Health. National Bureau of Economic Research Working Paper No 7078.

[16] Habitatou Gologo/WorldBank (2017). Rapid Urbanization in Africa: Investing in the development of Africa’s Cities accessed 13/3/18.

[17] Halicioglu, Ferda, (2009). "An econometric study of CO2 emissions, energy consumption, income and foreign trade in Turkey," Energy Policy, Elsevier, vol. 37 (3), pages 1156-1164, March.

[18] http://www.unep.org/geo/GE02000/pdfs/ov-fr.pdf Accessed on 19/2/18.

[19] http://www.usaid.gov/press/frontlines/II_mar05/ Accessed on 18/2/18. United States Agency for International Development.

[20] http://www.unhabitat.org/pmss/listItemDetails.aspx?publicatio nID=2562. Accessed on 19/2/18 United Nations Human Settlement Program.

[21] https://en.wikipedia.org/wiki/Urbanization accessed 30/01/2018.

[22] Im, K. S., Pesaran, M. H., & Shin, Y. C. (2003). Testing for unit roots in heterogeneous panels. *Journal of Econometrics*, 115, 53–74.

[23] Issooufi, F., Toumi, H. And Touili, W. (2015). Effects of CO2 Emissions on Economic Growth, Urbanization And Welfare: Application To Mena Countries. *MPRA* Paper No. 65683.

[24] Ivan Turok, Gordon McGranahan (2013) Urbanization and economic growth: the arguments and evidence for Africa and Asia: Research Article.

[25] Joseph, A. O. (2010), "Environmental Quality and Economic Growth in Some Selected West African Countries: A Panel Data Assessment of the Environmental Kuznets Curve" *Journal of Sustainable Development in Africa* Vol. 12, No. 8, pp. 35-48.

[26] Jude C. Eggo, Chrysost Bangake and Christopher Rault (2011) pg 7413 Enery Consumption and Economic Growth revisited in African Countries: Enery Policy 39 (2011) 7408-7421 www.elsevier.com/locate/enpol.

[27] Kamp, I., Leidelmeijer, K., Marsmana, G. and Hollander, A. (2003). Urban Environmental Quality and Human Well-Being Towards a Conceptual Framework and Demarcation of Concepts; a Literature Study.

[28] Kao and Chiang (2000) for more readings on the efficiency and advantages of these estimators.

[29] Leidelmeijer, K., van Kamp, I., Marsman, G., (2002). Leeftaardh na a begrapenkaer en Conceptuele inkadering (RIGO, RIVM). Rapportnummer 81330.

[30] Leila Rafei and Mahyar Eshragh Tabary (2014) Africa’s urban population growth: trends and projections.

[31] Levin, A., Lin, C. F., & Chu, C. S. J. (2002). Unit root tests in panel data: Asymptotic and finite-sample properties. *Journal of Econometrics*, 108, 1–24.

[32] Martinez zaro I. and Bengochea-Moranco. A (2004), pooled mean group estimation of an environmental Kuznets Curve for co2. Economics letters, 82, 121-126.

[33] Masih A. M. M., Masih R. (1996), Electricity consumption, real income and temporal causality: results from a multi-country study based on cointegration and error correction modeling techniques, *Energy Economics*, Vol. 18, p. 165–183.

[34] Matthew A. Adegbuye, B. and Fasina, F. (2015). Public Health Expenditure and Health Outcomes in Nigeria. *International Journal of Financial Economics*. Volume Vol. 4. Issue No. 1. Pages 45-56.

[35] Meadows D. H., Meadows D. L. Randers J, and. Behrens W. W III (1972), The Limits to Growth, Universe Books, New York.

[36] Mesagan, E P., Ishola, W. A., & Ajide K. B. (2018). The Capital Investment Channel of Environmental improvement: Evidence from BRIC Environment Development and Sustainability Springer.

[37] Mitchell, G., (2000). Indicators as Tools to Guide Progress on the Sustainable Development Pathway. In: Lawrence, R. J. (Ed.), Sustaining Human Settlement: A Challenge for the New Millennium. Urban International Press, pp. 55–104.

[38] Morimoto R., Hope C. (2004), The impact of electricity supply on economic growth in Sri Lanka, *Energy Economics*, Vol. 26, p. 77–85.

[39] Narayan, P. K., and Smyth, R., (2008). Energy consumption and real GDP in G7 countries, new evidence from panel cointegration with structural breaks. *Energy Economics* 30, 2331–2341.

[40] Olatunde, F., Toumi, H. And Touili, W. (2015). Effects of CO2 Emissions on Economic Growth, Urbanization And Welfare: Application To Mena Countries. *MPRA* Paper No. 65683.

[41] Oh W., Lee K. (2004), Energy consumption and economic growth in Korea: testing the causality relation, *Journal of Policy Modeling*, vol 26, p. 973–981.

[42] Pedroni, P. (1999). Critical values for cointegration tests in heterogeneous panels with multiple regressors. *Oxford Bulletin of Economics and Statistics*, 61, 653–670.

[43] Pedroni, P. (2000). Fully modified OLS for heterogeneous cointegrated panels. *Advances in Econometrics*, 15, 93–130.

[44] Revision of the World Urbanization prospects 2014.

[45] Usenobong, E. A., and Chukwu A. C. (2012), “Economic Growth and Environmental Degradation in Nigeria: Beyond the Environmental Kuznets Curve”. *Proceedings of the NAEE Conference on Green Energy and Energy Security Option for Africa*, pp. 212-234.

[46] UN report on Urbanization Report 2014.

[47] United Nations Population Fund https://www.unfpa.org/urbanization Retrieved 28/01/2018.

[48] Shafik, N. (1994): Economic Development and Environmental Quality: An Econometric Analysis. In: *Oxford Economic Papers*, Jg. 46, S. 757-773.
[49] Shahbaz, M., Tang, C. F. & Shabbir, M. S. (2011), 'Electricity consumption and economic growth nexus in Portugal using cointegration and causality approaches', Energy Policy (in press).

[50] Sharif Hossain «Panel estimation for CO2 emissions, energy consumption, economic growth, trade openness and urbanization of newly industrialized countries» Energy Policy, 2011, vol. 39, issue 11, pages 6991-6999.

[51] Soytas U., Sari R. (2003), «Energy consumption and GDP: causality relationship in G-7 countries and emerging markets», Energy Economics, Vol. 25, p. 33–37.

[52] Soytas, U., Sari, R. & Ewing, B. T. (2007), 'Energy consumption, income and carbon emissions in the United States’, Ecological Economics 62, 482–489.

[53] Soytas U. et Sari R. (2009): “Energy consumption, economic growth and carbon emissions: challenges faced by an candidate member”, Ecological Economics, Vol. 68, p. 1667-1675.

[54] Stern, D. I., (1993). Energy and economic growth in the USA, a multivariate approach. Energy Economics 15, 137–150.

[55] World Bank (2009), World Development Report 2009: Reshaping Economic Geography, The World Bank, Washington DC, 383 pages. Google Scholar.

[56] Yang, H. Y., (2000), A note on the causal relationship between energy and GDP in Taiwan. Energy Economics 22, 309–317.

[57] Yuyu Chen, Avraham Ebenstein, Michael Greenstone, and Hongbin Li (2013) Evidence on the Impact of Sustained Exposure to Air Pollution on Life Expectancy from China’s Huai River Policy, Edited by William C. Clark, Harvard University, Cambridge.