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Urbanization, CO_2 Emission and Longevity: The West African Experience

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Abstract: This study considered the dynamic relationship between urbanization and CO_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_2 emission). Hence the need to observe the effect of CO_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_2 emission (-11.38) and DOLS reaffirmed urbanization (1.126) with CO_2 (-18.10) at 1% significant respectively. PMG indicated that the confirmatory test of a priori expectation is correct. The result showed that CO_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_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_2 emission retards it.

Keywords: Urbanization, CO_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 Shaifk 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 relation 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 CO_2 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 CO_2 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, CO_2 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 CO_2 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 CO_2 emissions on per capita growth, energy consumption, life expectancy and urbanization in Middle East and North African (MENA) countries (Algeria, Bahrain, Egypt, Emirates Arabs, Jordan, Saudi Arabs, 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 CO_2 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 CO_2 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 CO_2 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, CO_2 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,

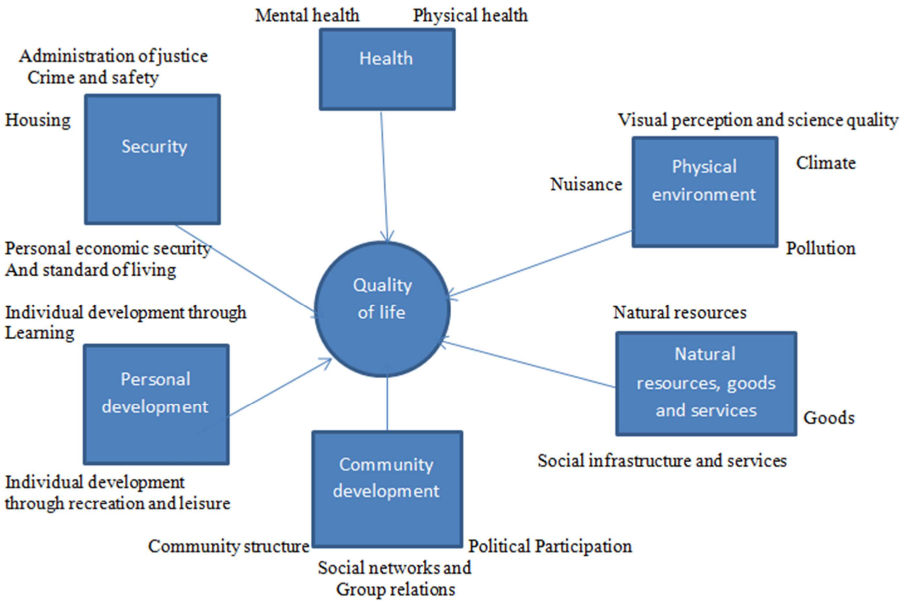
CO_2 emission and longevity in the West Africa context. It is on this background that the main objective is to empirically examine the effect of urbanization and CO_2 emission on longevity in ECOWAS countries. This study uses the panel data analysis, FMOLS, DOLS and PMG to test the effect of urbanization and CO_2 emission on longevity for ECOWAS countries. The study concludes that in ECOWAS countries, urbanisation spur longevity while CO_2 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].



Source: Mitchell, G., (2000)

Figure 1. *Quality-of-life components (Mitchell, 2000).*

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:

$$H_{it} = f(URBAN_{it}, CO2_{it}) \qquad (1)$$

Health outcomes represent (*H*) with longevity (LIFEXP), CO_2 emission (CO_2) and urbanisation (URBAN). Conversely, one of the key propositions of this study is that CO_2 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 from1992 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:

$$(H) = \beta_0 + \beta_1 Y_{it} + \beta_1 Y^2{}_{it} + \varepsilon_{it} \quad (2)$$

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 CO_2. Therefore, incorporating Grossman theory of health production, equation 1 into EKC hypothesis, equation 2 with the choice variables [15]. It becomes:

$$(LIFEXP) = \beta_0 + \beta_1 \mathrm{URBAN}_{it} + \beta_2 CO2_{it} \quad (3)$$

Considering, equation 3 β_0 is the intercept term, while β_1 and β_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 CO_2 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), CO_2 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 CO_2 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 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 FMOLS 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:

$$LIFEXP_{it} = \alpha_i + \beta_i X_{it} + \mu_{it} \quad (4)$$

LIFEXP remains as specified earlier, X_{it} is the vector for urbanization and Co_2 emission which are the explanatory variables and μ is the error term. It means that $LIFEXP_{it}$ and X_{it} are cointegrated with slopes β_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 $\sigma_i = lin\ T \to \infty\ \varepsilon$

$$n_i = \lim T \to \infty E[T^{-1}(\textstyle\sum_{t=1}^{T} \varepsilon_{it})[\sum_{t=1}^{T} \varepsilon'_{it}] \quad (5)$$

Therefore, it is possible to have $n_i = n_i + \sigma_i + \sigma'_i$ where n_i^o the contemporaneous covariance and σ_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:

$$\hat{\beta}^*_{GFM} = N^{-1} \textstyle\sum_{i=1}^{N} (\sum_{i=1}^{N} (x_{it} - \bar{x}_i)^2)^{-1} * [\sum_{i=1}^{N} (x_{it} - \bar{x}_i) LIFEXP_{it} - T\widehat{LIFEXP}_i) \quad (6)$$

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

Where: $LIFEXP^*_{it} = (LIFEXP_{it} - \overline{LIFEXP}_{it}) - \frac{\hat{n}_{21i}}{n_{22i}} \Delta x_{it}$ and $\widehat{LIFEXP} = \hat{\sigma}_{21i} + \hat{n}^0_{21i} - \frac{\hat{n}_{21i}}{\hat{n}_{22i}} (\hat{\sigma}_{22i} + \hat{n}^0_{22i})$. Author identifies the between-dimension estimator using $\hat{\beta}^*_{GFM} = N^{-1} \sum_{i=1}^{N} \hat{\beta}^*_{FMi}$ note that conventionally $\hat{\beta}^*_{FMi}$ is FMOLS estimator which is applied to ith member of the panel. Whereas, the t statistics for the between-dimension is given as $t_{\beta^*_{GFM}} = N^{-\frac{1}{2}} \sum_{t=1}^{N} t_{\hat{\beta}^*_{FMi}}$ while $t_{\hat{\beta}^*_{FMi}} = (\hat{\beta}^*_{FMi} - \beta_0)(\hat{n}_{11i}^{-1} \sum_{t=1}^{T} (x_{it} - \bar{x}_{it})^2)^{\frac{1}{2}}$

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 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:

$$LIFEXP_{it} = \beta_{0_{it}} + \beta_1 x_{it} + \textstyle\sum_{k=-ki}^{ki} Y_{it} \Delta x_{it-k} + \mu_{it} \quad (7)$$

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

$$\hat{\beta}^*_{GD} [N^{-1} \textstyle\sum_{i=1}^{N} (\sum_{+=1}^{T} z_{it} z'_{it})(\sum_{t=1}^{T} z_{it} LIFEEXP_{it})\text{-------}] \quad (8)$$

Whereas is $Z_{it} = (x_{it} - \bar{x}_i \Delta k_{it-k} \ldots \ldots \ldots \Delta x_{it+k})$ note that Z_{it} is the $2(k+1) * 1$ vector of regressors and $LIFEXP_{it} = LIFEXP_{it} - \overline{LIFEXP_i}$ is the transferred variable of longevity. The between-dimension estimator is then presented as $\beta^*_{GD} = N^{-1} \sum_{i-1}^{N} \beta^*_{D,i}$ where $\beta^*_{D,i}$ 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 $\partial_i^2 = \lim T \to$

$\infty\, E\,[T^{-1}(\sum_{t=1}^{T}\hat{\mu}_{it}^{*})^2]$ as the long run variance of the residuals from the DOLS, while the DOLS t-statistics for the between-dimension estimator is given as:

$$t_{\hat{\beta}_{GD}^{*}} = N^{-\frac{1}{2}}\sum_{i=1}^{N} t_{\hat{\beta}_{D,i}^{*}} \text{ and } t_{\hat{\beta}_{D,i}^{*}} = (\hat{\beta}_{D,i}^{*} - \beta_0)\{\hat{\sigma}_i^{-2}\sum_{t=1}^{T}(x_{it}-\bar{x}_i)^2\}^{\frac{1}{2}} \quad (9)$$

It has been observed that studies face the challenge of constructing the regressors in a way of not inhibiting the transitional dynamics to be similar among the countries considered when applying panel cointegration tests to long-run hypothesis in aggregate. On this ground, Bangake et al suggested a way out by employing the fundamental theme that only consider the data of long run hypothesis of interest and allow the short run to be potentially heterogeneous for the panel DOLS and FMOLS approaches [5]. In view of this, PMG developed by as Im et al. a general framework that adapt 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,,……., q) model, then the proposed PMG for the study adapt from pesaran bound test is

$$LIFEXP_{it} = \sum_{j=1}^{p}\omega_{ij}\,x_{it-j} + \sum_{j=0}^{q}\delta'_{it}x_{i,t-j} + \mu_{it} + \varepsilon_{it} \quad (10)$$

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

$$\Delta LIFEXP_{it} = \emptyset_i LIFEXP_{it-1} + \beta_i' x_{it} + \sum_{j=1}^{p-1}\omega_{ij}^{*}\,\Delta\, LIFEXP_{i,t-j} + \sum_{j=0}^{q-1}\delta_{ij}^{*\prime}\Delta x_{i,t-j} + \mu_{it} + \varepsilon_{it},$$ note that $\emptyset_i = -(1 - \sum_{j=1}^{p}\omega_{ij})$, $\beta_i = \sum_{j=0}^{q}\delta_{ij}$, $\omega_{ij}^{*} = -\sum_{m=j+1}^{p}\omega_{im}$, j= 1, 2,…., p-1 and $\delta_{ij}^{*} = -\sum_{m=j+1}^{q}\delta_{im}$, $j = 1, 2, \ldots\ldots\ldots, q-1$.

The PMG assumes that the ARDL (p, q, q… q) if the roots of the equation 1- $\sum_{j=1}^{p-1}\omega_{ij}z^{J} = 0$ it means it is stable and lie outside the unit circle. It shows that the assumption ensures that $\emptyset_i < 0$, and there exist a long-run relationship between urbanization and CO_2 emission with longevity specified as $LIFEXP_{it} = -(\frac{\beta_i}{\emptyset_i}(x)_{it} + n_{it})$, note that n_{it} is a stationary process and the long-run coefficients $\theta_i = -\frac{\beta_i}{\emptyset_i} = \emptyset$ which are the same across the countries.

***Table 1.** Panel Unit root.*

Variables	Heterogeneous unit root process						Homogenous unit root process			
	Level			1st diff			Level		1st diff	
	ADF	PP Fisher	IPS	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***
CO_2 14.95	14.95	13.60	1.08	141.9***	159.0***	-10.48***	-3.22	-1.99**	-15.42***	13.06***

ADF, PPF IPS LLC Levin, Lin and Chu
*** 1% significant; ** 5% significant

***Table 2.** Pedroni residual cointegration test.*

	Between-dimension		Within-dimension	
	Statistic	Statistic	Weighted	Statistic
Group rho	-0.36	Panel v-stat	4.63***	4.63***
Group PP	-3.30***	Panel rho-stat	-2.09**	-2.90**
Group ADF	-3.62***	Panel ADF-stat	-3.97***	-3.99***

***** 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.

4.2. Panel Cointegration Result

It has been established that the variables are stationary at first difference and not at levels. It then becomes necessary to establish the panel cointegration test in order to determine the long run relationship between longevity and explanatory variables that is urbanization and CO_2 emission. Author conducts the panel cointegration test using the Pedroni model; considers four within-dimension tests for panel and three between-dimension tests for group as presented in table 2 [42].

The table 2 shows the Pedroni residual cointegration test statistics which examine the between and within dimension of null hypothesis against the homogenous and heterogeneous alternatives. The computed value of statistics in the table are based on the estimates that average the coefficient estimated variables for all country in the between-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.*

ADF	-12.71***

*** 1% significance level

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

15 Countries	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	0162
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

***** And * represent 1%, 5% and 10%significance level, respectively.

Table 6. *Dols Result of Lifexp In West Africa.*

15 Countries	Variable		Coefficient of determination	
	Urban	CO_2	R^2	Adj. R^2
DOLS panel	1.126 (12.53) ***	-18.10 (-789) ***	0.892	0.848
Benin	1.126 (3.235) **	-18.10 (-203) *	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 (-2976) ***	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, 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 CO_2 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 prior 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 CO_2 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 CO_2 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 CO_2 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 CO_2 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 CO_2 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 CO_2 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 CO_2 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, CO_2 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 CO_2 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 CO_2 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 CO_2 will retard the gains negatively at the long run.

To add more credence to FMOLS and DOLS positions in the study, eliminate observe non-stationarity 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.*

Long-Run Co-efficient	Variable	
	Urban	**CO_2**
PMG	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 Co_2 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 theory 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

Johnasen 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 CO_2 emission on longevity considering the West African experience; to find out the level of impact created by urbanization and CO_2 emission on longevity in West African countries, to examine if there is dynamic relationship between urbanization and CO_2 emissionas 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 CO_2 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 CO_2 emission with longevity in West African countries. It suggests that longevity in West African counties has certain level of dependence on urbanization and CO_2 emission.

The level of impact created by urbanization and CO_2 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 CO_2 emission impact negatively on health quality among West Africans. The estimated coefficient for FMOLS presents urbanization (1.538) with CO_2 emission (-11.38) and DOLS reaffirms urbanization (1.126) with CO_2 (-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 CO_2 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 CO_2 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 CO_2 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 CO_2 emissions as long as life expectancy is negatively correlated to CO_2 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 CO_2 emission in West Africa will add credit to this study.

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