1 Introduction

The relationship between population, urbanization and environmental quality has attracted the attention of policy makers and academic researchers for many decades especially in issues of sustainable development. However, whereas environmentalists and sociologists have long been interested in the subject matter, development economists have only recently been aware of this very important issue and begun paying more purpose – driven attention to the relationship. Interestingly, there are many studies that have systematically assessed directly or indirectly the relationship between population and environmental quality, population and urbanization as well as urbanization and environmental quality; Dasgupta, Levin & Lubchenco (2000), Khan, Inamullah & Shams (2009), Mba, Uchegbu, Udeh & Mghalu (2004),Olaleye (2013) and, Oyeleye (2013). From literature, rapid population growth can affect the environment through human activities which ultimately would lead to the increase Green House Gases (GHG) emission in the environment and this can lead to environmental quality variation with its inherent undesirable outcomes. Such undesirable environmental outcomes can damage humanity, biodiversity, ecosystems and many others (Ifeanyi ,2002). It has been observed that with rapid population growth, it is usually challenging to cope with changes that accompany economic and social adjustment. Besides, a growing population is a threat to the environment as it is usually associated with extensive mass consumption of durable goods and household gadgets. Through production and consumption patterns, population dynamics affects the level and intensity of weather events. The existence of a large population clearly means the occurrence of greater human needs and a higher dependence on the environment.

The drivers of population dynamics (birth rate, death rate and migration) and other demographic variables are important in defining the quality of the environment. In the same vein, the forces behind the growth and movement of population play a critical role in the urbanization process. The urbanization rate in most developing countries is linked in many complex ways to population dynamics (that is the birth rate, dearth rate and migration). In 1982, United Nation had predicted that, by 2025, the main rural character of the developing countries may be gone as almost 30 per cent of the metropolitan population will be residing in the cities. This prediction seems evidenced in Nigeria ahead of 2025. Urban dwellers are rapidly becoming a majority of the population as the urban population is growing several times as fast as in the rural population either through natural growth or through migration from rural areas (United Nation, 1990). More so, Oyeleye (2013) hold the view that population mobility or dynamics naturally accelerates urbanization rate.

This is clearly evident in Nigeria, thus, six decades after independence, she has an approximate population of over 200 million persons which ranks her the 7th most populated country in the world (Leke & Leke,2019). Specifically, 2.35 per cent of the world's entire inhabitant is comprised of the Nigerian population. Population dynamics in Nigeria is such that has brought about an increase in the population and this has clearly led to increased needs for agricultural lands, infrastructural development, industrial activities and perhaps, human shelter. All these activities ultimately increase the rate of urbanization. Urbanization in Nigeria constitutes 47.8 per cent of the Nigerian dwelling space given the annual urbanization change rate of 4.6 per cent (Leke & Leke, 2019). Urbanization trend in Nigeria is not only unpredictable but also peculiarly very high. This peculiarity in the urbanization trend is not solely as a result of increase in population but also due to absence of a befitting rural infrastructure and rural employment, insurgencies/insecurity at urban centres peripherals (Ibrahim, Yusuf & Hassan, 2018). This observable fact of rapid urbanization rate has seen the clearing of forest areas in Nigeria as more people assemble to create new urban centres in the search for gainful means of livelihood. Regrettably, a combination of failed urban planning and an ever-increasing economic misery implies afflictions for the quality of Nigerian environment. Lawanson (2021) attributed the poor environmental quality in Nigeria to human attitudes especially in the absence of strong political will by policy makers to initiate and implement policies for sustainable environmental quality in the face of rising population growth rate. According to Lawanson (2021), the blend of soaring population growth and speedy urbanization has become the basic cause of towering rates of industrial rot, pollution and eventually, a compromised environmental quality in Nigeria.

This assertion by Lawanson (2021) is most noticeable in most Nigerian urban and some rural areas where most of the natural environment has been destroyed in the pursuit of industrialization and development. There are hardly green areas or designated places for recreation in a good number of urban centres in Nigeria (Imasuen, Oshodi & Onyeobi, 2013). Unmistakably, Nigeria is an emerging economy with intimidating environmental issues. The United Nations Development Programme (UNDP) revealed this in part of a report that different parts of the country have experienced massive environmental issues ranging from flooding, soil and coastal erosions, pollution (both air and water), constant oil spillage and deforestation. The information as contained in the report further discloses that these environmental issues were outcomes of reckless environmental administration procedures which Sub-Saharan African countries are well-known for. Lately, available data shows that 89.4 metric tons of Green House Gas (GHG) emissions was recorded in 2015, representing a rise of about 4.35 per cent. While in 2018 and 2019, 97.0

metric tons and100.2million metric tons was recorded respectively, indicating a borderline upsurge of 2.61 per cent (Uche & Effiom, 2021)

Despite this realization, demographic factors have not always been appropriately and conclusively documented and integrated into the analyses of population changes, urbanization and its effect on environmental quality. The foregoing realization provokes a number of questions. What is the effect of population dynamics on environmental quality in Nigeria? What is effect of urbanization on environmental quality in Nigeria? It is worthy of note that only few studies empirically examined the impact of population dynamics and urbanization on environmental quality in Nigeria. Therefore, this study is to re-examine the existing relationship between population dynamics, urbanization and environmental quality in Nigeria under the framework of the Stochastic Regression on Population, Affluence and Technology (STIRPAT) model. *The uniqueness of this paper lies in the fact that it is not interested in the static effects of population dynamics and urbanization on environmental quality but in the dynamic effect of population and urbanization on environmental quality in Nigeria using a data set covering the periods of 1980 to 2022. The study is structured into five sections with section one focusing on the introduction of the study, section two focused on conceptual and empirical issues, section three is concerned with theoretical issues and model specification, section four is focused on presentation, analysis and discussion of results while last section is the summary and conclusion of the study.*

2 Conceptual clarifications and empirical issues

Population dynamics: *This is simply the three key demographic factors of death rate, birth rate and migration that significantly determine variations in population composition, size and distribution. These variations raise a number of vital questions of cause and effect.*

Urbanization: *Hope and Lekorwe (2009) defined urbanization as the yearly percentage of change in the proportion of people living in urban centres. Also, Ibrahim, Yusuf and Hassan (2018) defined urbanization as a process by which urban localities multiply in size and density, population-wise. In the context of this study, Urbanization is defined as the rate of growth of urban population within a period of time.*

Environmental quality: *This is simply the heterogenous features of the environment and the potential effects of such features on the ecosystem caused by human activities. Environmental quality includes natural environment and also man-made environment such as air, water, pollution, etc.*

2.1 Empirical literature

Population and Environmental Quality

Reviewing the correlation between population and the environment is not straightforward. ''Population'' is a multi-dimensional concept that can be analyzed in terms of the size, density, distribution as well as in terms of composition of an area's dwellers or occupants. ''Environment'' is also not less thorny — covering qualities of the water, air and land on which creatures depend. The myriad of mediating influences (like technological factors, namely, forms of energy production; political factors, namely, environmental regulation; and cultural factors, namely, attitudes towards wildlife and conservation) that ultimately shape this association have further complicated the relationship between population and the environment.

Interestingly, research has proven the fact that population is deemed an important resource of economic development; however, it is an important cause of environmental quality depletion when it surpasses the tolerance limits of the livelihood system. Population dynamics have an effect on the quality of the environment predominantly through the utilization of natural reserves or resources and production of litters. It is also linked with environmental strains or tensions like air and water pollution, loss of biodiversity and enlarged strain on arable land (UNRISD, 2021). The leading causes of air quality degradation are: (a) fast rising energy demand; and (b) rapidly growing transportation sector. In cities, widespread usage of low-quality fuel, combined with the breathtaking growth in the number of automobiles on roads, has led to considerable air pollution complications.

Khalid, Khan, Saleem and Nawaz (2011) researched on the interaction between population and environmental degradation for India, Sri Lanka and Pakistan (three SAARC countries) from 1985 to 2009 using Seemingly Unrelated Regression Estimates. The estimates indicated that population dynamics (such as population increases) has a damaging effect on environmental quality, given that it was the only variable that negatively significantly impacted on environmental quality in the three SAARC countries. According to them, Khalid et al (2011), increase in population puts excessive pressure on land (be it agricultural land or otherwise) thus leading to poorer environmental quality over time. The trio therefore recommended good governance which has appreciable and long-lasting effect in lowering population growth as this may have the capability to improve environmental quality in the long run.

Issues of environment and its challenges in Nigeria were carefully itemized descriptively to include poverty, pollution, urbanization, deforestation and desertification. These issues/challenges have arisen basically because of the ever-increasing Nigerian population that has led to large scale expansion in human activities which have continually exacerbated the problems of deforestation and desertification in

Nigeria. Already, evidence abound that in Borno, Yobe, Jigawa and other states, between 35 per cent and 40 per cent of landmass has already been lost to desertification. Leke and Leke (2019) and Nneji (2021). Between 2001 and 2010, the forests area in Nigeria contracted from 14.4 per cent to 9.9 per cent (Nigeria: Millennium Development Goals Report, 2010. www.mdgs.gov.ng). The implication of such deforestation and desertification is the unceasing degradation of the environment and Nigeria's ecosystem leading to economic losses in the form of agricultural activities. The African Institute for Applied Economics (AIAE) estimated that about N106 billion had been lost to deforestation in Nigeria as at 2005 (Leke and Leke (2019) and Nneji (2021).

Ehrlic and Holden (1971) attributed pollution and decreasing environmental quality to solely rising human population in both less developed and developed countries. This view was strongly supported by other scholars who opined that population growth is a factor in the soaring rates of decreasing environmental quality both directly and indirectly. The outcome of the empirical study by Dasgupta and Lubchenco (2000) does support the view that population growth or increases impact negatively on environmental quality. Specifically, Dasgupta and Lubchenco (2000) discovered that the relationship between population expansion and environmental resources in the United States is such that the former (population) is changing the ''harmony'' of the nation's environment (that is water, land and atmosphere) so intensely that most of these alterations have adversely affected its natural environmental quality.

Though some scholars, like Khalid et. al. (2011) may view population growth in developing countries as the root cause of environmental decline, others like UNEP (1999), Gilletal, Hassan & Haseed (2019, Lahiani, (2020), Shoaib, Rafique, Nadeem & Huang (2020) believe that it is the costly environmental effects of industrial activities that are technologically driven among the developed nations that are actually responsible for the decline in environmental quality. Gillatel et.al. (2019) and Shoaib et. al. (2020) argued that energy intensive technologies are the dominant characteristic of these industrialized developed countries thus leading undoubtedly to an increase in the use of fossil fuels and its derivatives of oil, gas and coal and ultimately, to an upsurge in the quantity of greenhouse gases discharged into the atmosphere. In all of these, environmental quality is compromised.

Cui, Zhao and Shi (2018) employed transformed Kaya identity in light of local actual conditions for selecting eight influencing factors. More so, an extended STIRPAT model and ridge regression were used to make regression analysis. Results showed that contributing factors were efficiency, agricultural import, urbanization, agricultural mechanization, and population, whose 1 per cent increase caused 0.1852 per cent, 0.1663 per cent, 0.1597 per cent, 0.1573 per cent, and 0.1329 per cent increases in carbon

emissions, respectively, while 1 per cent growth in industry structure and agricultural affluence were responsible for 0.1475 per cent, and changing the elastic coefficient of (0.1314-0.2958lnA) per cent decrease in carbon emissions, respectively, where A represented agricultural output value per capita. Furthermore, the study concluded that there exist an inverted U-shaped EKC between economic progress and carbon emissions.

Bargaoui, Liouane and Nouri (2014) investigated the impact of economic and population growth, urbanization level, energy intensity and Kyoto protocol obligations on carbon dioxide emissions using the STIRPAT model (Stochastic Impacts by Regression on Population, Affluence and Technology). The study sample of countries was decomposed into groups according to the revenue level and the analyzed period extends from 1980 through 2010. The study adopted panel data and the finding show that there is a significant effect of economic growth, population growth, urbanization level and Kyoto protocol on emissions level and this effect depends on the revenue level.

Martinez-Zarzoso (2008) studied countries of different income groups during the period 1975-2003 and found that the impact of population growth on emissions is slightly different for upper, middle, and low income countries and that urbanization had a very different impact on emissions for low and lower-middle-income countries and upper-middle income countries. By their analysis of the driving forces of CO2 emissions in India during the period from1960 to 2007, Behera and Vishnu (2011) showed that urbanization, population, service sector, industrial sector and GDP per capita had negative effects on environment. Recently, Sanglimsuwan (2012) estimated the impact of changes in population, GDP and the structure of economy on carbon dioxide emissions for 83 countries from 1980 to 2007. Results suggested that higher population and higher percentage of working-age population lead to higher CO2 emissions.

Urbanization and Environmental quality

In Nigeria, it is no news that the urbanization trend is unpredictably alarming and it is projected that between 40 and 45 per cent of the population reside in urban centers (National Bureau of Statistics, 2006 and National Population Commission, 2009). This projection may not be mere statistical abstraction as currently, there seems to be more dimensions to the causes of urbanization (such as insurgencies and insecurity at cities' peripherals, higher rural unemployment, poor rural infrastructure, frequent creation of states and local governments, to mention but a few) in Nigeria than there were in the late seventies and eighties (Ibrahim et. al. 2018).

Using simple descriptive analysis to examine the impact of urbanization in Nigeria, Ibrahim and Hassan (2018) concluded that urbanization has altered the entire properties of the ecosystem in Nigeria thus degrading its environmental quality in terms of loss of vegetation, excess water runoff, accumulation of heavy metals, soil erosion, etc. According to the duo Ibrahim et al. (2018), these alterations have happened solely due to the fact that, in Nigeria, developments projects are guided by economic rather than environmental gains. The paper therefore recommended among other things, the preservation of ecological integrity, efficient and appropriate land use and healthy living conditions in Nigeria.

Also, the challenges and strategies towards guaranteeing sustainable urban growth and development in Nigeria were examined by Ayedun, Durodola and Akinjare (2011). The study used descriptive methodology to assess and upheld the fact that urbanization has had adverse effect on Nigeria's environmental quality, notably among which include issues of over-stretched, poorly managed and neglected ecosystem, undirected drainage system, environmental waste and degradation and loss of natural or primary vegetation. The paper concluded that for urban growth to be sustainable in Nigeria with little or no adverse impact on the environment, sincerity of purpose on the part of government and a strong political will to implement policies, laws and development strategies that would enhance urban qualities is required.

Several types of environmental challenges arising from urbanization have long been descriptively identified in Nigeria by Mba et.al (2004) and Oyeleye (2013). These challenges are pigeon-holed into ecological, habitat loss, soil erosion etc. Accordingly, pollution, deforestation global warming and slump developments that add up to decrease the environmental quality are common features resulting from rapid urbanization in Nigeria (Mba et.al. 2004; Oyeleye, 2013). Adedeji and Ezeyi (2010) emphasized that there is a common poor living condition in the urban centers in Nigeria which is an affront not only to environmental dignity but also to human dignity. Inappropriate waste management practice in Nigeria has worsened Nigeria's environmental problems specifically in the urban areas. Gas emissions from cars and other industrial sources, slumps developments in the urban areas deplete completely the physical environmental quality. In all, the environmental problems in Nigeria are products of high rate of urbanization which is statistically put at 4.7 per cent per annum, far higher than population growth rate (Adedeji & Ezeyi, 2010).

In fact, environmental quality variations in urban areas is as a result of the prohibitive rate of industrial and commercial activities in the metropolitan areas, with little or modest attention to the implications of these activities on the environmental quality. The environmental quality change causes the

occurrence of never-ending harsh temperature, flood, among other challenges (Mabo, 2006; Odjugo, 2011). Ohwo and Abotutu (2015) x-rayed the environmental impact of urbanization in Nigeria using descriptive method. The study being a snap shot analysis reveals that the aim of achieving environmental sustainability is critically endangered by urbanization which has given rise to many serious environmental issues such as pollution, erosion, flooding, urban sprawl, deforestation and natural aesthetic degradation that have had undesirable influences on other living creatures in the environment. Ohwo and Abotutu (2015) further pointed out that if the threat posed by urbanization in Nigeria is not properly handled, the capability of the environment to always sustain life may be endangered with threatening costs on human life.

Summarily, from the empirical literature, most of the studies reviewed used descriptive analysis in examining the effect of population and or urbanization on environmental quality in Nigeria. With such analyses, these studies were unable to quantify the effects of these demographic variables on environmental quality in Nigeria. Thus, there is need for further empirical study such as this to apply parametric econometric method as well as consider how other factors like gross domestic product per capita, crude birth rate and crude death rate contributes in the tripartite relationship between population changes, urbanization and environmental quality in Nigeria using an extended data point.

3 Theoretical issues and model specification

*From available literature, it is propounded that as the economy grows and progresses, reduction in environmental quality initially escalates and then declines, such that the appearance of the correlation between economic development and a decrease in environmental quality takes the form of an inverted U-shaped curve, that is called the environmental Kuznets curve popularly referred to as EKC (*Dinda, 2004; Grossman & Krueger, 1991; Munasinghe , 1999*). The advocates of this view argued that the EKC path is to be expected with soaring economic development. These beliefs of the EKC are grounded on 3 primary postulations that may not necessarily be applicable to all environmental conditions. The first postulation is that all contaminants or pollutants will react likewise to economic development. This is not necessarily true as there exist dissimilarity in response to economic development which could be partially ascribed to environmental externalities (after-effects of mercantile activities that affect other outfits and the environment, but are not captured in the production cost). The second postulation is that once economic recovery begins, the path is dependable and improvement will continue. However, soaring gross national income might lead to rising pollution associated with greater rates of resource utilization and ensuing litter generation, thereby altering the U-shaped EKC to an N-shaped curve (*Arrow, Bolin, Costanza, Dasgupta,

Folke, Holling, Jansson, Levin, Maler & Pimentel, 1995; Dinda, 2004). The EKC also is centred on the postulation that improvement in development and institution of trade relations will ease impoverishment for a larger segment of the populace. Nonetheless, in reality, growth/development plans and trade relations in less developed countries could worsen impoverishment or poverty-related pollution which may exacerbate the reduction in environmental quality (Asici, 2013; Daly, 1993)

Also, the theory of demographic transition model (DTM) developed in 1929 by the American demographer; Warren Thompson is centred on historical population leanings of two demographic features of birth and death rates to suggest that a country's total population growth rate rotates through five stages as the country progresses economically. As these rates (birth and death rates) change relative to each other, their influence significantly affects a country's aggregate population. Implicit in the model, a country will evolve over time from one stage to another as some social and economic forces act upon the birth and death rates. It is a widely held view that every country can be positioned within the DTM but not every stage of the model has a country that experiences its exact definitions.

But Ehrlich and Holdren in 1971 put forward the Stochastic Regression on Population, Affluence and Technology (*STIRPAT) model which is an expansion of the environmental impact as a product of pf three factors: population (P), affluence (A) and technology (T) - (IPAT) model* to explain the dynamics of impact of population and human well beings on the environment. The formulation of this relation was conducted with a simple identity, known as, IPAT. Their research results suggested that population growth entails a negative impact on the environment which is not proportional and that affluence is one of the main drivers of the Carbon dioxide emissions (deterioration of environmental quality). Furthermore, Dietz and Rosa (1997) considered human activities as the essential driving force of CO2 emissions. For this they divided human activities into four anthropogenic forces that are: population (P), economic activity or affluence (A), technology (T) describing technical standard of production.

$$I = P \times A \times T \qquad (1)$$

Where;

I represent environmental impact

Several researches such as Dietz and Rosa (1994), Dietz and Rosa (1997) and York et al, (2003) used this simple formulation to investigate the interactions populations, economic growth and technological development. However, Since the IPAT model is an accounting equation, it presents some drawbacks among them the fact that this model is not useful for statistical analysis since statistic associations don't

reflect causal relationship and that it cannot consider non-monotonic or non-proportional effects of the variables. To overcome these imperfections, the Stochastic Regression on Population, Affluence and Technology (STIRPAT) was developed by Dietz and Rosa (1997) allowing for empirical hypothesis test. The STIRPAT model specification is as follows;

$$I_i = \alpha P_i^{\beta} A_i^{\pi} T_i^{\acute{\omega}} \varepsilon_i \qquad (2)$$

α represents the constant term; β, π and ώ are parameters to be estimated and ε is the error term. A represents affluence measured by GDP per capita, P captures Population is measured by the number of inhabitants and T captures Technology changes' and is proxies by industrial activity calculated by the share of the manufacturing industry in total GDP and energy efficiency measured by GDP per unit of energy use. Estimated values of A, P, T and ε vary across countries represented by i. By applying the natural logarithms (ln) to both sides we obtain:

$$ln(I_i) = \propto_0 + \beta ln(P_i) + \pi ln(A_i) + \omega \ln(T_i) + \mu_i \qquad (3)$$

Where; $ln \propto = \propto_0 \ and \ ln\varepsilon_i = \mu_i$

These forms permit a simple calculation of environmental impact elasticity according to each anthropogenic factor. In fact, STIRPAT model was used to analyze the effect of explanatory variables on environment. However, there isn't accordance about the importance of these factors.

The Model for this study is anchored on the STIRPAT model. This study attempts to estimate the equations in order to detect their relevance with some modifications. The equation is called environmental quality equation, and it regresses environmental quality (EQU) on population dynamics variables (crude birth rate, crude death rate and net migration), Affluence is proxied by GDP per capita, Technology is proxied imports of capital goods as a ratio of total imports and Urbanization rate as a control variable. Its functional form is as follows:

$$lnEQU = \propto_0 + \omega_1 \ln(EQU_{t-1}) + \beta_2 ln(CBR_t) + \pi_3 \ln(CDR_t) + \vartheta_4 \ln(NM_t) + \gamma_5 ln(UBR_t) + \rho_6 ln(TEC_t) + \eta_7 ln(GDPP_t) + \mu_t \qquad (4)$$

Where; *EQU = Carbon dioxide emission in metric tons (the proxy for measuring environmental quality)*

CBR = Crude Birth rate, CDR = Crude Death rate, NM = Net migration, UBR = Urbanization rate.
TEC = Technology, GDPP = Gross Domestic Product per capita, μ_t *= error term*

The time frame of investigation is 1980-2022. This is the time frame that is long enough to capture recent trends in population dynamics and data is also accessible. This research work employed annual time series data to estimate the model in the context of ARDL. To sufficiently assess the time series properties of the data (knowing that most time series data are erratic), it is conventionally necessary to test the time series properties of the data used to avoid spurious economic outcomes. The signs of the elasticity coefficients of all the explanatory variables are expected to be positive except technology (TEC) which is expected to be either positive or negative. The annual time series data set for the variables were sourced from World Development Indicators, 2022 while Technology data is from CBN statistical bulletin.

4 Presentation, analysis and discussion of results

Table 1: Descriptive statistic

	CBR	CDR	EQU	GDPP	NM	TEC	UBR
Mean	42.70810	16.27667	79573577	1911.387	-0.301429	22.47619	38.37414
Median	42.79000	17.23000	81321500	1724.447	-0.330000	22.50000	38.64300
Maximum	46.79000	19.21000	96051730	2688.267	2.490000	43.00000	52.73000
Minimum	38.03000	12.85000	63383410	1388.535	-1.710000	1.000000	21.97000
Std. Dev.	2.035175	2.246160	8174085.	477.7444	0.581921	12.30950	8.992009
Skewness	-0.071770	-0.350993	-0.215188	0.335040	2.274147	-0.011640	-0.079764
Kurtosis	2.637580	1.422468	2.458173	1.433024	14.88007	1.814636	1.847219
Jarque-Bera	0.265916	5.217432	0.837900	5.082740	283.1904	2.459853	2.370119
Probability	0.875502	0.073629	0.657737	0.078758	0.000000	0.292314	0.305728
Sum	1793.740	683.6200	3.34E+09	80278.25	-12.66000	944.0000	1611.714
Sum Sq. Dev.	169.8194	206.8545	2.74E+15	9357827.	13.88391	6212.476	3315.105
Observations	42	42	42	42	42	42	42

Source: Author's computation, 2024

The descriptive statistic result show that environmental quality has the highest mean and median as well as the minimum and maximum value followed by crude birth rate. The result also indicates that all the variables are negatively skewed except GDPP and NM while the Jarque-Bera result show that the variables used in the study are all normally distributed.

Table 2: Correlation matrix

	CBR	CDR	EQU	GDPP	NM	TEC	UBR
CBR	1.000000	0.698519	-0.488936	-0.781996	0.171630	-0.652781	-0.750259
CDR	0.698519	1.000000	-0.321948	-0.735301	0.145953	-0.551589	-0.643967
EQU	-0.488936	-0.321948	1.000000	0.262660	0.245546	0.508633	0.507179
GDPP	-0.781996	-0.735301	0.262660	1.000000	0.102377	0.539214	0.523939
NM	0.171630	0.145953	0.245546	0.102377	1.000000	-0.140153	-0.155424
TEC	-0.652781	-0.551589	0.508633	0.539214	-0.140153	1.000000	0.698008
UBR	-0.750259	-0.643967	0.507179	0.523939	-0.155424	0.698008	1.000000

Source: Author's computation, 2024

The correlation result show that there is no high correlation amongst the variables used in the study. This implies that the estimated results are true estimates of the parameter devoid of multi-collinearity problem.

Table 3: Unit root result

The study adopted the Phillip Perron test and the result is stated here below;

Variables	Level	Ist difference
CBR	-1.721988	-10.60185
CDR	-0.253640	-4.030420
EQU	-2.490928	-1O.62801
GDPP	-0.666988	-4.460041
NM	-4.948957	
TEC	-6.342778	
UBR	-1.084906	-6.494022

	Critical values at level	Critical values at first difference
1%	-3.596616	-3.600981
5%	-2.933158	-2.935001
10%	-2.604867	-2.605836

Source: Author's Computation, 2024

From the result, it shows that all the variables were stationary at first difference except net migration and technology which were stationary at level.

Table 4: ARDL Bound test result

F-Bounds Test			Null Hypothesis: No levels relationship	
Test Statistic	Value	Signif.	I(0)	I(1)
			Asymptotic: n=1000	
F-statistic	3.689224	10%	1.99	2.94
K	6	5%	2.27	3.28
		2.5%	2.55	3.61
		1%	2.88	3.99

Source: Author's Computation, 2024

According to the bound test result in table 4, it shows that there is a long run relationship amongst the variables used. This is because the F-statistic estimate is greater the lower bound critical value of 2.27 and upper bound critical value of 3.28 at 5per cent level.

Table 5: ARDL Long-run result

Dependent variable: D(EQU)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
CBR	-0.851919	0.373137	-2.283126	0.0398
CDR	0.229866	0.084641	2.715760	0.0197
GDPP	-1.302862	0.486949	-2.675561	0.205
NM	0.208664	0.320733	0.650584	0.5203
TEC	0.639018	0.214675	2.976676	0.0365
UBR	0.681041	0.355393	1.916303	0.0649
C	0.114485	0.416608	0.274802	0.7853

Source: Author's Computation, 2024

From the long run result in table 5 above, all the explanatory variables were consistent with their a priori expectations except crude birth rate (CBR) and gross domestic product per capita (GDPP). This indicates that a unit increase in crude death rate (CDR), net migration (NM), technology (TEC) and urbanization (UBR) will instigate an increase of 0.2299 units, 0.2087 units, 0.6390 units and 0.1145 units in environmental quality in Nigeria. More so, a unit increase in CBR and GDPP will lead to a reduction of about 2.2831 units and 2.6756 units in environmental quality in Nigeria. The results reveal that all the explanatory variables are significant except net-migration though urbanization was significant at 10 per cent level of significance.

Table 6: ARDL Short-run result

Dependent variable: D(EQU)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(NM)	-0.240239	0.261045	-0.920297	0.3648
D(TEC)	0.704666	0.279493	2.521229	0.0172
D(GDPP)	0.642616	0.198701	3.234085	0.0091
CointEq(-1)*	-0.648288	0.125855	-5.151070	0.0000

R-squared = 0.536183

Adjusted R-squared = 0.510468

Durbin-Watson Stat = 1.897169

Source: Author's Computation, 2024

According to the result in table 6 above, it shows that net migration- D(NM) was inconsistent with the a priori expectation while technology – D(TEC) and gross domestic product per capita -D(GDPP) supported their a priori expectation. However, a unit increase in NM will stimulate a reduction of about 0.2402 unit in environmental quality in Nigeria. Also, a unit increase in TEC and GDPP will cause

environmental quality to be affected by 0.7047 units and 0.1987 units respectively. The result indicates that TEC and GDPP are statistically significant except net-migration which is insignificant at 5 per cent and 10 per cent level of significance. The adjusted R-squared show that about 51.05 per cent of the environmental quality is explained by the factors considered in the study leaving the remaining 48.95 per cent for other factors not captured in the study. The Durbin-Watson estimate of 1.897169 falls on the inconclusive region; hence, we cannot conclude on the existence and none existence of auto-correlation in our result estimate. The error term estimate of -0.648288 indicate that the speed of adjustment is about 64.83 per cent and is high.

Normality result

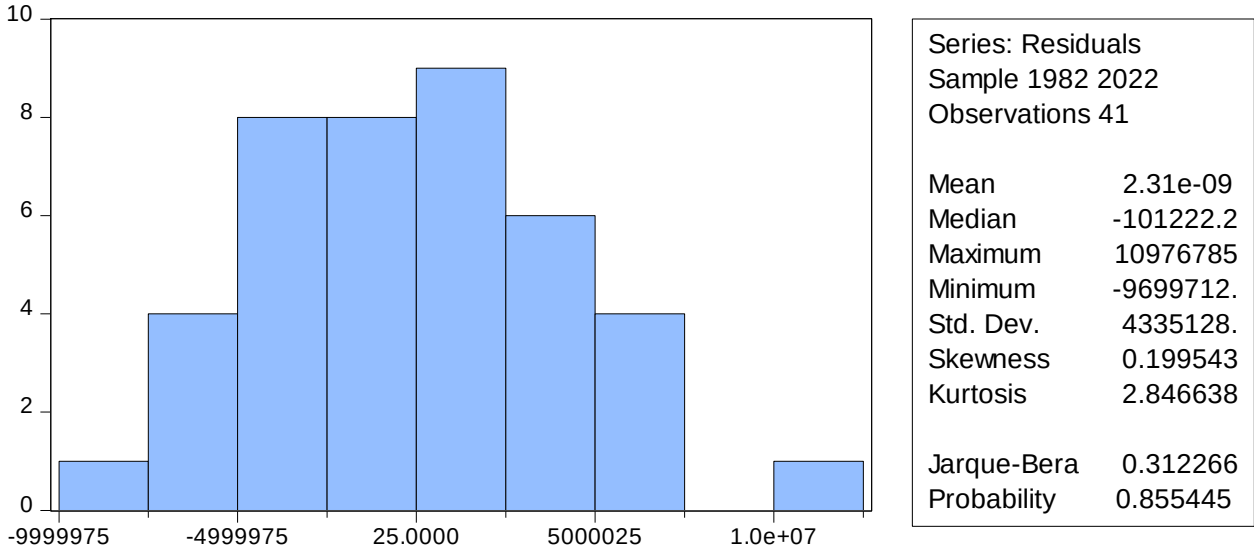

Fig.1: Normality test

The Jarque-Bera result in the normality test show that our estimates are normally distributed and is in line with the outcome of the descriptive statistic.

Serial Correlation test

Breusch-Godfrey Serial Correlation LM Test:

F-statistic	1.619633	Prob. F(2,28)	0.2160
Obs*R-squared	4.251378	Prob. Chi-Square(2)	0.1194

Source: Author's computation,2024

The result indicates that the there is no auto-correlation in our result estimate since the null hypothesis is not rejected.

Stability

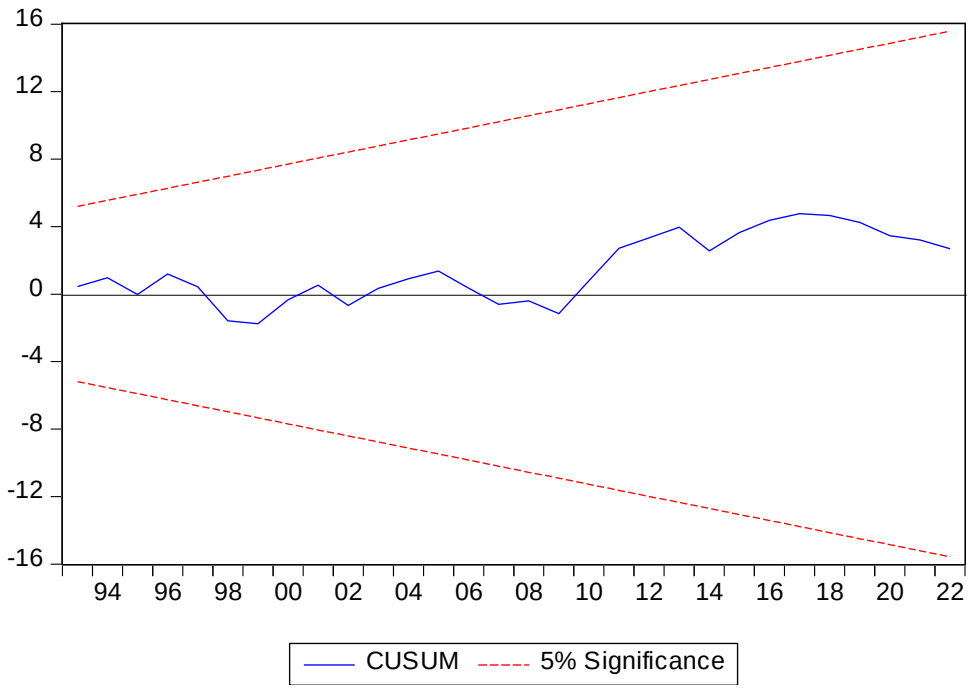

Fig.2: CUSUM test result

According to the CUSUM result in fig.2, the model is stable over time since the blueline lie in between the upper and the lower red line.

Discussion of results

Environmental quality is largely determined by natural occurrences and activities of humans. Therefore, the air quality and other environmental issues can be worsened if human activities are not checked. From the results, it has been discovered that crude birth rate and gross domestic product per capita impacted negatively and significantly on environmental quality. This implies that these factors cause an improvement in the quality of our environment. This is surprising because gross domestic product per capita is theoretically supposed to hinder environmental quality in Nigeria, the reason for this may be due to the fact that Nigeria's gross domestic product per capita is low, signifying a low level of productive activity. The contribution of birth rate in this study contradicts the outcome of previous studies (Dasgupta, 2000 and Bargaoui et.al., 2014) which found that birth rate worsened environmental quality.

The impact of technology and urbanization according to the findings of the study is theoretically and significantly detrimental to environmental quality. This means that as new technology and the size of urbanization expands, environmental quality is also reduced in Nigeria. This supports the findings of

Ayedim et.al. (2011), Baraoui et.al. (2014), Ohwo & Abotutu (2015), Ibrahim et.al. (2018), Lahiani (2020) and Shoaib et.al. (2020) that these factors hinder environmental quality. Also, net migration disrupts the quality of the environment in Nigeria but its effect was not significant in the long run. However, in the long run the net migration causes an improvement in environmental quality while technology and gross domestic product per capita significantly hinder environmental quality. This implies that for the environmental quality in Nigeria to be improved upon, these factors must be regulated effectively.

5 Summary and conclusion

This study was interested in examining the relationship between population dynamics, urbanization and environmental quality in Nigeria. To achieve the objectives of the study, Auto-regressive Distributed Lag model was adopted using data between 1980-2022 and the result show that net migration and technology significantly hinder environmental quality in Nigeria. The outcome of the study indicates that gross domestic product per capita in the long run improve environmental quality but its hinder environmental quality in short-run. The result reveals that the explanatory power of the model is fairly high while the speed adjustment is high. The study therefore recommends that government should initiate a policy that prohibit the adoption of any technique of production that harm the environmental. Also, the government should provide direction on the area urbanization should occur as well as the pattern and how it should take place.

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