POLLUTANT EMISSIONS, INSTITUTIONS AND ECONOMIC GROWTH IN NIGERIA

I.O. Bankefa[1*], P. A. Olomola[2], O. P. Olofin[3] & M.O. Fatai[4]

[1]Subank Advanced Global Services Limited, Lagos State, Nigeria
[2]Department of Economics, Obafemi Awolowo University, Ile Ile, Osun state, Nigeria
[3]Department of Economics, Obafemi Awolowo University, Ile Ile, Osun state, Nigeria
[4]Department of Economics, Obafemi Awolowo University, Ile Ile, Osun state, Nigeria
[*]Corresponding author's email: supobankefa@gmail.com

Abstract
The literature shows that to minimize the adverse effects of pollution on economic growth, the appropriate institutions must be put in place. While this is a plausible explanation, there are few evidences to confirm this assertion. This paper examined the dynamic effect of pollutant emissions and institutions on economic growth in Nigeria. Secondary data for the period of 1980-2015 were used and the data were sourced from the World Bank Development Indicators (WDI) and the Central Bank of Nigeria (CBN) Statistical Bulletins. VECM based impulse response and variance decomposition were used to analyze the data and estimate the model built for the paper. The results showed that democratic accountability (DA) has a positive (but not statistically significant) impact on economic growth while CO_2 emissions have a negative and statistically significant impact on economic growth in Nigeria. The results also showed that institutions (although not statistically significant) cannot be overlooked in the growth process as far as Nigeria is concerned. Similarly, the impulse response function showed that a shock to CO_2 emission would produce no immediate effect on economic growth but its effect in the medium term was negative before responding positively in the long run. In the same way, a shock to DA produced no immediate effect on economic growth but its effect in the medium term was negative with a significant negative response in the long run. The study concluded that a strong and efficient institution is needed to reduce the negative effect of CO_2 emission on economic growth in Nigeria.

Keywords: VECM, institutions, Nigeria, growth, pollutions
JEL Classification: K2, Q53, O4

Introduction

The relationships between economic growth and carbon-dioxide (CO_2) emissions have been the subjects of researchers in recent time. Nigeria as a country and other Sub-Saharan African countries have been faced with environmental challenges which have negative effects on the people and the environment. The country is facing a major challenge, mainly, to ensure stable economic growth and also to protect the environment free of pollution. For this purpose, various studies have suggested that strong institution is necessary to reduce pollution in the country and at the same time encourage economic growth (Foye, 2014, Lau, Choong & Eng, 2014; Adejumo, 2016). Despite this development, it has become very difficult to find any studies that empirically examined the role of institution on the relationship between pollutant emissions and economic growth in Nigeria.

It is important to note that the challenges facing humanity are of two fold namely: the first is the issue of economic development while the second is how to preserve the environment. However, environmental issues have come to the forefront of contemporary issues for both developed and developing countries since the deterioration of environmental quality raises concerns about global warming and climate change arising mainly from greenhouse gases (GHGs) emissions (Uddin, Salahuddin, Alam, & Gow, 2017). Unlike many other resources such as financial benefits, environmental goods and services are such ecologically relevant decisions made today which have effects on future generations (Clayton, Kals, & Feygina, 2016).

From 1960s, Nigeria has been participating with other African nations in environment-focused meetings concerning important environmental issues, including the protection of the marine and coastal environment, the conservation of natural resources, and the management of trans-boundary hazardous wastes within Africa. While these environment-focused meetings have produced admirable goals, in practice they have done little to actually address environmental problems particularly in the African countries. In spite of these regional efforts, Nigeria and many other African nations still experience serious and diverse environmental problems particularly, air pollution. Ultimately, an environmental crisis that occurred in southern Nigeria in the 1980s compelled Nigeria to start viewing environmental matters more seriously and begin to enact environmental regulations.

Furthermore, researchers have been increasingly interested in the role of institutional quality in examining the relationship between pollution and economic growth. Some researchers suggested that the relationship between pollution and economic growth may be dependent on certain institutional conditions such as democratic accountability, rules of law, bureaucratic quality, and corruption. There is a new argument postulating that economic performance of developing countries depends to a large extent on their own institutional conditions. This finding has been widely investigated in the institution-growth literature (Lau, Choong & Eng, 2014).

It has been argued, based on the findings of existing literature, that in order to minimize the effect of pollution on economic growth, the appropriate institutions must be put in place. While this is a plausible explanation, there are few direct empirical evidences to confirm that institutional quality makes a difference to the way in which pollution affects economic performance in Nigeria, as a developing country (Adejumo, 2016; Foye, 2014).This study, therefore, intends to provide a further insight on this phenomenon by examining the possible relationships among Carbon dioxide ($CO_{2)}$ emission and institutional quality on economic growth in Nigeria. The next section of this paper presents literature review while section 3 discusses the methodology of the paper. In section 4, we discuss the empirical results while section 5 reveals the conclusion and policy implications.

Literature Review

The increase in the emissions of greenhouse gases that causes global warming has become a major threat to mankind. Amongst several environmental pollutants, scientists have found carbon dioxide (CO_2) emissions as the main source causing climatic change. Therefore, various strategies are being considered to mitigate the effect of the emission. Among the strategies are the conditions of institutional quality in countries. In this case, few studies have been identified examining the relationship among the institution, CO_2 emission and economic growth. For instance, Arouri, Youssef, M'henni and Rault (2012) implement recent bootstrap panel unit root tests and cointegration techniques to investigate the relationship between carbon dioxide emissions, energy consumption, and real GDP for 12 Middle East and North African Countries (MENA) over the period 1981–2005. Their results show that in the long-run, energy consumption has a positive significant impact on CO_2 emissions. More interestingly, they show that real GDP exhibits a quadratic relationship with CO_2 emissions for the region as a whole.

The study of Lau, Choong, Eng (2014) investigated the existence of long run relationship among carbon dioxide emission, institutional quality, exports, and economic growth and further examined the causal relationship among these variables in Malaysia for the period 1984-2008. From the bounds test, it was found that a long run relationship existed among the variables, even using different conditioning information sets. A positive and significant interaction term between carbon dioxide emission and institutional quality indicator (i.e. law and order) implies that good institutional quality is important in controlling carbon dioxide emission in the process of economic development. The results for Granger causality tests further confirmed the importance of institutional frameworks in reducing carbon dioxide emissions since institutional quality is found not only affects economic growth directly, but also indirectly via carbon dioxide emissions. This indicates that sound institutional frameworks are essential for Malaysia to achieve high economic growth without sacrificing its environment.

Runar, Amin and Patrik (2016) examined the convergence of per capita carbon dioxide (CO_2) emission for a panel of 124 countries taking into account the impact of economic growth and the quality of government institutions. The analysis builds on both parametric and non-parametric panel data techniques, and they examined the b-convergence hypothesis in a neoclassical growth model setting with institutional quality as one of the independent variables influencing both emissions and output growth. The results revealed evidence in support of b-convergence of per capita CO_2 emissions for the global sample, and for the sub-samples comprising OECD versus non-OECD countries and high- versus low-income countries, respectively. There is, however, heterogeneity in b-convergence and it tends to vary with the level of the initial per capita CO_2 emissions. They also report evidence of a negative direct effect of institutional quality on growth in per capita CO_2 emissions, especially for the global and high-income samples. However, institutional quality also promotes economic growth, thus generating a positive indirect effect on emissions growth. Overall the empirical results suggest a positive net effect of institutional quality on growth in per capita CO_2 emissions in the global sample. Finally, the non-parametric approach reveals some evidence of bias in the parametric approach, in particular in the case of the estimates for the convergence parameter at either end of the distribution.

Likewise, Cho, Chu, and Yang (2014) examined the relationships amongst CO_2 emissions, energy use and gross domestic product for Organization for Economic Cooperation and Development (OECD) countries. Applying panel unit root, panel co-integration and the fully modified Ordinary Least Squares (OLS) methods, the empirical results reveal that energy use still plays an important role in explaining the greenhouse gas emissions for OECD countries. The results of Cho, Chu, and Yang (2014) show that there is a nonlinear relationship between CO2 emissions and economic growth in the long-run, which support the EKC hypothesis.

Ozturk and Al-Mulali (2015) examine whether better governance and corruption control contribute to the formation of the inverted U-shaped relationship between economic growth and pollution. Applying the generalised method of moments and the two-stage least squares methods of estimation, their results do not support the validity of the EKC hypothesis because the coefficients of the economic growth and economic growth square are negative and positive, respectively.

Furthermore, they document evidence that economic growth, energy consumption, trade openness, and urbanisation increase CO_2 emissions. Conversely, control of corruption and improved governance decrease CO_2 emissions. Ozturk and Al-Mulali (2015) concluded that Environmental Kuznets Curve hypothesis is not supported in their study suggesting that policies that reduce environmental pollution are encouraged.

In addition, Marsiglio, Ansuategi, and Gallastegui (2016) used a simple macroeconomic approach to investigate the role that structural changes might play in generating an inverted U-shaped income-pollution relationship in 15 European Union countries. Unlike previous research focusing on empirical, static or general equilibrium models, they developed a standard Balanced Growth Path (BGP) analysis. Their results revealed that along the BGP equilibrium, an inverted U-shaped income pollution relationship appears to occur as a response to structural changes. Nevertheless, whether this is the case or not mainly depends on the magnitude of a production externality parameter. Also, Marsiglio, Ansuategi, and Gallastegui (2016) showed that the negative relationship between pollution and income appears to be a transitory phenomenon, and in the long-run pollution increases as income rises, generating an N-shaped pattern. Table 1 summarizes the position of the previous studies on the topic.

Table 1: Summary of previous contributions

Author(s)	Country	Method	Scope	Objectives	Findings
Arouri, Yousef,M'henni & Rault(2012)	Middle East and North African countris (MENA)	Panel unit root and cointegration techniques	1981-2005	investigate the relationships between carbon dioxide, energy consuption and real GDP	They found that in the long run, energy consumption has a positive and significant impact on CO_2 emissions and that real GDP exhibits a quadratic relationships with CO_2 emissions
Cho, Chu & Yang(2014)	OECD countries	Panel unit root, panel cointegration and Fully Modified Ordinary Least square (OLS)		To examine the relationships among carbon dioxide (CO_2) emission, energy use and GDP for OECD countries.	They found that Energy played an important role in explaining the greenhouse emissions for OECD countries and that there is a non-linear relationships between CO_2 and Growth
Lau, Choong & Eng(2014)	Malaysia	Bond Test and Granger causality test	1984-2008	Relationships among CO_2, Institutions, Export and Growth	The found that there are long run relationships among the variables

Marsiglio, Ansuategi & Gallastegui(2016)	15 European countries	Balanced Growth Path (BGP) analysis		The role that structural changes might play in generating an inverted U	Negative relationship between pollution and income
Ozuturk & Al-Mulali(2015)	Vietnam	Generalized Method of Moment (GMM) and 2-stage least square	1981-2011	To examine whether better governance contributes to the formation of the inverted U-shaped in Growth-pollution nexus	Environmental Kuznets Curve (EKC) hypothesis is not supported
Rumar, Amin & Patrick(2016)	124 OECD and Non-OECD countries in high and low income countries	parametric and non-parametric panel data techniques		To examine the convergence of per capita CO_2 in the impact of growth and the quality of government institutions	They found that there is evidence of negative direct effect of institutional quality in GDP per capita, CO_2 emissions for global high income countries
Ibitoye, Bamidele, Hlalefang and Pierre (2017)	Nigeria	ARDL bounds testing approach		To Investigate the impact of green growth on sustainability in Nigeria	Negative short-run and long run.

Source: Authors' compilation

From our reviews, we discovered that few studies have investigated the relationships among CO_2 (as a proxy for pollutant emissions) and institution on economic growth in developed and developing countries. However, only few studies have investigated the situation of Nigeria in such scenario. As a result, this study intends to fill the gap by looking at the relationships between pollutant emission and institutions on economic growth using Nigeria as a case study.

Methodology

The theoretical basis of most growth models are derived from Solow growth model which states output (Y) as a function of labour (L) and capital (K) as specified below:

$$Y_t = f(K, L) \tag{1}$$

However, this study derives its theoretical models from the theories established by Brock and Taylor (2005, 2010) and Orda´s Criado *et al*. (2011). This represents another variant of Solow growth model, called Green Solow growth models.

$$Y_t = f(K, BL) \tag{2}$$

Where B is labour-augmenting technological progress that grows at a constant exponential rate gB. The population grows at rate n and the capital stock grows according to:

$$K = sY - \delta K \tag{3}$$

Emission of pollution are given by

$$E = \partial F - \partial A(F, F^A)$$
$$= \partial F[1 - A(1, \frac{F^A}{F})$$
$$= \partial F a(\emptyset) \tag{4}$$

Where E is emitted pollution, ∂ is pollution from output, A is abatement with CRS function and $A(F, F^A)$ is technological growth at exogenous rate Ga. F is total economic activity, F^A is total abatement activity, $\emptyset$ is the fraction of economic activity dedicated to abatement. Output available for consumption or investment is then modified as:

$$Y = F - F^A = (1-\phi)F \tag{5}$$

The model written in intensive form is

$$y = f(k)(1-\phi) \tag{6}$$

$$e = f(k)\delta a(\phi) \tag{7}$$

k=K/BL, y=Y/BL, and e=E/BL.

Equation (2) to (7) explained the model of Brock and Taylor. The model is based on the Solow growth model, but with an emission function that incorporates pollution abatement, with abatement and savings rate assumed to be exogenously determined. In their study, the theoretical model predicts that growth in CO_2 emissions depends on the initial level of CO_2 emissions, saving rate, abatement intensity, population growth rate and the depreciation rate. Still, abatement is assumed to be zero in the empirical application of the model. It is, however, possible to replace the savings rate, population growth and the depreciation rate with economic output as these variables are the key factors determining output in the Solow growth model.

Model specification

Following the work of Runar, Amin and Patrik (2016), we specify the empirical model as follow:

$$EG = f(\mathrm{CO2}, DA, TO, GF) \tag{8}$$

In specific form, we re-specify the model as:

$$EG_t = \beta_0 + \beta_1 \mathrm{CO2}_t + \beta_2 DA_t + \beta_3 TO_t + \beta_4 GF + u \tag{9}$$

Where EG is economic growth, CO_2 is the carbon dioxide emission, DA is the institutional variable, GF is the gross fixed capital formation, TO represents Trade Openness. u is the error term. The study examined the dynamic effect of CO_2 emissions and institutions on economic growth in Nigeria via VAR while unit root test was conducted to examine the stationarity of the data used. Bound test approach to co-integration was also conducted to determine the long run relationships between the variables. Vector Autoregression estimate (VAR) is simply a reduced form of many simultaneous equation models. A VAR model is thus specified below;

$$Z_t = \alpha_0 + \sum_{i=1}^{p} \beta Z_{t-1} + \varepsilon_t \tag{10}$$

Equation (10) contains a VAR (p) process where Z_t is a vector of endogenous variables, α_0 is an (nx1) vector of constants, β is an (nxn) matrix of co-efficient, p is the maximum lag length, and ε_t is an (nxn) vector of error terms. Although, the dynamic relationships among variables are modeled empirically as a VAR, but a simple linear model based on economic theory is used to model the contemporaneous relationships. One of the benefits of VAR technique is that, it accounts for the dynamic properties and relation of time series variable. VAR technique is better compared to a single approach for capturing the long run dynamic relationship among variables (Ahmet, 2008). VAR model is a common framework that is used to explain the dynamic interrelationship among stationary variables.

Variables measurement

However, the variables used for the study are measured as highlighted below:

- *Economic Growth (G):* Growth is proxied by GDP per capita growth
- *Carbon dioxide Emission (CO_2):* For most of the previous work done, they used CO_2 (Carbon dioxide emissions) as proxy for Environmental Quality. In this study, we also used CO_2 for the measurement of Environmental Quality.
- *Trade Openness (TO):* Some authors have incorporated international trade in the analysis of economic growth- environment linkages (e.g., Frankel & Rose, 2002). They argued that trade affects the domestic economy and therefore also environmental behavior. The sign of this relationship, however, appears theoretically ambiguous due to offsetting forces (the pollution haven hypothesis, the positive effects of trade on income, and the effects of trade on the scale of production). Yet, Antweiler *et al.* (2001) established that, at least for CO_2 emissions, the net effect of trade is to reduce pollution levels. In this analysis, we measured Nigeria's trade openness by the ratio of the sum of exports and imports to GDP.
- *Gross fixed capital formation (GF):* As one of the control variables data also, we employed gross fixed capital formation as a percentage of GDP.
- *Institution (Democracy):* we used Democratic Accountability (DA) to measure institution.

Sources of data

To estimate the concerned models and examine the statistical significance of the variables that relate to the relationship among the pollutant emissions, institution and economic growth in Nigeria, this paper employed annual data time series covering 1980 – 2015.

Secondary data on all the variables used in the model were obtained from the Central Bank of Nigeria Statistical Bulletins (Various Issues) and as well data published by the World development Indicators (WDI).

Results and Discussion

Unit root tests and cointegration

Since non-stationary time series data can pose some challenges in regression result, it is important to check the properties of time series data before analysing the relationship that exists among the variables. Econometric studies have shown that most financial and macro-economic time series variables are non-stationary, and using non-stationary variables leads to spurious regression (Engle & Granger, 1987). To avoid spurious regression result, unit root tests were performed on all the variables used in this study. Unit root test was used to ascertain the stationarity level of the variables to be used in the model using Augmented Dickey-Fuller and Phillips-Perron tests. The results in Table 2 showed that the variables are stationary at first difference in both Augmented Dickey-Fuller and Phillips-Perron tests with the exception of EG that is stationary at level. The results of the two tests showed that there was no higher order of integration such as I(2) in the model. Thus, bound test approach to cointegration is applicable given its dynamic advantage. That is, it is capable of testing for cointegration of a model comprising variables of different orders of integration, provided these variables are I(1) and I(0).

Table 2: Unit root test

Variables	ADF Stat.	at 5%	PP Stat.	at 5%	Remarks
EG	-4.4286	-2.9511	-4.4351	-2.9511	I(0)
CO_2	-6.3418	-2.9511	-6.3375	-2.9511	I(1)
DA	-5.706	-2.954	-9.353	-2.9511	I(1)
GF	-3.0412	-2.9571	-3.6269	-2.9511	I(1)
TO	-8.0679	-2.9511	-8.0353	-2.9511	I(1)

Source: Authors' computation

Table 3: ARDL Bounds Test

Null Hypothesis: No long-run relationships exist			
F-statistic	K	Models	ARDL Selected
8.120699	4	$EG = f(\mathrm{CO2}, DA, TO, GF)$	(4,4,4,3,4)
Significance level	I0 Bound	I1 Bound	
10%	2.45	3.52	
5%	**2.86**	**4.01**	
2.5%	3.25	4.49	
1%	3.74	5.06	

Source: Authors' computation

Table 3 shows the result of bound test for all the three models built for the study and critical values provided by Pesaran *et al.* (2001). The F-statistic is compared with the critical bounds at 5% level of significance with unrestricted intercept and no trend (Upper bound is 4.01 and Lower bound is

2.86). Specifically, the F-statistics of the model is 8.12 which is greater than the upper bound critical value (4.01), and we therefore concluded that there are evidences to reject the null hypothesis of no long run relationship among the variables. Hence, the alternate hypothesis is accepted that there is long run equilibrium relationship among the variables.

VAR lag order selection criteria

In order to estimate VAR equation, it is appropriate to determine the optimal lag length to be used. It is evident that various lag selection criterion produced conflicting results. For the purpose of estimating VAR, Akaike Information Criterion (AIC) is considered and used to confirm the appropriate number of length to be used given its superiority over other information criteria. Like Akaike Information Criteria (AIC), the lower the value of SIC, the better the model. From Table 4 it was evident that the various lag selection criteria produced different results. Log likelihood indicated lag zero; LR, Final Prediction Error (FPE), AIC and Hannan Quinn (HQ) chooses lag four, SIC chooses lag two. Drawing from the justification for AIC, this study chooses the lag length of four for the independent variables as indicated by the AIC and is used to estimate the VAR/VECM.

Table 4: VAR Lag Order Selection Criteria

Endogenous variables: $EG = f(\text{CO2}, DA, TO, GF)$

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-410.1896	NA	295714.8	26.78642	27.01771	26.86182
1	-358.3402	83.62806	53612.97	25.05421	26.44193*	25.50657
2	-341.4797	21.75540	103907.1	25.57934	28.12351	26.40867
3	-307.5837	32.80262	86267.81	25.00540	28.70601	26.21171
4	-233.9377	47.51358*	9383.047*	21.86695*	26.72400	23.45022*

* indicates lag order selected by the criterion
LR: sequential modified LR test statistic (each test at 5% level)
FPE: Final prediction error
AIC: Akaike information criterion
SC: Schwarz information criterion
HQ: Hannan-Quinn information criterion

Source: Authors' computation

For dynamic effects of CO_2 emission and institutions on economic growth in Nigeria, the study estimated Vector Error Correction model (VECM), impulse response and variance decomposition within VECM framework. It is important to note that when the order of VECM i.e., lag length is too short, problem of serial correlation among the residuals arises and test statistic will become unreliable. Conversely, if lag length (order of VECM) is too high there will be an upward bias in the test statistics, again causing doubts on the reliability of the estimates of parameters. Therefore, it is very important to choose appropriate lag length in VEC modelling. For this purpose, lag length selection test which was based on VECM analysis has been carried out as reported in Table 3. There are four lag length selection criteria's Likelihood Ratio (LR), Final Prediction Error (FPE), Akaike Information Criteria (AIC), Schwarz Information Criteria (SIC), and Hannan-Quinn Information Criteria (HQIC). However, for the purpose of our analyses, this study employs AIC in all models, because it is found that it has performed well in Monte Carlo studies (Kennedy, 1994).

Following the lag selection criteria test in Table 3, impulse response and variance decomposition were estimated. The impulse-response and variance decomposition are then used to illustrate the dynamic relationships among the variables of interest and the empirical results are presented in in Table 5.

Table 5: Vector error correction results

Vector Error Correction Estimates

Error Correction:	D(EG)	D(CO_2)	D(DA)	D(TO)	D(GF)
CointEq1	-1.493718*	-0.000752	0.106137	0.086990	0.071443
	(0.30713)	(0.00620)	(0.51344)	(0.52230)	(0.11118)
	[-4.86351]	[-0.1212]	[0.20672]	[0.16655]	[0.64262]
CointEq2	12.14711***	-0.056323	22.12011***	10.27133	-6.7340**
	(7.89567)	(0.15951)	(13.1994)	(13.4273)	(2.85811)
	[1.53845]	[-0.3531]	[1.67584]	[0.76496]	[-2.3561]
CointEq3	0.214809***	0.001286	-0.466532**	-0.241343	0.104634**
	(0.13193)	(0.00267)	(0.22055)	(0.22435)	(0.04776)
	[1.62825]	[0.48256]	[-2.1153]	[-1.0757]	[2.19104]
D(EG(-1))	0.556557**	0.000633	-0.537439	-0.302374	-0.053094
	(0.24175)	(0.00488)	(0.40414)	(0.41112)	(0.08751)
	[2.30218]	[0.12967]	[-1.32982]	[-0.7354]	[-0.6067]
D(EG(-2))	0.124206	-0.001181	-0.51897***	0.151439	-0.002708
	(0.15924)	(0.00322)	(0.26621)	(0.27080)	(0.05764)
	[0.77999]	[-0.3672]	[-1.9495]	[0.55922]	[-0.0469]
D(CO_2 (-1))	-17.58065	-0.062887	22.54077	3.609920	2.072025
	(12.7868)	(0.25832)	(21.3761)	(21.7451)	(4.62861)
	[-1.37491]	[-0.2434]	[1.05449]	[0.16601]	[0.44766]
D(CO_2 (-2))	-19.30483***	0.195059	33.87063***	-66.0534*	2.376454
	(12.4589)	(0.25169)	(20.8279)	(21.1874)	(4.50991)
	[-1.54949]	[0.77499]	[1.62621]	[-3.1175]	[0.52694]
D(DA(-1))	-0.119165	0.000296	-0.126753	0.391065***	-0.024388
	(0.14400)	(0.00291)	(0.24073)	(0.24488)	(0.05212)
	[-0.82755]	[0.10184]	[-0.52655]	[1.59696]	[-0.4678]
D(DA(-2))	-0.179315	-0.002208	-0.141681	0.291884	-0.056437
	(0.12890)	(0.00260)	(0.21548)	(0.21920)	(0.04666)
	[-1.39115]	[-0.8479]	[-0.6575]	[1.33158]	[-1.2095]
D(TO(-1))	-0.156205	-0.000401	-0.234632	-0.077737	0.060620
	(0.13037)	(0.00263)	(0.21795)	(0.22171)	(0.04719)
	[-1.19814]	[-0.1523]	[-1.07655]	[-0.35062]	[1.28452]
D(TO(-2))	-0.371748**	-0.001849	-0.110811	0.261605	0.039955
	(0.12888)	(0.00260)	(0.21546)	(0.21917)	(0.04665)
	[-2.88441]	[-0.7100]	[-0.5143]	[1.19359]	[0.85644]

D(GF(-1))	0.277702	-0.004716	-0.276906	-0.229424	0.302131***
	(0.46882)	(0.00947)	(0.78374)	(0.79727)	(0.16971)
	[0.59234]	[-0.4979]	[-0.3533]	[-0.2877]	[1.78032]
D(GF(-2))	-0.150925	0.004007	1.719858**	0.401457	-0.29331***
	(0.44556)	(0.00900)	(0.74486)	(0.75772)	(0.16129)
	[-0.33873]	[0.44519]	[2.30895]	[0.52982]	[-1.81857]
C	-0.452632	-0.008877	1.995020	-0.723272	-0.392891
	(1.10097)	(0.02224)	(1.84053)	(1.87230)	(0.39853)
	[-0.41112]	[-0.3991]	[1.08394]	[-0.3863]	[-0.9858]
R-squared	0.764985	0.192209	0.564010	0.644045	0.706336
Adj. R-squared	0.595252	-0.391196	0.249128	0.386967	0.494244
F-statistic	4.506993	0.329460	1.791181	2.505247	3.330341
Akaike AIC	6.660614	-1.143357	7.688336	7.722563	4.628305

NB: Standard errors in ( ) & t-statistics in [ ]
*1%, **5%,***10% Significance level

Source: Authors' computation

Results in Table 5, showed the past values of CO_2 emissions and indicated a positive and significant impact on economic growth while the institutional variable that is Democracy (DA) is not statistically significant and have implication on the relationship between DA and Economic growth in Nigeria (that is, DA does not really affect the growth of the economy in Nigeria). However, in order to be able to provide further insight into the dynamic properties of the VECM/VAR system we present the Impulse Response (IRF) analysis in Figure 1 and the Variance Decompositions (VDs) in Table 5. The IRFs analysis traces out the responsiveness of the dependent variable in VAR to shocks to each of the other explanatory variables over a period of time horizon (10 years' time horizon). A shock to a variable in a VAR not only directly affects that variable, but also transmits its effect to all other endogenous variables in the system through the dynamic structure of VAR.

Impulse response

Impulse response analysis traces out the responsiveness of the dependent variables in a VAR to shocks from each of the variables (Brooks, 2008). It also showed the effects of shocks on the adjustment path of the variables. It showed the size of the impact of the shock plus the rate at which the shock dissolves, allowing for the interdependencies and showed how each variable reacts dynamically to shocks. The ordering applied are Economic Growth (EG), CO_2 emission (CO_2), Institution (DA), Trade openness (TO), and Gross fixed capital formation (GF).

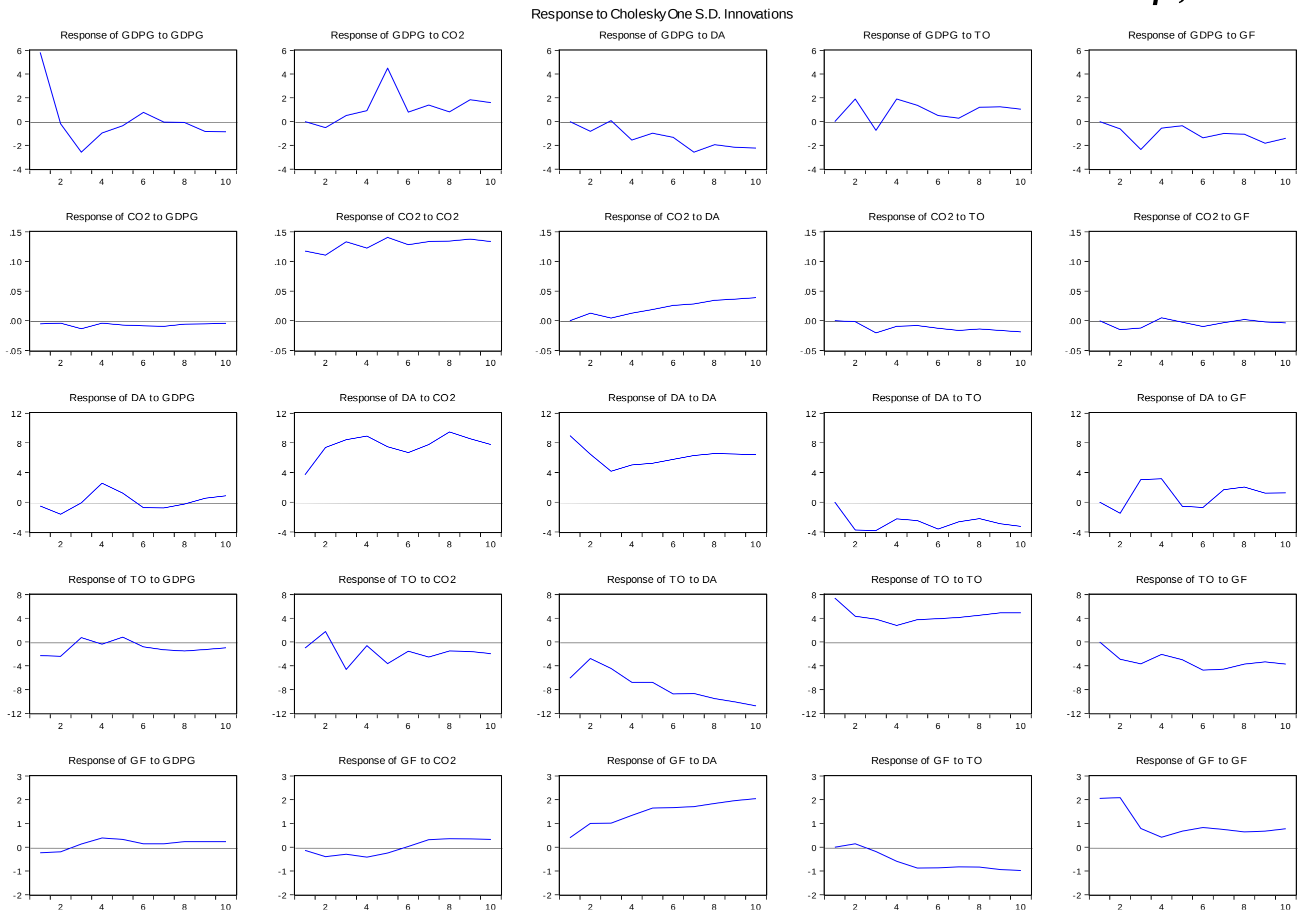

Figure 1: Impulse Response
Source: Authors' computation

The results of the response of EG to its own shocks as presented on the first row in Figure 1 showed the impulse response function of economic growth illustrating the dynamic response of economic growth to a one period standard deviation shocks to the innovations of the system and also indicates the directions and persistence of the response to each of its own shocks over ten years' time horizon. These results showed that the response of economic growth to a one standard deviation innovation in its past values was significantly positive in the short run (basically from period one to somewhat around the 3rd horizon) before an oscillatory movement around negative values in the medium (say the 4th horizon to the 5th horizon) and in the long run, the scenarios repeated to negative shocks of EG to its own response (say from the 9th horizon to the 10th horizon). The policy implication of the results showed that GDP per capita growth level is affected contemporaneously by the shocks from its own past value but diminished over time horizon. Similarly, the results of the impulse response function showed that a shock to CO_2 emission would produce no immediate effect on economic growth as showed in Figure 1 from the 1st horizon to the 2nd horizon, but its effect in the medium run was negative and short-lived before responding positively in the long run (up till the last horizon (10th)). In the same way, the results of the impulse response function showed that a shock to Democracy variable would produce no immediate effect on economic growth as EG did not respond to shocks to DA from the 1st horizon up till the 2nd horizon but its effect in the medium run was negative form the 3rd horizon and especially with significant negative response (in the 6th horizon) and as in the long run till the 10th horizon. Furthermore, the response of economic growth to a one standard deviation innovation in Trade Openness (TO) was naturally positive in the short run but it was significantly positive in the medium run and long run. This implies that, EG respond positively to the shocks to TO throughout the time horizon and the policy implication is that, TO spurs economic growth in Nigeria. However, EG responded negatively to one standard deviation innovation in the Gross fixed capital formation (GF) in both short run and long run periods (that is, throughout the time horizon). The implication is that, GF has a negative relationship with economic growth in Nigeria (see Figure 1 and row 1 for details).

The graphs in row 2 showed the response of CO_2 emission to shocks to other variables, the response of CO_2 to a one standard deviation shock to economic growth was not high in both the short run and long run even negative (but slightly around the 3rd horizon and short-lived), in the medium run up till the 10th horizon. However, the response of CO_2 to a one standard deviation shock to itself was very high and contemporaneously positive in the short run and medium run (1st to 5th horizon). It remains positive and very high in long run (say from the 6th to the 10th horizon) (see Figure 1, row 2 and graph 2 for details). More so, the response of CO_2 to a one standard deviation shock to Democracy (DA) was significantly and contemporaneously positive in both short and the momentum picked up entirely from the 4th horizon that is, medium run and with high positive response in the long run (the 10th horizon). The response of CO_2 to Gross Fixed Capital Formation (GF) is negative before exerting an oscillatory movement in the medium run to be positive and later became slightly negative in long run. However, Democratic Accountability (DA) responded contemporaneously and positively to a one standard deviation shock to economic growth in the short run but oscillated around negative values in the medium-long run and becomes positive. Again, a shock to CO_2 emission would produce immediate effect on Democratic Accountability (DA) and it remains positive in the medium and long run periods.

Variance decomposition

Variance decomposition analysis provides a means of determining the relative importance of shocks in explaining variations in the variable of interest (Andren, 2007). It offers information about the importance of each random innovation to the variables in the VAR model. We present the variance decomposition of the variables of interest as shown in Table 6.

Table 6: Variance Decomposition

Variance Decomposition of EG:						
Period	S.E.	EG	CO_2	DA	TO	GF
1	5.821455	100.0000	0.000000	0.000000	0.000000	0.000000
2	6.234064	87.28086	0.663264	1.764121	9.343751	0.948004
3	7.202861	78.26594	0.979185	1.335977	8.077369	11.34153
4	7.744887	69.26076	2.260878	5.147254	13.01387	10.31724
5	9.128575	49.99604	25.92678	4.858845	11.63917	7.579169
6	9.406260	47.77856	25.11975	6.599479	11.26233	9.239877
7	9.906544	43.07615	24.62097	12.70125	10.23903	9.362599
8	10.25550	40.20245	23.61884	15.43258	10.92268	9.823452
9	10.90044	36.17138	23.76974	17.61068	10.98115	11.46705
10	11.40730	33.60217	23.65312	19.87204	10.87552	11.99715
Variance Decomposition of CO_2:						
Period	S.E.	EG	CO_2	DA	TO	GF

1	0.117604	0.200313	99.79969	0.000000	0.000000	0.000000
2	0.162647	0.161503	98.36890	0.617239	0.011179	0.841174
3	0.211879	0.490186	97.34165	0.412959	0.937545	0.817664
4	0.245286	0.394180	97.53303	0.577225	0.846208	0.649361
5	0.283465	0.361440	97.55806	0.869538	0.717594	0.493364
6	0.312729	0.373130	96.97827	1.389704	0.755980	0.502920
7	0.341788	0.387548	96.46858	1.850590	0.864495	0.428787
8	0.369078	0.354713	95.93967	2.450865	0.883240	0.371516
9	0.395908	0.324603	95.42941	2.983066	0.937707	0.325215
10	0.420139	0.298334	94.85562	3.516508	1.033384	0.296157
Variance Decomposition of DA:						
Period	S.E.	EG	CO_2	DA	TO	GF
1	9.731921	0.291281	14.51022	85.19850	0.000000	0.000000
2	14.48508	1.379455	32.42953	58.40407	6.736920	1.050022
3	17.94558	0.901404	43.18448	43.39220	8.926392	3.595531
4	21.17074	2.121243	48.77982	36.75242	7.550948	4.795569
5	23.22450	2.045033	50.86235	35.63324	7.416026	4.043355
6	25.13249	1.836549	50.53508	35.69172	8.402380	3.534272
7	27.23845	1.646311	51.14265	35.73230	8.089369	3.389374
8	29.72472	1.390031	53.08268	34.86567	7.344498	3.317126
9	31.75884	1.247214	53.73175	34.70650	7.260789	3.053745
10	33.50590	1.185782	53.63601	34.81823	7.479921	2.880060
Variance Decomposition of TO:						
Period	S.E.	EG	CO_2	DA	TO	GF
1	9.899905	5.370344	1.060399	37.86360	55.70566	0.000000
2	11.91436	7.792797	2.953975	31.59601	51.66620	5.991018
3	14.55697	5.482976	12.05066	30.47534	41.58202	10.40901
4	16.44693	4.345130	9.575265	40.88067	35.47040	9.728534
5	18.79463	3.519349	11.05525	44.31930	31.16128	9.944813
6	21.70364	2.781293	8.811729	49.49682	26.64442	12.26574
7	24.33717	2.501434	8.093314	52.04289	24.07162	13.29074
8	26.86449	2.362050	6.961302	55.28673	22.58179	12.80813
9	29.38652	2.158020	6.113027	58.05021	21.68903	11.98972
10	31.96670	1.915254	5.542620	60.36888	20.70147	11.47178
Variance Decomposition of GF:						
Period	S.E.	EG	CO_2	DA	TO	GF
1	2.107275	1.296546	0.390070	3.496072	7.38E-05	94.81724
2	3.168252	0.970393	1.798667	11.58970	0.198971	85.44227
3	3.439537	0.974963	2.256525	18.56350	0.450493	77.75452
4	3.805141	1.838244	3.034759	27.60061	2.771939	64.75445
5	4.309826	2.000288	2.686521	36.10021	6.288535	52.92444

6	4.776488	1.722053	2.189985	41.55040	8.452289	46.08527
7	5.203791	1.521573	2.216284	45.74721	9.651454	40.86348
8	5.636796	1.470504	2.282907	49.66538	10.44718	36.13403
9	6.094441	1.405590	2.284780	52.83975	11.32577	32.14411
10	6.559038	1.336483	2.215460	55.30345	12.00648	29.13813

Cholesky Ordering: EG CO_2 DA TO GF

Source: Authors' computation

Table 6 depicts the proportion of forecast error variance in economic growth in Nigeria explained by innovations to the endogenous variables considered. In Table 6, looking at the variance decomposition of economic growth; it is illustrated that CO_2, democracy, trade openness, gross fixed capital formation did not explain variation in economic growth in the short run which is the first period. However, CO_2 emission variable and democracy variable explained about 0.66% and 1.76% variation in the second period respectively and increased to 25.92% and 4.85% in the fifth period which is the medium run but CO_2 later decreased to 23.6% while increased gradually to 19.87% in the tenth period which is the long run.

The results in Table 6 further showed the variance decomposition of CO_2 emission. In the first period, nothing is explained by democracy (DA) while economic growth explained 0.2% of the variation in CO_2 emission. In the first period, the variation explained by economic growth increased to 0.36% while that of democracy is 0.86%. The response of democracy is explained by economic growth up to 0.29% while that of CO_2 emission is 14.51% in the first period. Looking at the first period, the explained variations increased to 2.045% attributes to economic growth while that of CO_2 emission is 50.86%. This shows level of dynamic interactions between CO_2 emission and democracy in Nigeria. In the long run attributes to period 10, the variance explained by economic growth decreases to 1.18% while that of CO_2 increased to 53.63%. In conclusion, the results from variance decomposition confirmed that the CO_2 emission improve the level of economic growth in Nigeria. The results also indicated a strong relationship between CO_2 emission and democracy compared to economic growth which was less significant in explaining variations in democracy in Nigeria. Furthermore, the study reports the inverse roots of the characteristic AR polynomial as seen in Figure 6. The estimated VAR is stable (stationary) because all roots have modulus less than one and lie inside the unit circle. In this case we confirm that the VAR is stable, the certain results (such as impulse response and variance decomposition) are valid.

We also perform VEC Residual Heteroskedasticity Tests as shown in Table 7. The results show that the joint coefficients of the model is free from residual Heteroskedasticity.

Table 7: VEC Residual Heteroskedasticity Tests

Joint test:		
Chi-sq	Df	Prob.
375.8857	390	0.6871

Source: Authors' computation

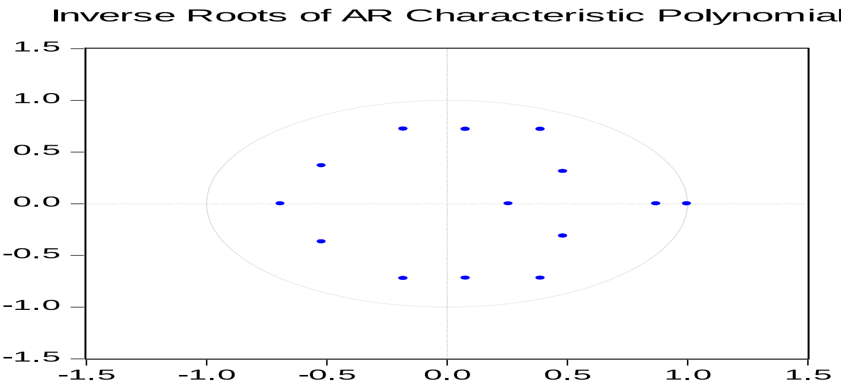

Figure 2: Inverse Root of AR

Conclusions

This paper examined the dynamics of institutions, CO_2 emission and economic growth in Nigeria using VECM based impose response and variance decomposition. It was discovered that the response of economic growth to a one standard deviation innovation in its past values was significantly positive in the short run before an oscillatory movement around negative values in the medium and long run. That is, the results showed that GDP per capita growth level is affected contemporaneously by the shocks from its past value but diminishes over time. Similarly, the impulse response function showed that a shock to CO_2 emission would produce no immediate effect on economic growth but its effect in the medium run was negative before responding positively in the long run. In the same way, the impulse response function showed that a shock to Democracy variable would produce no immediate effect on economic growth but its effect in the medium run was negative with significant negative response in the long run.

The response of CO_2 emission to shock of other variables, the response of CO_2 to a one standard deviation shock to economic growth was not high in both the short run and long run even negative in the medium run. However, the response of CO_2 to a one standard deviation shock to itself was very high and contemporaneously positive in the short run and medium run. It remains positive and very high in long run. More so, the response of CO_2 to a one standard deviation shock to democracy was significantly and contemporaneously positive in both short and medium run with high positive response in the long run. The response of CO_2 to gross fixed capital formation is negative before exerting an oscillatory movement in the medium run to be positive and later became negative in long run. Moreover, Democracy variable (DA) responded contemporaneously and positively to a one standard deviation shock to economic growth in the short run but oscillated around negative values in the medium-long run and becomes positive.

The variance decomposition of economic growth illustrated that CO_2, democracy, trade openness, gross fixed capital formation did not explain variation in economic growth in the short run which is the first period. However, CO_2 emission variable and democracy variable explained about 0.66% and 1.76% variation in the second period respectively and increased to 25.92% and 4.85% in the fifth period which is the medium run but CO_2 later decreased to 23.6% while increased gradually to 19.87% in the tenth period which is the long run.

The study demonstrated that CO_2 emission mitigation policies are unlikely to have any adverse effects on Nigerian' long-term growth paths if there is effective institutional system. This implies that Nigeria can pursue CO_2 emission reduction policies without necessarily compromising their quest for a long term positive growth trajectory based on effective institutions. The followings are hereby recommended:

- The gaps between the formulation and implementation of the pollution and environmental treatment policies /regulations in Nigeria should not be too wide and there must be prompt follow-up of the execution of the agreed policies. Hence, the government needs to strengthen its institutional environment and ensure strict enforcement and compliance to the regulations.
- The federal government of Nigeria need to reduce the cumulative emissions of carbon dioxide by engaging the stakeholders, scientists and policy makers to take more active care for clean and environmental friendly energy production as well as appropriate technology and to adapt some policies regarding the reduction of carbon dioxide emission rather than to increase the GDP only.

References

Adejumo, O.P. (2016). Environmental quality, health capital and economic growth in Nigeria, 1970-2013. *Unpublished PhD Thesis,* Department of Economics, Obafemi Awolowo University, Ile-Ife, Nigeria.

Andrén,T.(2007). The persistence of welfare participation, DAV Institute of Management - *National Institute of Economic Research*, IZA Discussion Paper No. 3100

Antweiler, W., Copeland, B. R., Taylor, & M. Scott,(2001), Is free trade good for the environment? *American Economic Review 91 (4)*, 877–908.

Arouri, E., Youssef,A. B., M'henni,H.,& Rault,C.(2012). Energy consumption, economic growth and CO_2 emissions in Middle East and North African Countries, *IZA* DP No. 6412

Bernauer, T. & Koubi, V. (2009), Effects of political institutions on air quality. *Ecological Economics, 68*,1955-1965.

Brooks, C. (2008).Introductory econometrics for finance. *Cambridge:* Cambridge

Clayton, S., Kals, E., & Feygina, I. (2016). Justice and environmental sustainability. Handbook of social justice theory and research (pp. 369–386). *Springer.University Press*.

Cho, C.H.,Chu, Y.P., & Yang, H.Y.(2014), An environment kuznets curve for GHG emissions: A panel cointegration Analysis*, Journal of Energy Sources, Part B: Economics, Planning, and Policy 9, (2).* 123-130.

Drury, A.C., Krieckhaus, J., & Lusztig, M(2016), Corruption, democracy, and economic growth, *International Political Science Review , 27(2),* 121-136.

Engle, R.F., & Granger, C.W.J., (1987). Co-integration and error-correction: representation, estimation and testing. *Econometrica 55 (2)*, 251–276.

Frankel, Jeffrey A., & Rose, Andrew K., (2002). Is trade good or bad for the environment: Sorting out the causality. *Working Papers 9201*. NBER.

Fredriksson, *P.G., &* Svensson,*J. (*2003). Political instability, corruption and policy formation: the case of environmental policy. *Journal of Public Economics,*

Foye, .O. (2014). Environmental quality, financial development and economic growth in Nigeria. *Unpublished PhD Thesis*, Department of Economics, Obafemi Awolowo University, Ile-Ife, Nigeria.

Kennedy, P. W., (1994). Equilibrium pollution taxes in open economics with imperfect competition. *Journal of Environmental Economics Management*, *27,* 141-159

Lau, L., Chee-Keong, & Choong, Eng, Y. (2014). Carbon dioxide emission, institutional quality and economic growth: Empirical evidence in Malaysia. *Journal of Renewable Energy,68,*276-281.

López, R., &S. Mitra, (2000). Corruption, pollution and the kuznets environment curve. *Journal of Environmental Economics and Management, 40,* 137-50.

Marsiglio, S., Ansuategi, A., & Gallastegui, C. (2016), The environmental kuznets curve and the structural change hypothesis. *Environmental and Resource Economics, 63(2),*265-288

Ordás Criado, C. & Valente, S. & Stengos, T., (2011). Growth and pollution convergence: Theory and evidence. *Journal of Environmental Economics and Management, Elsevier,* 62(2), pages 199-214,

Payne, RA (1995) Freedom and the environment. *Journal of Democracy 6(3),* 41–55.

Pellegrini, L., & Gerlagh, R(2006), Corruption, democracy, and environmental policy**,** *Environment,15, (3),* 234-345.

Pesaran, M.H., Shin, Y., & Smith, R.J.,(2001), Bounds testing approaches to the analysis of level relationships. *Journal of Applied Econometrics 16,* 289–326.

Runar, B., Amin, K. & Patrik,S. (2016). Convergence in carbon dioxide emissions and the role of growth and institutions: a parametric and nonparametric analysis. *Environ Econ Policy Stud*

Sachs, J. D. (2003). Institutions don't rule: Direct effects of geography on per capita income. *NBER Working Paper No. 9490*.

Uddin G A, Salahuddin M, Alam K, & Gow J., (2017). Ecological footprint and real income: Panel data evidence from the 27 highest emitting countries. *Ecological Indicators*; 77, 166-175.