*Journal of Quantitative Finance and Economics.* **2020**, 2, 1

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# Pollutant Emissions, Institutions and Economic Growth in Nigeria

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*Received: 25 November 2019; Revised: 5 January 2020;*
*Accepted: 25 January 2020; Publication: 20 February 2019*

***Abstract:*** The study examined the dynamic effect of pollutant emissions and institutions on economic growth in Nigeria. Secondary data for the periods of 1980-2015 were sourced from World Bank Development Indicators and Central Bank of Nigeria statistical bulletins (several issues). VECM based impulse response, variance decomposition and other cointegrating regression techniques such as Fully Modified OLS and Dynamic OLS including Generalised Method of Moment were employed to analyze the data and estimate the model built for the study. The results showed that democratic accountability has positive impact on economic growth while $CO_2$ emissions have negative and significant impact on economic growth in Nigeria. The results also confirmed that bureaucratic quality improve the level of economic growth. Governance stability had significant effect on economic growth. This result showed that institutions cannot be overlooked in the growth process as far as Nigeria is concerned. Furthermore, the response of economic growth to a one standard deviation innovation in its past values was significantly positive in the short run with negative values in the medium and long runs. 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 democratic accountability produced no immediate effect on economic growth but its effect in the medium run was negative with significant negative response in the long run. The study concluded that strong institution is needed to reduce the negative effect of $CO_2$ emission on economic growth in Nigeria.

***Keywords:*** VECM, institutions, Nigeria, growth, pollutions

## 1. 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 countrieshavs been faced with environmental challenges which has negative effects on the people and the environment. The country is facing a major challenge, namely, to ensure stable economic growth and also to protect the environment. In order to correct this abnormality various studies suggested that strong institution is necessary to reduce pollution in the country which will encourage economic growth (Adejumo, 2016). Despite this assertion, it has become very difficult to find many studies that examined the role of institution on the relationship between $CO_2$ emission and growth in Nigeria. Hence, this study introduces and examines the role played by institution specifically, democratic accountability in the $CO_2$ emission-growth nexus in Nigeria.

The challenges facing humanity are of two fold namely: first is the issue of economic development while the second is how to preserve the environment. However, environmental issues has 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).

Environmental regulations do not start in Nigeria as a systematic effort to provide a progressively inclusive framework for managing its natural resources. For a considerable number of years after the country's independence in 1960, the nation was preoccupied with providing basic social amenities and advancing national economic development neglecting the future effects of environmental degradations.

From the 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 developing 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 that postulated 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 evidence 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 fill the gap 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.

## 2. Literature Review

Table 2 below shows the previous contribution to the topic.

**Table 2**
**Previous Contributions**

| *Author(s)* | *Country* | *Method Used* | *Scope* | *Objectives* | *Findinds* |
|---|---|---|---|---|---|
| Arouri, Yousef, M'henni & Rault (2012) | Middle East and North African countris (MENA) | Panel unit root and coiintegration techniques | 1981-2005 | To investigate the relationships between carbon dioxide, energy consuption and real GDP for 12 MENA countries over th period of 1981-2005 | 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 for the region. |
| Cho, Chu & Yang (2014) | OECD countries | Panel unit root, panel coiintegration and Fully Modified Ordinary Least square (OLS) | | To examine the relation-ships 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 |

| Author(s) | Country | Method Used | Scope | Objectives | Findinds |
|---|---|---|---|---|---|
| | | | | | relationships between $CO_2$ emissions and Economic Growth in the long run. |
| Lau, Choong & Eng (2014) | Malaysia | Bond Test and Granger causality test | 1984-2008 | To investigate the existence of long run relationships among carbon dioxide ($CO_2$) emission, Institutional Quality, Export and Economic Growth Malaysia. | The found that there are long run relationships among the variables |
| Marsiglio, Ansuategi & Gallastegui (2016) | 15 European countries | Balanced Growth Path (BGP) analysis | | To investigate the role that structural changes might play in generating an inverted U-shaped income – pollution relationships in 15 European Union countries | They found that there is a 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 |
| Ozuturk & Al-Mulali (2015) | Vietnam | Generalized Method of Moment (GMM) and 2-stage least square | 1981-2011 | To examine whether better governance and corruption control contribute to the formation of the inverted U-shaped relationships between Economic Growth and pollution | The concluded that Environmental Kuznets Curve (EKC) hypothesis is not supported suggesting that policies that reduce environmental pollution should be encouraged |
| Rumar, Amin & Patrick (2016) | 124 OECD and Non-OECD countries in high and | parametric and non-parametric panel data techniques | | To examine the convergence of per capita carbon dioxide ($CO_2$) emission | They found that there is evidence of negative direct effect of institutional |

| *Author(s)* | *Country* | *Method Used* | *Scope* | *Objectives* | *Findinds* |
|---|---|---|---|---|---|
| | low income countries | | | for a panel of 124 countries taking into account the impact of economic growth and the quality of government institutions | 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 environ-mental sustainability in Nigeria | They found that a negative short-run relationship between carbon dioxide emission, deforestation, energy depletion, non-renewable energy and green growth variables. There is also an inverse relationships in the long run. |

From our reviews, we discovered that few studies have investigated the relationship among $CO_2$ emission 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.

## 3. Data, variable measurements and econometric strategies

For us to achieve the objective of this study, we followed the work of Runar, Amin and Patrik (2016) to specify the model as stated below:

$$EG = f(CO2, IS, TO, IF, GF\ \ FD) \tag{1}$$

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

$$EG_t = \beta_0 + \beta_1 CO2_t + \beta_2 IS_t + \beta_3 TO_t + \beta_4 IF + \beta_5 GF_t + \beta_6 FD_t + u \tag{2}$$

Where EG is economic growth, $CO_2$ is the carbon dioxide emission, IS is the institutional variable, FD is the financial development, GF is the gross fixed capital formation, IF represents inflation rate, TO represents Trade Openness. u is the error term.

We first examined the effect of $CO_2$ emission and institutions on economic growth in Nigeria using GMM. While unit root test was conducted to examine the stationarity of the data. Co-integration procedure was also conducted to determine the long run relationships between the variables. In order to examine the relationship among $CO_2$ emission, institutions and growth, a model was developed to explain the contemporaneous or instantaneous relationship among $CO_2$ emission, institution and economic growth in Nigeria. Moreover, with a view to explaining these relationships, the study employs a Vector Autoregression estimate (VAR). VAR is simply a reduced form of many simultaneous equation models. A VAR model is thus specified below;

$$Z_t = \alpha_0 + \sum_{i=1}^{p} \beta Z_{t-1} + \varepsilon_t \qquad (3)$$

Equation (3) contains a VAR (p) process where $Z_t$ is a vector of endogenous variables, $\alpha_0$ is an (nx1) vector of constants, $\beta$ is an (nxn) matrix of co-efficient, $p$ is the maximum lag length, and $\varepsilon_t$ 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. However, the variables used for the study are measured as highlighted below:

- **Economic Growth (G):**. Growth is proxied by LOG of GDP per capita
- **Carbon dioxide Emission ($CO_2$)**: For most of the previous work done, they used $CO_2$ (Carbon dioxide emissions) as proxy for Environmental Quality or $CO_2$ emission. 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 $SO_2$ 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.

- **Financial Development (FD)**: As one of the control variables, we employed credits to private sector as a percentage of GDP in Nigeria.
- **Gross fixed capital formation (GF)**: As one of the control variables data also, we employed gross fixed capital formation as a percentage of GDP.
- **Inflation rate (IF)**: The Central bank of Nigeria data on Inflation rate was used for this study.
- **Institutional variables (IS)**: These include: Democratic Accountability (DA) to measure institution. Other institutional variables used to achieve this objective include: Bureaucratic quality (BQ), Corruption perception index(Corp), and Law and Order (Laord)

## 4. 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 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 1 showed that economic growth (EG) and average temperature (AT) are stationary at first difference in both Augmented Dickey-Fuller and Phillips-Perron tests. Meanwhile, other variables are stationary at level in both tests. 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 1**
**Unit Root Test**

| *Varriables* | *Adf Stat.* | *At 5%* | *Pp Stat.* | *At 5%* | *Remarks* |
|---|---|---|---|---|---|
| EG | -4.4286 | -2.9511 | -4.4351 | -2.9511 | I(0) |
| BQ | -6.2049 | -2.9511 | -6.2049 | -2.9511 | I(1) |
| $CO_2$ | -6.3418 | -2.9511 | -6.3375 | -2.9511 | I(1) |
| CORP | -4.9528 | -2.9511 | -4.9595 | -2.9511 | I(1) |
| DA | -5.706 | -2.954 | -9.353 | -2.9511 | I(1) |
| FD | -5.3048 | -2.9511 | -9.5506 | -2.9511 | I(1) |
| GF | -3.0412 | -2.9571 | -3.6269 | -2.9511 | I(1) |
| GS | -4.5512 | -2.9511 | -4.3921 | -2.9511 | I(1) |
| IF | -5.5134 | -2.9511 | -10.5379 | -2.9511 | I(1) |
| LAWORD | -3.5989 | -2.9511 | -3.5472 | -2.9511 | I(1) |
| TO | -8.0679 | -2.9511 | -8.0353 | -2.9511 | I(1) |

*Source:* Authors' Computation

**Table 2**
**ARDL Bounds Test**

**Null Hypothesis: No long-run relationships exist**

| *F-statistic* | *K* | *Models* | *ARDL Selected* |
|---|---|---|---|
| 8.120699 | 5 | EG = f(CO2, IS, TO, IF, GF) | (4,4,4,4,3,4) |
| 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 2 showed 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 three models range from 4.022 to 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 3 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 3**
**VAR Lag Order Selection Criteria**

Endogenous variables: *EG = f(CO2, IS, TO, IF, 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

First, we examined the relationships among $CO_2$ emission and institution on economic growth in Nigeria as documented in Table 4. We achieved this objective using a number of econometric techniques such as GMM, fully modified OLS and Dynamic OLS. The first column shows that democratic accountability (DA) has positive effect on economic growth while $CO_2$ emissions have negative and significant effect on economic growth in Nigeria. The results confirmed that bureaucratic quality improve the level of economic growth in Nigeria as demonstrated by its coefficients. The coefficient of $CO_2$ emission also improves the economic growth. It implies that the higher the quality of the environment, the higher the economic growth. Governance stability (GS) also has significant effect on economic growth. This shows that the important of stability of the government cannot be overlooked in the growth process as far as Nigeria is concerned. Corruption affecting environmental issues is more frequent in developing countries with higher political instability and weaker institutions (Lopez & Mitra, 2000).

**Table 4**
**Examine the relationship among $CO_2$ emission and Institutions on Economic Growth**
**Dependent Variable: EG**

| | *GMM* | *FMOLS* | *DOLS* | *DOLS* | *FMOLS* |
|---|---|---|---|---|---|
| $C0_2$ | -20.3759** (0.0642) | 16.76581** (0.0266) | -9.134167 (0.7094) | 17.27491 (0.3422) | 12.85519** (0.0362) |
| DA | 0.261841** (0.0214) | | | | |
| GS | | 0.230422*** (0.0719) | | | |
| TO | | -0.013102 (0.8690) | 0.090623 (0.5624) | -0.040809 (0.7993) | 0.061971 (0.2771) |
| IF | | 0.056318 (0.4653) | 0.27514 (0.1024) | -0.057697 (0.8574) | -0.110144*** (0.0649) |
| GF | | -0.430191** (0.0258) | -1.0751** (0.0325) | -1.088717*** (0.0734) | -0.613429* (0.0001) |
| FD | | -0.090456 (0.5598) | -0.107609 (0.7311) | 0.231343 (0.5232) | -0.086442 (0.5108) |
| Laword | | | -0.818435*** (0.0703) | | |
| BQ | | | | 0.441152 (0.3795) | 0.183433 (0.1169) |
| C | 2.928102 (0.5988) | -12.71756 (0.2842) | 41.48324 (0.1497) | -6.922087 (0.7206) | -1.305593 (0.8547) |
| R-Sq | | 0.291464 | 0.730745 | 0.7459 | 0.239701 |
| Instrument Rank | 8 | | | | |
| J-statistic | 8.569276 (0.12752) | | | | |

*1%, **5%,***10% Significance level

For the dynamic relationships among $CO_2$ emission, institutions and 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 as presented below.

**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] |

*contd. table 5*

| *Error Correction:* | *D(EG)* | *D($CO_2$)* | *D(DA)* | *D(TO)* | *D(GF)* |
|---|---|---|---|---|---|
| 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 levelSource: Authors' computation

From Table 5, past values of $CO_2$ emissions have positive and significant impact on economic growth while the institutional variable (Democracy, DA) is not significant. In order to be able to provide further insight into the dynamic properties of the VECM/VAR system we present Variance Decompositions (VDs) and Impulse Response Functions (IRFs) as shown in Table 5.13 and Figure 5. 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 (10 years in the presented study). 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), Inflation rate (IF) and Gross fixed capital formation (GF).

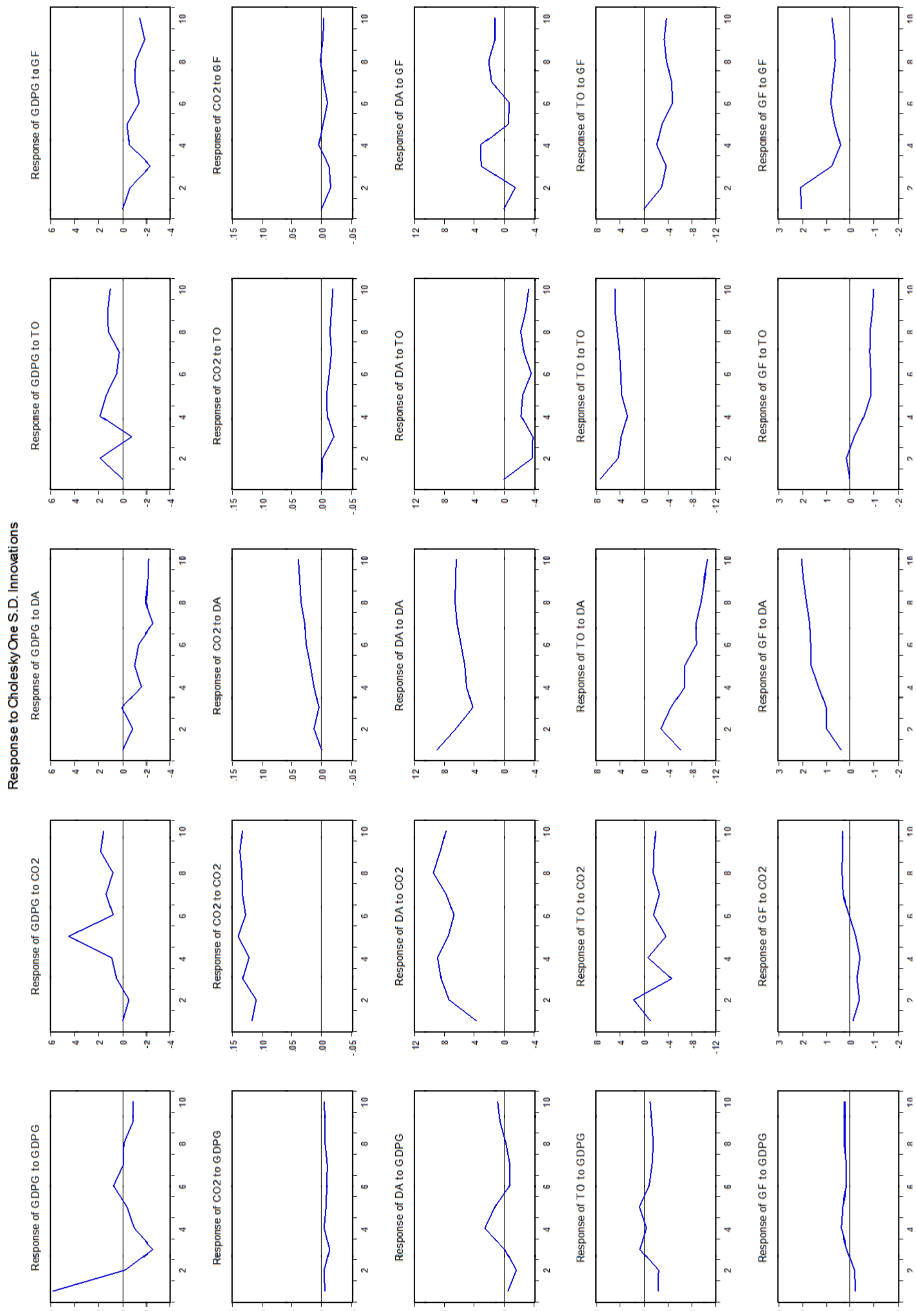


**Figure 1:** Impulse Response

The graphs on the first row 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 the shocks over ten years. 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 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. 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. However, EG responded negatively to one standard deviation innovation in the Gross fixed capital formation (GF) in both short run and long run periods.

The graphs in row 2 showed 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, 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

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 Table further shows 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 |

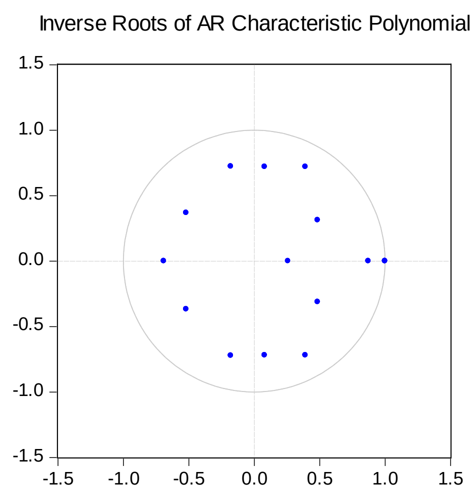


**Figure 2:** Inverse Root of AR

### *Further Discussion of Key Findings*

The study verifies the dynamic relationship among $CO_2$ emission, institution and growth in Nigeria using various econometric analyses. The study found that democratic accountability reduces air pollution. This confirms the view that democratic accountability is beneficial to environmental protection efforts (Pellegrini & Gerlagh 2006). The close association of freedom provides compelling reasons why democratic accountability may be able to better protect their environments.. In addition, the results of impulse-response analysis, institutions and $CO_2$ are more dynamically effective in the long run than in the short run to improve economic growth in Nigeria. The study also considers other institutional variables such as corruption, governance stability among others. We discover that corruption reduces air quality in Nigeria, while good environment improves the level of economic growth. This is shared and consistent with the work of Drury *et al.* (2006) who found that environment suffer significant economic harm from corruption. Governance stability improves the level of economic growth. However, corruption has a negative effect on environmental policymaking and outcomes. Lopez and Mitra (2000) provided a game-theoretic model which demonstrated that corruption and environmental policy stringency are characterized by a monotonic (negative) relationships. The result supports the work of Fredriksson and Svensson (2003). They provided that environmental quality is negatively influenced by both corruption and political instability.

## 5. Conclusions

The study's objective is to examine the dynamics of institutions, $CO_2$ emission and growth in Nigeria for the period of 1980-2015 using GMM, FMOLS, DOLS and 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.

In general, most of the robustness checks show that political institutions matter in strengthening the relationship between $CO_2$ emission and economic growth in Nigeria. The empirical analysis also indicates that democracy don't "works" through the form of democratic system: controlling for the form of democratic government, democratic institutions always have a direct impact on environmental quality. The results suggest that an improvement of democratization process in Nigeria would allow a high awareness of people. Nigerian government can find ways to reduce the impact of democratic institutions on environment quality (by the implementation of ecologically appropriate investments).

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:

- Although, the empirical results of the study showed that the ongoing policy of the pollution and environmental treatment in

Nigeria are working, but the question is how effective is the impact in the country? Perhaps too slow. Hence, the government needs to strengthen its institutional environment.

- It is important that the government needs to reduce the cumulative emissions of carbon dioxide in Nigeria by engaging the scientists and policy makers to take more care for clean and environment 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.

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