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RENT-SEEKING IN WEST AFRICA – HOW CORRUPTION AFFECTS ECONOMIC GROWTH AND INCOME INEQUALITY

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Abstract

Using panel data from 15 West African countries for the period 2010-2017, the paper examines the effects of corruption on economic growth and income distribution. Results from the System Generalized Method of Moments estimation technique reveal that decreasing corruption tends to increase economic growth. In addition, corruption and income inequality are positively correlated. As rising corruption generates lower economic growth, it also exacerbates increasing levels of income inequality in the West African sub-region. The implications on the economy are profound, and this calls for institutional reforms, implementation of enhanced anti-corruption policies and efficient use of resources to reduce corruption, and promote sustainable development and inclusive economic growth.

Keywords: Corruption, Economic Growth, Income Inequality, System GMM Estimator, West Africa

JEL Classification: O11, O55, K42, D73, O43

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1.0 INTRODUCTION

Over the years, corruption in its various forms has emerged as a major issue that affects all levels of society in Africa, a continent which is endowed with abundance of resources but remains poor. It is even more critical when attention is focused on Sub-Saharan Africa where 33 out of the 47 Least Developed Countries (LDCs) are found. Although economic growth in West Africa has been relatively impressive in the last two decades and a few countries have consequently seen significant reductions in poverty levels, the benefits of this growth have largely accrued to a small group and inequality has reached extreme levels (OXFAM, 2019). These outcomes are mainly attributed to high and sustained levels of corruption. For example, Blundo and de Sardan (2001) reveal convergent outcomes of corruption practices in Benin, Niger and Senegal, and rent-seeking activities such as widespread charging of commission, racketeering by the police and the system of favoritism particularly from the political elites are common phenomena in all three countries. Furthermore, Abu, Karim and Aziz (2015) posit corruption as a deep-rooted practice in almost every facet of the Nigerian economy including various arms of government. These studies emphasize the insidious nature of rent-seeking practices and suggest that corruption is endemic in West Africa. It is therefore not surprising that West African countries are consistently rated poorly in global corruption perception indexes.

Although economists have long recognized the role corruption plays in economic development, contemporary studies (Nurudeen and Staniewski, 2019; Blundo and de Sardan, 2001) have largely centered on the causes of corruption at the expense of the impact of corruption on economic performance. Few studies such as Anoruo and Braha (2005) and Gyimah-Brempong (2002) have investigated the effect of corruption on economic growth and income inequality in the African context. However, no study has particularly focused on West Africa. Hence, this study aims to bridge that gap. The questions I ask and seek to address are: 1) Is corruption a principal factor accounting for poverty and income inequality in West Africa? and 2) Are there empirical evidence demonstrating the effect of corruption on economic growth and income distribution in West Africa?

This study is significant to West Africa for the following reasons: First, West Africa has the greatest number of countries compared with other regions of the continent where more than 30% of the population are living on less than $1.90 a day (OXFAM, 2019). Even though West Africa has been a major recipient of external aid to improve the economic fortunes of the region, there exists a myriad of economic problems.

Research suggests that aid may have been siphoned into private accounts, and not used for the purposes for which it was received due to systemic corruption pertaining in West Africa and Africa at large (Gyimah-Brempong, 2002; Willett, 2009). Moreover, despite the abundance of natural resources in Africa, the region has witnessed declining foreign direct investment compared to other parts of the world, an outcome that is partly due to the persistence of corruption (Brunetti, Kisunko and Weder, 1998). This paper is therefore critical in investigating the effects of corruption on economic growth and income inequality in West Africa. The outcomes of the study will provide policy options in the areas of governance and institutional reforms to aid curb corruption practices whilst stimulating efforts to promote economic growth and equitable income distribution in West African countries. I employ a dynamic panel estimator to analyze the impact of corruption on economic growth and on income inequality. Results confirm that rising corruption leads to lower economic growth and higher levels of income inequality in West Africa. This result is robust with respect to alternative econometric specifications of the relationship.

Following the introduction in section 1, the pertinent literature on the impact of corruption on economic growth and income distribution is reviewed in section 2. In Section 3 the econometric growth and the income inequality equations are presented, while section 4 presents a description of the data and the estimation method. Section 5 discusses the empirical results while section 6 presents the conclusion of the paper.

2.0 Literature Review

2.1 Defining Corruption

According to Khan (1996) and Nye (1967), corruption is the behavior that deviates from the formal rules of conduct governing the actions of someone in a position of public authority because of private-regarding motives such as wealth, power, or status. Heidenheimer, Johnston, and Le Vine (1989) and Rose (1978) stated that corruption exists at the interface of the public and private sectors. Murphy, Shleifer, and Vishny (1993) argue that corruption in terms of bribery may divert firms and talented individuals from productive activities to rent-seeking activities which leads to sub-optimal use of human capital thereby reducing economic growth. The World Bank (1997) defines corruption as the use of public office for private benefit. Here, the public is expanded to include: government, private businesses, international organizations and parastatals. Andvig, Fjeldstad, Amundsen, and Søreide (2000) clarify corruption to range from misuse of public power and moral decay to strict legal definition of

corruption as an art of bribery involving public servant and a transfer of tangible resources whilst Jain (2001) categorizes corruption into three levels, namely: 1) Grand corruption, 2) bureaucratic corruption, and 3) legislative corruption. Grand corruption refers to the acts by which political elites use their powers to influence economic policies, while bureaucratic corruption refers to the corrupt practices by appointed bureaucrats either with their superiors (the political elite) or with the public. Legislative corruption refers to how legislative votes of legislators are influenced by interest groups.

Empirical studies have identified the following factors to increase corruption: 1) low levels of law enforcement; 2) lack of clarity of rules and regulations; 3) lack of accountability and transparency in public dealings; 4) too many controls that give so much power to public office holders; 5) high levels of centralization and monopoly given to public officials; 6) low relative wages of public officers and 7) the large size of the public sector (Ades and Di Tella, 1999; Kaufmann and Siegelbaum, 1997; Rose-Ackerman and Palifka, 2016; Tanzi, 1998; Van Rijckeghem and Weder, 2001).

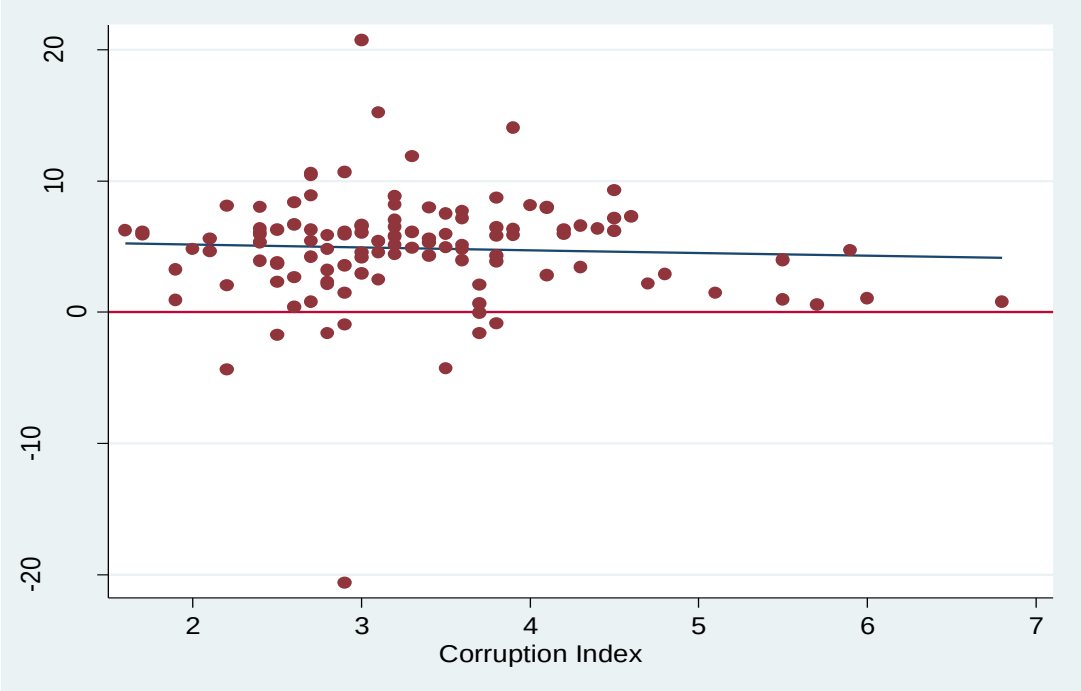
2.2 A Review of Theoretical and Empirical Literature

The economic analysis of corruption can be applied to the standard economic model of crime originally developed by Becker (1968) and later extended by Polinsky and Shavell (1979, 1984). In this model, persons who are contemplating corruption are likely to benefit in terms of bribes, favors or payment in kind and often consider the costs and benefits of their actions which may lead to conviction. This formulation is closely parallel with the application of Becker's model to the economics of tax evasion by Allingham and Sandmo (1972) in which corruption is expected to occur if the net gain is positive.

The theoretical and empirical literature on the effect of corruption on economic growth have generated debates over the years. Knack and Keefer (1995); Hall and Jones (1999); and Sachs and Warner (1997) reveal negative correlation between corruption and economic growth. Using developed and developing countries samples shows that corruption negatively and significantly impact economic growth through a decreased investment in physical capita (Mauro, 1995; Mauro, 1998). Tanzi and Davoodi (1997) and Tanzi (1998) discover that corruption increases government expenditures but decreases expenditures on maintenance which reduces economic growth and private investment. Wei (2000) also notes corruption to reduce foreign direct investment. Ehrlich and Lui (1999) show that corruption and per capita income negatively correlated across different stages in a country's economic development.

Arguably, Alesina and Weder (2002) identify that corrupt governments may receive more foreign aid under some circumstances. Figure 1 presents the plots of the growth rate of real GDP against the corruption index. The plots suggest that there may be a positive correlation between growth rate of real GDP and corruption index; however, this relationship could be truly observed after controlling for other variables in the relationship.

Figure 1. Relationship between Economic Growth and Corruption



Regarding the impact of corruption on income inequality, Gyimah-Brempong (2002) find increased corruption to positively correlate with income inequality in Africa. In furtherance, Gupta, Verhoeven, and Tiongson (2002) reveal that corruption increases income inequality and poverty in developing countries. They suggest corruption reducing policies are most likely to reduce income inequality when implemented. Samadi and Farahmandpour (2013) also reveal corruption to decrease in high economic-freedom countries and subsequently reduce income inequality but it increases in low economic-freedom countries leading to high income inequality.

In the terms of economic modeling, Mo (2001) use Ordinary Least Square (OLS) estimates to measure the effect of corruption on economic growth in Asia. He finds

that corruption has negative impact on growth rate, level of human capital and the share of private investment. Moreover, Anoruo and Braha (2005) employ Phillips-Hansen modified (FM) OLS to investigate the effect of corruption on economic growth in Africa. The study reveals that corruption retards economic growth directly by lowering and indirectly restricting investment. Dridi (2013) also use channeled methodology system of simultaneous equations to evaluate the effect of corruption on economic growth. The results suggest that the negative effect of corruption on economic growth is mainly transmitted by its impact on human capital and political instability. Gyimah-Brempong (2002) uses panel data and dynamic panel estimator to investigate the effect of corruption on economic growth and income inequality. He unveils that corruption decreases economic growth and indirectly through decreased investment in physical capital.

In summary, literature has identified the various causes of corruption to include: low levels of law enforcement, lack of clarity of rules, lack of transparency and accountability in public action and relative low wages of public servants. In addition, literature has unearthed the effect of corruption on economic growth and income inequality which include: increased government expenditure, decreased investment in physical capital, reduction in foreign direct investment and increased poverty and high disparity in income distribution. However, none of the studies have specifically focused on West Africa in which few countries on average score relatively well in the corruption ranking as shown in Table 1.

Table 1: Average Corruption Perception Index (CPI) per Country: 2010-2017

Country	CPI Score (0=highly corrupt and 10=highly clean)
Benin	3.5
Burkina Faso	3.7
Cabo Verde	5.8
Cote d'Ivoire	2.9
Gambia	3.0
Ghana	4.4
Guinea	2.4
Guinea-Bissau	2.0
Liberia	3.6
Mali	3.1
Niger	3.2
Nigeria	2.6
Senegal	3.9
Sierra Leone	2.9
Togo	2.9

Source: Transparency International

On the premise that corruption is a complex and multifaceted phenomenon and the extent of its causes and effects are linked to one's discipline, cultural background and political dimensions, it is deemed necessary to investigate the effect of corruption on economic growth and income distribution in the West African context. This will aid in devising workable policies and strategies in curbing corruption in West Africa. This study uses a dynamic panel estimator model to estimate economic growth and income inequality in West African countries. This model has the advantage in ensuring that the parameter estimates are consistent in the presence of dynamics and endogenous regressors.

3.0 Model

3.1 Modeling Corruption on Economic Growth

This paper determines the extent to which corruption impacts economic growth and income inequality. Empirical research on the impact of corruption on economic growth can be observed through two main channels: 1) by the reduction of existing

resources which decreases productive effort or by misallocating the existing resources and 2) by reduction in investment which affect both human and capital investment as well as degradation on institutions (Wei 2000; Gupta, Davoodi, and Alonso-Terme, 2002; Mauro, 1998; Tanzi and Davoodi, 1997). In this section, the effect of corruption on economic growth by extending Solow's (1956) original growth modeling approach is estimated. This approach has been adapted by many studies (Ahmad, Ullah, and Arfeen, 2012; Gyimah-Brempong, 2002; Gyimah-Brempong and Traynor, 1999; Mauro, 1995; Barro, 1991) to examine the relationship between income growth and corruption. Economic literature has clarified economic growth rate to largely depend on government expenditure, investment rate, growth rate of trade, and educational attainment of the adult population. In furtherance, I modify the growth model to encapsulate corruption perception index and political stability as explanatory variables measuring corruption and institutional quality in an economy. Following Ahmad, Ullah, and Arfeen (2012), this analysis starts with the Solow's (1956) production function which takes into account the growth process. The aggregate production function can be express as follows:

$$Y_{it} = A_{it}F(K_{it,}L_{it,}) \quad (1)$$

or

$$Y_{it} = A_{it}K_{it}^{\theta}L_{it}^{1-\theta} \quad (2)$$

where Y_{it} is the aggregate output, A_{it} is the total factor productivity (TEP), K_{it} is the capital stock, and L_{it} is the quantity of labor in country *i* at time period *t*. The parameter θ measures the share of capital and $1-\theta$ measures the share of labor in total output. Dividing Equation (2) by *L* and taking the natural logarithms, I obtain:

$$y_{it} = a_{it} + \theta k_{it,} \quad (3)$$

where $y_{it} = ln\left[\frac{Y_{it}}{L_{it}}\right]$, $a_{it} = lnA_{it}$, and $k_{it} = ln\left[\frac{K_{it}}{L_{it}}\right]$.

The model obtains its dynamic feature due to the inclusion of a lag dependent variable. The empirical analysis which specify the above relationship is as follows:

$$a_{it} = n_0 + \sum \beta_j X_{itj} + \sum \delta_k X_{itk} + \gamma y_{i(t-1)} + \mu_{it} \quad (4)$$

where a_{it} is the total factor productivity, X_j is a set of *j* conditioning variables, which includes: government expenditure as a percentage of GDP, primary school enrollment rate, and gross foreign direct investment (a proxy of investment rate), X_k is a set of *k* variables measuring the level of corruption and institutional quality, which includes: corruption perception index (a proxy of corruption), corruption perception index square, and political stability index. $\beta_j's$ represents the conditioning variables and δ_k represents the corruption and institutional quality variables, γ is the coefficient of the

lag of GDP per worker and μ_{it} is the error term. Thus, substituting Equation (4) in Equation (5), the growth model of corruption is stated as follow and $y_{i,t-1}$ is the logarithm of GDP per worker at the start of the period.

$$y_{it} = n_0 + \sum \beta_j X_{itj} + \sum \delta_k X_{itk} + \gamma y_{i(t-1)} + \rho \frac{K_{it}}{L_{it}} + \mu_{1it} \quad (5)$$

This model captures both growth-enhancing and growth-reducing effect of corruption on growth by estimating the long-run growth as a linear-quadratic function of corruption. For simplicity, a modest attempt is made to estimate the following equation:

$$Y_{it} = \alpha_0 + \alpha_1 Corrupt_{it} + \alpha_2 Corrupt_{it}^2 + \alpha_3 PSI_{it} + \alpha_4 FDI_{it} + \alpha_5 Edu_{it} + \alpha_6 Gov_{it} + \alpha_7 Y_{it-1} + e_{it} \quad (6)$$

Where Y_{it} is the GDP per worker, $\alpha_i s$ are the coefficients to be estimated, $Corrupt_{it}$ is the corruption perception index (a proxy of corruption), $Corrupt_{it}^2$ is the squared of corruption perception index, PSI_{it} is the political stability index of a country, FDI_{it} is foreign direct investments (a proxy of investment rate), Edu_{it} is the primary education enrollment, Gov_{it} is government expenditure, Y_{it-1} is the lag of the dependent variable, GDP per worker, subscript *i* represents the country and *t* stands for the time and e_{it} is the error term.

3.2 Corruption and Income Inequality

Over the years, there have been several studies on the effect of corruption on income inequality. These studies focused on several channels through which corruption may impact income inequality and thereby affect the poor the most. Among prominent empirical research on this issue include: Gupta, Davoodi, and Alonso-Terme (2002), Li, Colin, and Zou (2000), Hindriks, Keen, and Muthoo (1999), and Johnston (1999). They argue that corruption increases income inequality, poverty and led to a bias tax system which impacts the poor disproportionately. Gyimah-Brempong (2002) suggests that due to the bias tax system in many African countries, "corruption allows the rich and powerful to escape their tax obligations, hence the tax burden falls almost exclusively on the poor." Fields (1980) states that development strategy could impact income inequality and as such labor-intensive development strategy produces more equitable distribution as compared to capital intensive development strategy.

Furthermore, the poor usually benefit from government social programs and as such if corruption is prevalent, the poor will not benefit from programs such as education and health care. Thus, resources are diverted toward the rich or other opportunities such a defense spending which could be considered as rent extraction (Gupta, Davoodi, and Alonso-Terme, 2002). Cerdeiro and Komaromi (2017) argue that countries with

higher trade openness (export plus imports as a share of GDP) tend to have higher living standards and lower income inequality. In view of these considerations, the relationship between corruption and income inequality is estimated as follows:

$$Gini_{it} = \varphi_0 + \varphi_1 GDP_{it} + \varphi_2 Corrupt_{it} + \varphi_3 Edu_{it} + \varphi_4 Gov_{it} + \varphi_5 Trade_{it} + \varepsilon_{it} \quad (7)$$

where $Gini_{it}$ represents the Gini coefficient of income distribution; GDP_{it} is the annual percentage growth rate of GDP; $Corrupt_{it}$ is the corruption perception index (a proxy of corruption); Edu_{it} is the primary school enrollment rate; Gov_{it} is the government expenditure as a percentage of GDP; $Trade_{it}$ represents external competitiveness as a measure of trade-to-GDP ratio; subscript *i* represents the country and *t* stands for the time; and ε_{it} stands for the error term.

4.0 Data and Estimate Method

4.1 Data

The data are annual observations for 15 West African countries for the period 2010-2017. The period reflects the post-global food and financial crisis of 2007-2009 and substantial covariate risks due to economic upheavals and political volatility in part linked to heightened corruption, changes in government administration, wave of terrorism in the Sahel region and the health crisis (e.g. the Ebola Virus Disease outbreak) among others. The variables used in this analysis include: GDP per worker, corruption perception index, political stability index[1], gross foreign direct investment (a proxy of investment rate), primary school enrollment rate, government expenditure as a percentage of GDP, trade as a percentage of GDP, Gini index, mortality rate, and annual percentage growth rate of GDP. The data were mainly sourced from *Transparency International* and the World Bank's *World Development Indicators Dataset* 2010-2017.

The endogenous variables in this model are the GDP per Worker and Gini coefficient of income inequality. The regressors in the model are corruption perception index, political stability index, gross foreign direct investment, primary school enrollment rate, government expenditure as a percentage of GDP, annual percentage growth rate of GDP, and trade-to-GDP ratio.

[1] Political Stability Index measures perceptions of the likelihood of political stability and/or politically motivated violence, including terrorism. The Political Stability index is ranked from -2.5 (weak) to 2.5 (Strong).

KThe summary statistics of the data are presented in Table 2. There are 120 total useable observations for the different regressions. The summary statistics indicate that GDP per worker, investment, trade, as well as other variables vary across countries in West Africa. On average, countries are perceived as having weak political stability. Also, the low average of corruption index among countries indicates that they are perceived as highly corrupt. The correlation coefficients for the model explanatory variables are presented in the Appendix. For example, the correlation coefficients show negative (-0.030) correlation between corruption index and gross foreign direct investment as well as negative (-0.255) correlation between corruption index and annual percentage growth rate of GDP.

Table 2. Summary Statistics of Sample Data

Variables	Mean	Standard Deviation	Minimum	Maximum
GDP per Worker (log)	8.636	0.609	7.618	9.875
Corruption Perception Index	3.323	0.953	1.600	6.800
Political Stability Index	-0.559	0.731	-2.211	0.902
Foreign Direct Investment (gross)	19.505	1.753	12.155	22.903
Primary School Enrollment Rate (log)	96.125	17.298	62.673	132.468
Government Expenditure (% GDP)	13.998	4.225	4.624	26.041
GDP Growth (Annual %)	1.541	0.682	-0.902	3.031
Trade (% GDP)	4.216	0.353	3.031	4.920
Gini Index	39.750	5.700	31.500	50.700
Mortality Rate	58.340	18.020	15.000	108.400
N	120			

Source: Author computation

4.2 Estimation Method

4.2.1 Growth Equation: The Dynamic Panel Estimator

The Growth model on corruption in Equation (6) above is estimated using panel data from 15 West African countries for the period 2010-2017. Baltagi (1995) and Baltagi and Li (1995) note that in a panel estimation, neither the Generalized Least Squared (GLS) estimator nor Fixed Effect (FE) will produce consistent estimates in the presence of dynamics and endogenous regressors. This argument was further strengthened by (Caselli, Esquivel, and Lefort, 1996) in which they indicate that due to the nature

characterized by growth equations, that is dynamics and endogenous regressors, GLS and FE are not appropriate estimators. Thus, instrumental variables (IV) are needed to produce consistent estimates particularly in the presence of dynamics.

To produce a consistent estimate in the presence of dynamics and endogenous regressors, Arellano and Bond (1991) proposed a dynamic panel Generalized Method of Moments (GMM) estimator. The dynamics GMM panel estimator is an IV estimator which considers both current and past values of endogenous regressors applied in this paper as instruments. Consequently, a dynamic panel estimator is invoked as there are no reasonable instruments to proxy endogenous regressors in the growth equation. As noted in the empirical literature, dynamic panel estimator provides consistent estimates in the presence of endogenous regressors.

To decide whether to use Difference or System GMM estimator, the paper follows the suggestions made by Bond, Hoeffler, and Temple (2001) and Bond (2002). First, the autoregressive model is estimated by pooled OLS and the fixed effects approach. The pooled OLS estimate of the coefficient of the lagged dependent variable should be an upper-bound estimate, while the corresponding fixed effects should be the lower-bound estimate of the GMM. Finally, if the Difference GMM estimates obtained is close to or below the fixed effects estimate, then the former estimate is downward biased due to weak instrumentation; therefore, a System GMM estimator should be preferred.

Moreover, the Difference GMM instrument variables are prone to correlation biases with the fixed effects which according to Roodman (2009), the System GMM was built to overcome that deficiency and improves efficiency. As indicated in Table 3 following Bond (2002) rule-of-thumb, the result shows that the Difference GMM estimates obtained are close to and below the fixed effects estimate. Therefore, to overcome the problem of bias and endogeneity, the System GMM estimator is in addition adopted in this paper.

Table 3: **Difference vs. System GMM**

Estimators	Coefficients
Pooled OLS	0.993***
	(-0.010)
Fixed Effects	0.309**
	(-0.129)
One-Step Diff. GMM	0.046
	(0.219)
Two-Step Diff. GMM	0.212
	(-0.659)

Notes: Robust standard errors in parentheses. Parameter estimates are statistically different from zero at *10%, **5%, and ***1% significance levels, respectively. Coefficients are estimate of the lagged dependent variable (GDP per Worker) after controlling for other variables.

4.2.2 The Gini Equation

Equation (7) presents the Gini equation which estimates the relationship between corruption and income inequality. As previously stated, GDP per worker and corruption index are considered as endogenous variables; therefore, an IV estimation approach will be an appropriate methodology to use. I estimate the Gini equation using an Ordinary Least Square (OLS) and an IV estimation methodology. Kaufmann, Kraay, and Zoido-Lobaton (1999), show that corruption reduces life expectancy and literacy, and increases infant mortality rates. Acemoglu, Johnson and Robinson (2001) and Gyimah-Brempong (2002) suggest that mortality rate is strongly correlated with the quality of present-day institutions. Thus, mortality rate is used as an instrument for corruption.

5.0 Results and Discussion

This section presents the regression results for both the growth and Gini equations. The first sub-section presents the growth equation, the second sub-section presents the Gini equation and the third sub-section present the general discussion regarding the results.

5.1 Growth Equation

5.1.1 Coefficient Estimates

The main results of applying the System GMM technique are presented in Table 4. All equations include a set of year dummies. The Arellano-Bond test for AR (2) of the error term indicates that there is no evidence that the differenced error term is second order serially correlated. Thus, this implies that the original error term is serially uncorrelated, and the moment conditions are correctly specified. The Hansen Test of Overid Restrictions test for instruments validity. This tests failure to reject the null hypotheses and as such gives support to the choice of instruments.

The coefficients of corruption and corruption squared in Table 4 column 1 are statistically significant at the 5% and 1%, respectively. The results are similar for the coefficients of corruption and corruption squared in Table 4 column 3 but at the 10% significance level. The results are robust after including other control variables. In Table 4 column 1, a one-standard-deviation increase (an improvement) in the corruption index raises the log of GDP per worker by 11.6% while a one-standard-deviation decrease (a decline) in the corruption index squared lowers the log of GDP per worker by 1.7%. In column 2, 4, and 5, political stability index coefficients indicate that a one-standard-deviation improvement in political stability index will raise the log of GDP per worker on average by 4.1%, respectively with a significant level of 5% and 1% levels. It is important to note that the lag of GDP per worker is also statistically significant at 1% in column 1-4.

In Table 4 column 3, a one-standard-deviation increase (an improvement) in the corruption index raises the log of GDP per worker by 8.1% while a one-standard-deviation decrease (a decline) in the corruption index squared lowers the log of GDP per worker by 1.2%. I estimate the long-run impact of corruption on GDP per worker in Table 5. The result indicates that a decrease in corruption index lowers the log of GDP per worker in the long-run and it is significant at the 10% level while an improvement in the corruption index squared of one-standard-deviation increases the log of GDP per worker by 23.9% and it is statistically significant at the 5% level.

Table 4: **System GMM Estimates of the Relationship between Economic Growth and Corruption**

Dependent variable: GDP per Worker					
Variables	(1)	(2)	(3)	(4)	(5)
Corruption Perception Index	0.116**	0.059	0.081*	0.035	0.060
	(0.040)	(0.083)	(0.043)	(0.059)	(0.083)
Corruption Perception Index Squared	-0.017***	-0.007	-0.012*	-0.005	-0.006
	(0.005)	(0.008)	(0.007)	(0.006)	(0.007)
Political Stability Index		0.043**	0.004	0.040***	0.039**
		(0.017)	(0.014)	(0.013)	(0.016)
Gross Foreign Direct Investment				0.002*	0.001
				(0.001)	(0.003)
Primary School Enrollment Rate	0.003		0.006		
	(0.063)		(0.064)		
Government Expenditure (%GDP)					-0.002
					(0.003)
GDP per Worker (-1)	1.070***	1.013***	1.055***	1.067***	1.106
	(0.029)	(0.204)	(0.046)	(0.098)	(0.659)
N	90	105	90	105	100
Year Dummies	Yes	Yes	Yes	Yes	Yes
Arellano-Bond test for AR (2)	0.485	0.416	0.800	0.394	0.464
Hansen Test of Overid Restrictions	0.396	0.477	0.570	0.363	0.388

Notes: Robust standard errors in parentheses. Parameter estimates are statistically different from zero at *10%, **5%, and ***1% significance levels, respectively.

The results in Tables 4 and 5 suggest that corruption has a significant impact on the log of GDP per worker in the short and long run, respectively. The impact is larger when corruption is not properly addressed by the authorities and as such lower productivity in the economy. This is evident in the score of corruption perception index in Table 1 which shows that more than half of West African countries are among the less developed nations in Africa.

Table 5: **Long-Run System GMM Coefficients**

Variables	Coefficients
Corruption Perception Index	-1.657*
	(0.834)
Corruption Perception Index Squared	0.239**
	(0.096)
Political Stability	-0.599
	(0.934)
Gross Foreign Direct Investment	-0.002*
	(0.001)

Notes: Robust standard errors in parentheses. Parameter estimates are statistically different from zero at *10%, **5%, and ***1% significance levels, respectively.

5.2 Corruption and Income Inequality

I investigate the impact of corruption on income distribution by regressing the Gini coefficient of income distribution on corruption and other regressors using OLS and IV estimation techniques. The results are presented in Table 6. The OLS and IV estimate show that the equation fits the data by explaining 72.4% and 41.9%, respectively. The Durbin Score and Wu-Hausam Test for endogeneity with the null hypothesis that the variables are exogenous is rejected at the 1% significance level, respectively. The First Stage Regression (Partial R-sq) test for instrument with null hypothesis that instrument is weak is rejected at the 5% significance level. Thus, mortality rate is a good instrument for corruption.

Column 2 presents the OLS estimates. The coefficient estimates of the annual percentage of GDP growth is negative and insignificant as well as corruption index is positive and insignificant. But a one-standard-deviation increase in primary school enrollment rate improves the Gini coefficient of income distribution by 46.6% and it is significant at the 1% level. Also, the result indicates that one-standard deviation decrease in government expenditure as a percentage of GDP lowers the Gini coefficient of income distribution by 1.5% at a statistically significant level of 10%. Furthermore, a one-standard deviation decrease in trade openness decreases income distribution by 20.7% at the 5% significant level.

Table 6: **OLS and IV Estimates of the Gini Equation**

Dependent variable: Gini Index

Variables	**OLS Coefficients**	**Estimates IV(Mortality)**
GDP Growth (Annual %)	-0.004	-0.014
	(0.038)	(-0.044)
Corruption Perception Index	0.034	0.155**
	(0.036)	(0.072)
Primary School Enrollment Rate	0.466***	0.438***
	(0.123)	(0.143)
Government Expenditure (% GDP)	-0.015*	-0.022**
	(0.007)	(0.009)
Trade (% GDP)	-0.207**	-0.255**
	(0.086)	(0.102)
N	16	16
F	5.24	23.81
R^2	0.7237	0.4185
Durbin Score		8.7282***
Wu-Hausam Test		10.8025***
First Stage Regression (Partial R-sq)		0.3305**

Notes: Robust standard errors in parentheses. Parameter estimates are statistically different from zero at *10%, **5%, and ***1% significance levels, respectively.

Column 3 presents the IV estimates. The coefficient estimates of the annual percentage of GDP growth is negative and insignificant as well as corruption index is positive and significant at the 5% level. Thus, a one-standard-deviation improvement in the corruption index will improve the Gini coefficient of income distribution by 15.5% which is statistically significant at the 5% level. But a one-standard-deviation increase in primary school enrollment rate improves the Gini coefficient of income distribution by 43.8% and it is significant at the 1% level. Also, the result indicates that one-standard deviation decrease in government expenditure as a percentage of GDP lowers the Gini coefficient of income distribution by 2.2% at a statistically significant level of 5%. Furthermore, a one-standard deviation decreases in trade openness decrease income distribution by 25.5% at the 5% significant level. Thus, corruption index is positively correlated with income inequality and as such reducing corruption would improve the standard of living particularly for the poor.

6. Conclusion

This paper uses panel data from West African countries from 2010-2017 period with a dynamic panel estimator, OLS, and IV estimation techniques to investigate the effects of corruption on economic growth (GDP per worker) and the distribution of income. The result shows that growth-maximizing level of corruption is not necessarily equal to zero which confirms years of political economy theory. The evidence of corruption is statistically significant in explaining GDP per worker. In addition, rising corruption generates lower economic growth and it also exacerbates increasing levels of income inequality in the West African sub-region.

Thus, the well-being of West African citizens will be greatly improved if there exist appropriate policies and strategies to reduce corruption. This can be achieved by maximizing the use of domestic resources while limiting recourse to seek external aids which are partly responsible for widespread corruption due to their misuse. Therefore, institutional reforms could further help reduce corruption and improve the well-being of West African citizens whilst promoting sustainable and inclusive economic growth.

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Correlation Coefficients for Model Explanatory Variables

Variables	Corruption Perception Index	Political Stability Index	Gross Foreign Direct Investment	Primary School Enrollment Rate	Government Expenditure (%GDP)	Trade (%GDP)	Mortality Rate	GDP Growth (Annual %)
Corruption Perception Index	1.000							
Political Stability Index	0.552	1.000						
Gross Foreign Direct Investment	-0.030	-0.383	1.000					
Primary School Enrollment Rate	0.099	0.507	-0.020	1.000				
Government Expenditure (%GDP)	0.379	0.199	-0.458	-0.193	1.000			
Trade (%GDP)	0.294	0.438	-0.290	0.326	0.250	1.000		
Mortality Rate	-0.676	-0.492	0.136	0.079	-0.299	-0.172	1.000	
Growth Rate (Annual %)	-0.225	-0.162	0.118	-0.053	-0.169	0.079	0.354	1.000

DOES THE EXPORT-LED GROWTH (ELG) HYPOTHESIS HOLD FOR SERVICES EXPORTS IN NIGERIA?

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Abstract

The paper examines the growth effect of services exports in Nigeria during the 1981-2018 period. This is done to verify the validity of ELG hypothesis for services exports in the country. Annual time series data are analysed using the ARDL modeling approach to cointegration and error correction and cointegration modeling. For robustness check, the FMOLS, DOLS and VECM are employed to verify the long run growth effects. The pairwise Granger causality test is also conducted to determine the short run causal relationship between services export and economic growth. The study finds that services exports positively affect economic growth in the short run and in the long run, but the effects are not significant. This result is quite robust to alternative estimation techniques. The causality test results indicate no causal relationship between the variables. Thus, the ELG hypothesis does not hold for services exports in Nigeria. The implication is that services export is not a significant economic growth factor in the country. Consequently, it may not be prioritised in strategising the nation's export diversification route. The study further finds that domestic investment, FDI and domestic credit contribute to the growth of the nation's economy, while import openness adversely affects economic growth in the long run, though it is favourable to growth in the short-run. In light of the evidence, the study advocates for policies and programmes to boost domestic credit in the economy and enhance domestic investment and inflow of FDI (especially in other real sectors of the economy including manufacturing and solid minerals which should be taken into consideration in the nation's export diversification strategies). It also advocates for restrictions on imports particularly importation of final (consumer goods).

Keywords: Export-Led Growth Hypothesis, Services Exports, Goods Exports, FM-OLS, Economic Growth, Nigeria.

JEL Classification Codes: E51, E52, F11, F13, F14, O47

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1.0 INTRODUCTION

The need for less developed countries (LDCs) to diversify their exports cannot be over-emphasised. Export diversification has been prescribed as a panacea to the growth and development challenges facing the LDCs. According to Samen (2010), diversification of export has the potentials to mitigate instability in export earnings, expand export revenues, upgrade value-addition and enhance economic growth through the channels of improved technological capabilities, market sophistication, scale economies and externalities, and substitution of commodities with positive price trends for those with declining price trends.

Nigeria is near mono-product economy. The country's economy is largely dependent on earnings from crude oil exports which as at 2018 accounted for about 65% of total government revenues and over 90% of total exports (OPEC, 2018; EITI, 2020). Hence the country's export is highly concentrated in a single primary commodity – crude oil whose price is quite volatile in the global crude oil market. According to the Prebisch-Singer hypothesis attributed to Prebisch (1950) and Singer (1950), prices of primary commodities decline relative to those of manufactures over the long run, engendering terms of trade deterioration, income volatility and poor growth performance. Buttressing this, Agosin (2009) noted that real exchange rates of countries whose exports are highly dependent on one or a few products tend to be more volatile than those of countries with more diversified export baskets. Cadot, Carrere and Strauss-Kahn (2011) argued that volatility in export prices, sudden closure of export markets triggered by regulatory changes, entry of new competitors, supply shocks in domestic economy (all of which are part of course of events in international markets) take on threatening dimensions when exports are concentrated. Thus, the long run growth of Nigeria's economy may be adversely affected by crude oil export concentration.

In consideration of the potential benign growth effect of export diversification, Nigeria recently began to make efforts to diversify her economy and her export basket. Much attention is being paid to diversifying the economy away from crude oil to agriculture, manufactures and solid minerals and some progress is being made in this regard as some improvements are being recorded in exports from these sectors, though their contribution to total exports remain low (PwC, 2020). However, the potential of the services sector as a viable foreign exchange earner has received less attention by government and researchers over the years. The sector is a key real sector of the economy accounting for the largest share of the nation's GDP over the last four decades (CBN, 2018). The vastness of the sector calls for attention by the government to take it into consideration in the push for export diversification, as services export has

the potential to drive economic growth (Gabriele, 2006; Karam and Zaki, 2015; Gyimah-Brempong, Baah-Boateng and Oryema, 2018). This will be empirically investigated using Nigeria's data in this study.

Conceptually, services exports refer to services rendered by nationals (individuals or firms) of a country for nationals of other countries living outside the country. The service rendered is not location-bound. A finance expert (stockbroker) based in Nigeria may render stockbrokerage service for an American investor on the South African or Nigerian stock-exchange using the online real-time automated platform. A real estate consultant based in Nigeria may assist a Mexican acquire property in Nigeria or Dubai. A laboratory scientist based in Nigeria may organized DNA testing for individuals based in Togo. A Nigerian economist may be engaged by the governments of other countries to develop models, formulate and implement policies and programmes to improve the lot of their countries. Nigerian agriculture expert may be engaged by government of another country to render agriculture extension services training to its farmers. Energy services may be exported by a country to (an) other country or countries. A Nigerian investor may establish telecommunication services enterprise abroad. These are some examples of services exports. Services exports no doubt require skills/expertise, access to technology or infrastructure etc. It has been reported that trade in services constitutes significant portion of global trade in recent times. Global trade in services was valued at US$5.8trillion in 2018. This amount represented a quarter of total global exports and 7% of global GDP. Currently, global trade in services is dominated by the U. S., U. K., Japan, China and other developed countries (UNCTAD, 2019). The viability of trade in services is not unconnected to technological development (Mishra, Lundstrom & Anand, 2011).

The export-led growth (ELG) hypothesis posits that export expansion is an important growth factor (Findley, 1984; Krueger, 1985). The validity of this hypothesis is still being debated. Medina-Smith (2001) argued that the ELG is probably valid for a limited number of developing countries and moreso, to a certain extent. In this study, the validity of the hypothesis shall be tested for Nigeria's services exports.

Ample studies on the growth effect of (aggregate) exports in Nigeria exist in the literature (Udude & Okulegu, 2012; Akanegbu and Chizea, 2017; Ugochukwu & Chinyere, 2013; etc.). Several other studies examined the growth effect of non-oil exports, most of them focusing on agriculture and industrial (manufacturing) exports (Lawanson, Lawanson & Bankole, 2004; Badejo, Maku, Adelowokun & Alimi, 2018; Osabohien, *et al*, 2019, etc.). Less attention has been paid, specifically, to the

potentials of services exports to drive the growth of the nation's economy. The study by Alege and Ogundipe (2015) examined the role of services trade (Exports and imports) in economic development in SSA within a panel framework using pooled data, ignoring the country-specific effects. In this paper, the services export-led growth hypothesis (hereafter referred to as the SELG hypothesis) is tested using Nigeria's data. To my knowledge, this is an initial attempt at empirically investigating the potential of services exports to drive long run economic growth in Nigeria. The study is significant in view of the contribution of the services sector to the nation's GDP.

For ease of presentation and analysis, the study is organized as follow: Apart from the introductory section (that is Section 1) wherein the motivation of the study among other things has been discussed, some background issues on the service sector, services exports and economic growth in Nigeria are discussed in Section 2. Section 3 contains a review of the relevant literature. In Section 4 the data and the methodology of the study are discussed. The empirical analysis is presented in Section 5. Section 6 concludes the paper and proffers recommendations for policy considerations.

2.0 Background Issues

The services sector is the largest sector of Nigeria's economy. For nearly four decades, Nigeria's services sector has contributed the most to her GDP (Table 1). This is not unexpected, considering the vastness of, and level of activities in the sector which also provides employment for a large segment of the population.

Table 1. Average Sectoral Contributions to GDP (%), 1981-2018

Activity Sectors	Periods							
	1981-1985	1986-1990	1991-1995	1996-2000	2001-2005	2006-2010	2011-2015	2016-2018
Agriculture	15.00	20.64	23.38	27.15	30.47	25.61	21.29	21.23
Industry	24.92	27.45	30.25	27.44	22.21	20.34	21.43	17.56
Construction	5.43	3.49	2.54	1.90	1.82	2.49	3.34	4.01
Trade	9.45	12.38	15.60	17.59	14.94	17.59	17.36	18.83
Services	**45.50**	**36.04**	**28.22**	**25.91**	**30.56**	**33.96**	**36.58**	**38.37**

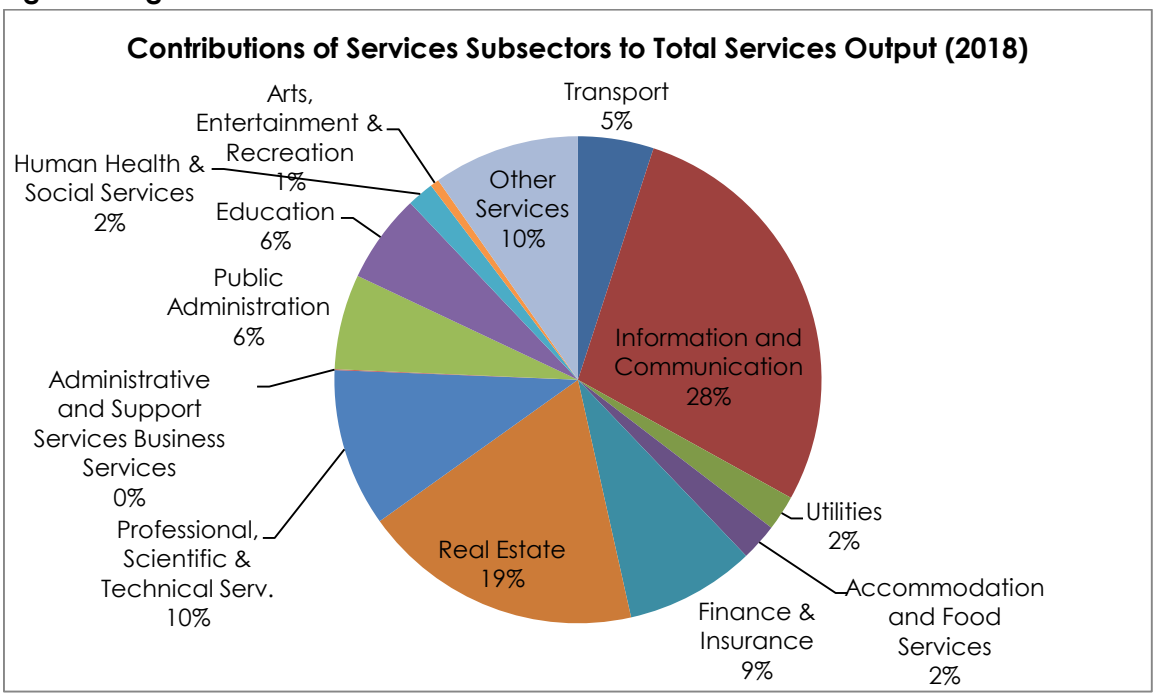
Source: Author's calculations using data from CBN Statistical Bulletin (2018).

According to a report prepared for the U.S. International Trade Commission,

> *The Nigerian services sector has shown impressive gains amid tough economic circumstances. This program has been spearheaded by a number of services industries: retail and wholesale trade, telecommunications, banking, and motion pictures ("Nollywood"). Spurred by favorable government policies and increased foreign direct investment (FDI), growth in these industries has helped to diversify Nigeria's economy…* (Oh, 2017, p.1).

The components of Nigeria's services sector and the contribution of each subsector to sectoral output are shown in Figure 1.

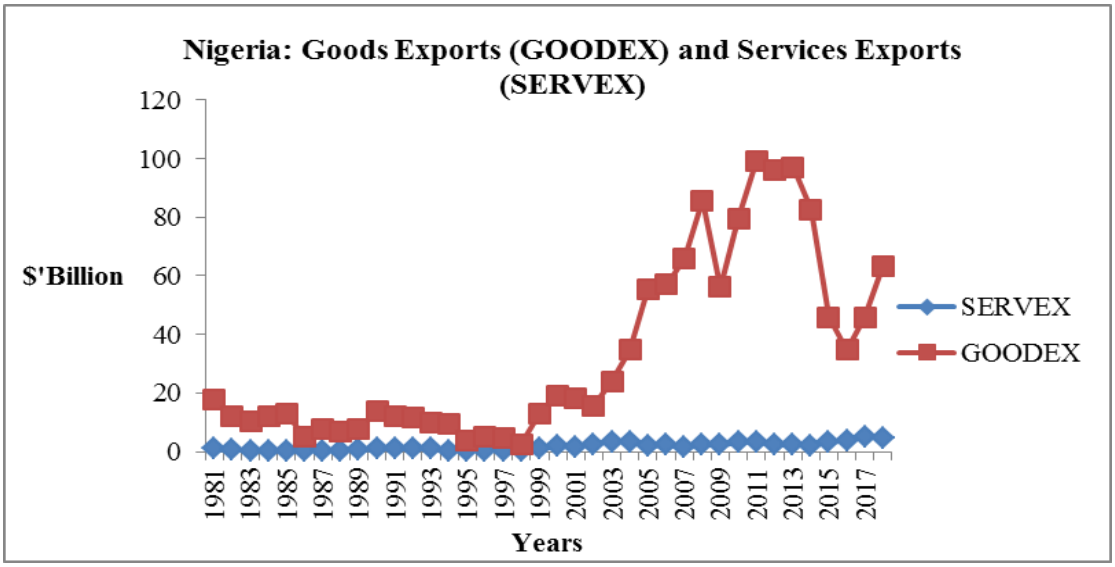
Figure 1. Nigeria's Services Sector



Source: CBN, 2018.

Information and communication, real estimates, professional, scientific and technical services and finance & Insurances subsectors were the largest contributors to output (GDP) of services sectors in Nigeria in 2018, accounting for 28%, 19%, 10% and 9% respectively of the sector's output. However, the sector has not contributed much to the nation's exports composed mainly of crude oil exports and small and varying amounts of manufactures, solid minerals and agricultural products. Figure 2 shows the trends in goods exports and services exports from 1981 to 2018.

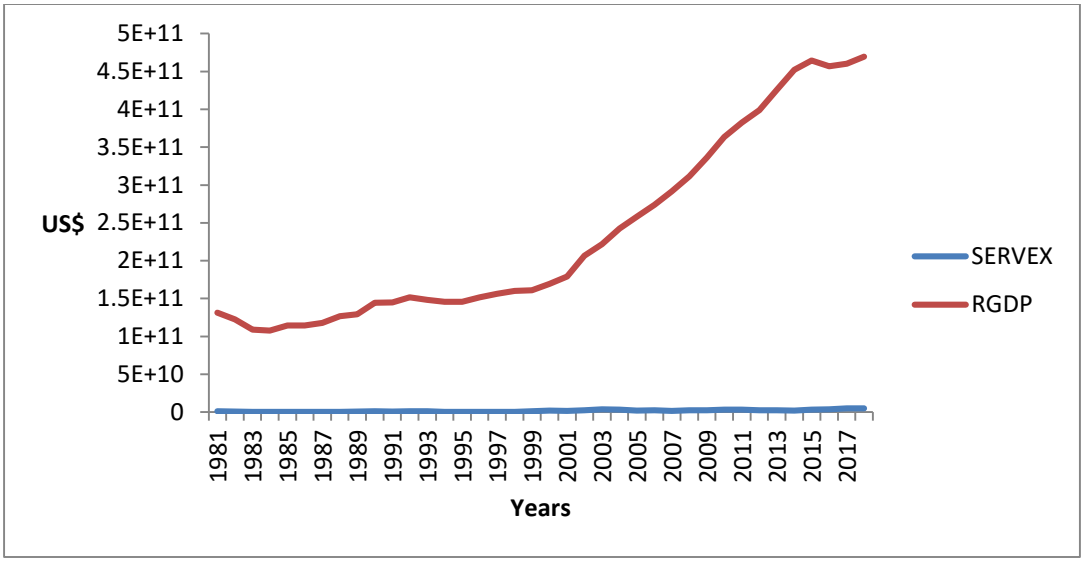
Figure 2. Trends in Goods and Services Exports.



Source: World Bank's World Development Indicators (2019).

Figure 2 shows that over the years, there has been huge gap between goods and services exports. The low value of services exports indicates that the nation's services sector has been less competitive. This may not be unconnected to the low level of technological and infrastructural development (including energy, telecommunications, and internet infrastructure, etc.), inadequate skillsets required for facilitation of service export and negligence of the sector by successive governments over the years.

Figure 3. Trends in Nigeria's Real GDP and Services Exports



Source: Data from the World Bank's WDI (2018)

Figure 3 shows the trends in Nigeria's real GDP and services exports between 1981 and 2018. It can be seen from the figure that while real GDP generally tended upwards, services exports showed no significant improvement. It therefore appears that though the service sector contributed significantly to the GDP over the years as seen in Table 1, changes in its exports may not have been significantly related to changes in the nation's real GDP over the years.

3.0 LITERATURE REVIEW

Previous studies on the test for validity of the ELG hypothesis in different countries and regions are reviewed in this section. Studies on the growth effect of services exports are also reviewed. The gap in the literature which this study intends to fill is identified.

3.1. Exports and Economic Growth: Empirical Evidence on the ELG Hypothesis

In this subsection, the empirical literature on the export-economic growth relationship is reviewed. For clarity of presentation, the review is organized into three groups namely group (panel studies), single country studies and Nigeria studies.

3.1.1. Group (Panel) Studies

Foster (2007) employed white Heteroskedasticity consistent standard errors estimator to examine the relationship between exports and economic growth in a sample of 43

African countries during the period from 1960 to 1999. The study also employed threshold regression modeling analysis to investigate whether a threshold level of export exists for the export-economic growth relationship. The results showed that exports positively affected economic growth in the continent, but no threshold exists for exports to drive economic growth.

Bbaale and Mutenyo (2011) investigated the effects of agricultural and manufactured exports on economic growth in 35 sub-Sahara African countries, using the GMM technique. The study found that economic growth in the region was promoted by agricultural exports, not manufactured exports. Based on this observation it was recommended governments in the susbregion adopt policies that are favourable to agriculture in the medium term. Further evidence from the study are that gross capital formation, infrastructure, total exports, and education (secondary school enrolment) positively affected economic growth, while inflation and government consumption, adversely affected economic growth.

In a study to test the ELG hypothesis, Kilavuz and Topcu (2012) investigated the effect of high technology manufacturing industry exports on economic growth in 22 developing countries in the 1998-2006 period. Various techniques including the panel OLS, random and fixed effect, and panel corrected standard errors were employed for the analysis. The study found that the growth effect of high-tech manufacturing industry exports was positive and significant. It also found that investment and low-tech manufacturing industry imports positively and significantly affected economic growth. Mosikari, Senosi and Eita (2016) examined the effect of manufactured exports on economic growth in the Southern African Development Community (SADC) during the 1980-2012 period. The panel FMOLS and panel DOLS estimators were employed to examine the long run relationship between the variables. The study found that the effect of manufactured exports on economic growth in the Community is positive and significant. Thus the ELG hypothesis is validated in the region.

In a panel study on the growth impact of trade in ECOWAS countries, Iyoha and Okim (2017) employed the methodology of fixed effects, random effect, pooled OLS and system GMM to investigate the impacts of exports and other variables on economic growth in the subregion during the 1990-2013 period. The study found that in all estimations, exports positively and significantly impacted economic growth, thereby robustly validating the ELG hypothesis and the new growth theory.

The Bulmer-Thomas approach to analysis of panel data was used in a study by Alvarado, Ochoa-Jiménez and García-Tinisaray (2018) to investigate the effect of exports and domestic demand on economic growth in 28 Latin American countries. The study found that exports and domestic demand positively and significantly affected economic growth in the entire sample, though the growth effect of domestic demand was larger. However, for sub groups based on income per capita, it was found that domestic demand positively and significantly affected economic growth in high-income, upper-middle-income and lower-middle-income countries. The growth effect of export was positive only in high income and upper-middle income countries, but negative in lower-middle income countries.

Sultanuzzaman, *et al*. (2019) examined the effects of exports and technology on economic growth in 16 selected emerging Asian countries during the 2000-2016 period within a dynamic panel framework. The system GMM estimation technique, pooled OLS and Discroll Kraay estimators were employed for the analysis. The study found that exports positively and significantly affected economic growth in the region in the short run and in the long run. The study therefore validates the ELG hypothesis.

3.1.2. Single Country Studies

Chemeda (2001) employed the methodology of cointegration and error correction to examine the role of export in economic growth of Ethiopia during the period from 1950 to 1986. The study found that real export growth positively affected economic growth in the short- and long-run in the country.

The validity of the ELG hypothesis in Egypt was tested by Abou-Stait (2005) using cointegration and Granger causality analysis. In the study, the relationships among GDP, exports and imports were examined. Annual time series data spanning the period from 1977-2003, and the sub-period from 1991-2003 were used for the analysis. The hypothesis was tested for the sub-period to examine whether the ELG hypothesis still held in the period following the economic reforms of 1991 in the country. The Johansen cointegration test found no cointegration between the variables of the study during the 1977-2003. It however found long run (cointegration) relationship between them in the 1991-2003 sub-period. The Granger causality test result indicated unidirectional causality from export to GDP in the 1977-2003 period. Unidirectional causality was also found to run from export to GDP net of exports (i. e. GDP minus export). It was also found that GDP Granger caused exports unidirectionally within the period. Thus the ELG hypothesis is validated in the country and more so in the period sub-from 1991-2003, suggesting that the economic reforms were productive.

Nushiwat (2008) investigated the causal relationship between export and economic growth in six countries namely India, Indonesia, Mexico, South Korea and Thailand using annual time series data which spans the period from 1981 to 2005. The analysis involved Granger causality tests. The results indicated no causality between exports and economic growth in Brazil, Indonesia, Korea and Mexico. In India, unidirectional causality flowed from economic growth to export, suggesting that export is growth-led in the country. In Thailand, the direction of causality was from export to economic growth, with no feedback or reverse causation.

The relationship between exports and economic growth in India in the period from 1970-2009 was examined in Mishra (2011) using time series regression techniques of cointegration and vector error correction modeling and Granger causality analysis. The study found that the variables are cointegrated. The VECM results indicated long run causality from economic growth to exports. The Granger causality test results showed no causation between the variables in the short run. Thus going by these results, the ELG hypothesis does not hold in the country. Export in the country is growth-led.

Hamid, Iqbal and Davi (2012) investigated the causal relationship between exports and economic growth of Pakistan during 1960-2009 period, using Granger causality analysis. The study found unidirectional causality running from economic growth to exports, suggesting that the ELG hypothesis is not validated in the country, rather, export is growth-led in the country.

Shihab, Soufan and Abdul-Khaliq (2014) examined the relationship between exports and economic growth in Jordan during the 2000-2012 period using Granger causality analysis. The results showed no causal relationship between the variables as the p-values failed to reject the null hypothesis of no causality between the variables.

Shahbaz and Rahman (2014) examined the effects of exports and financial development on economic development in Pakistan using quarterly data spanning the period from first quarter of 1991 to fourth quarter of 2012. The ARDL approach to cointegration and error correction was employed to examine the short run and long run effects, while VECM was employed to investigate the long run causality among the variables. The study found that exports and financial development positively and significantly affected economic growth in the country. It also found two-way causalities between exports and economic growth, financial development and economic growth and financial development and exports.

The validity of the ELG hypothesis was tested for agricultural exports in major rice exporting countries namely Thailand, Vietnam, India and Pakistan in a study by Kang (2015) using VECM. The study found that rice exports stimulate economic growth in the countries. Hence the hypothesis was validated for rice exports in the country. The study also found that the long run growth effect of other agricultural exports was not significant in any of the countries. Non-agricultural export positively affected economic growth in all four countries, but the effect was only significant in three namely Thailand, Vietnam and India. Further evidence from the study were that capital was also a significant determinant of long run economic growth in all four countries, while labour significantly explained growth in Thailand, India and Pakistan. Its growth effect in Vietnam, though positive, was not significant.

Karabou (2017) examined the effect of exports on economic growth in Togo during the 1961-2014 period using Johansen cointegration test and error correction modeling. The empirical evidence validated the ELG hypothesis as export was found to affect economic growth positively and significantly in the long run and also in the short run.
Simasiku and Sheefeni (2017) employed the methodology of Johansen cointegration and error correction modeling to investigate the short run effect of agricultural and non-agricultural exports on economic growth, while controlling for consumer price index (proxy for inflation) and capital formation in Namibia. Quarterly data spanning the period from 1990 to 2014 was used for the analysis. The study found that all explanatory variables in the specified model positively affected economic growth. However, the effects of agricultural exports and consumer price were not significant. Thus, non-agricultural exports and capital formation are key determinants of growth in the country in the short run.

Kalaitzi and Cleeve (2018) tested the ELG hypothesis for primary and manufactured exports in the UAE during 1981-2012 period using multivariate Granger causality and modified Wald's Test. The normalized cointegration equation from the Johansen cointegration test indicated that primary export and manufactured exports positively and significantly affected economic growth in the long run. Thus the ELG hypothesis is valid in the long run for primary and manufactured exports in the country. The short run causality test result indicated bidirectional causality between manufactured exports and economic growth, and unidirectional causality from economic growth to primary exports, suggesting the primary exports in the UAE is growth-led in the short run.

Fatemah and Qayyum (2018) employed the methodology of cointegration and error correction modeling to investigate the ELG hypothesis in Pakistan during the period

from 1971-2016. The growth effects of other variables such as capital, labour, inflation and domestic credit to private setor were controlled for. The analysis revealed that real export positively and significantly affected real income in the country in the long run, thus validating the ELG hypothesis for the country. The long run effects of capital, labour and credit on real income were also positive, but only those of capital and labour were significant. Inflation adversely affected real income in the country.

Zayone, Henneberry and Radmehr (2020) investigated the effects of agricultural, manufacturing and mineral exports on economic growth in Angola during the 1980-2017 period. ARDL modeling was employed for the analysis. The analysis revealed that exports from the three sectors positively and significantly affected economic growth in the long run, whereas only agricultural and mineral exports contributed significantly to economic growth in the short run. These results validate the ELG hypothesis as well as reveal the country is not plagued with the Dutch disease syndrome.

3.1.3. Nigeria Studies

Deme (2002) tested the validity of the export-led, the import-led and the total trade-led growth hypotheses in Nigeria using quarterly data spanning the period from 1970Q1-1999Q1. The variables of the study were per capita income, import-GDP, export-GDP and total trade-GDP ratios. The methodologies of Johansen cointegration test, VAR-based Granger causality and impulse response functions (IRF) were employed for analysis of the data. The cointegration test result indicated no long-run relationship among the variables. The Granger causality test indicated bidirectional causality between export and economic growth; unidirectional causality from export-GDP ratio to per capita income; no causality between import and per capita income; no causality between import-GDP ratio and per capita income; bidirectional causality between total trade (export plus import) and per capita income, unidirectional causality from trade openness to per capita income. The IRF showed that initial positive shock or an innovation to exports drives up per capita income up to the third quarter, after which it fluctuates downwards.

Omotor (2008) investigated the role of exports in Nigeria's economic growth during the 1979-2005 period, using the ARDL (Bounds) test approach to cointegration analysis. Pairwise Granger-causality test were also performed to examine the short run causal relation between the variables. The analysis revealed that the long run effect of export on economic growth in Nigeria was not significant. It further showed that unidirectional causality runs from economic growth to exports, thus invalidating the ELG hypothesis in the country.

Udude and Okulegu (2012) investigated the growth effects of export on economic growth in Nigeria during the 1972-2012 period, using Johansen cointegration and error correction analysis. The study found negative effect of exports, and positive effects of imports and exchange rate on economic growth in the country.

Ugochukwu and Chinyere (2013) examined the effects of oil and non-oil exports on economic growth in Nigeria during 1986-2011 period. The OLS estimation technique was employed for analysis of the data. The study found that both oil and non-oil exports were positive and significant determinants of economic growth in the country. Foreign exchange reserves were also found to affect economic growth positively and significantly within the period.

Adenugba and Dipo (2013) applied OLS estimation technique to estimate a linear regression model in a study to investigate the effect of non-oil export (agricultural and mineral resources exports) on economic growth in Nigeria during the period from 1981-2010. The estimated result, corrected for autocorrelation showed that non-oil export positively and significantly affected economic growth in the country. The growth effect of exchange rate was also found to be positive, but significant at the 10% level. Adejare and Saidi (2014) also examined the growth effects of aggregate nonoil export in Nigeria during the period from 1970 to 2012. The ARDL (Bounds test) approach to cointegration and error correction modeling was employed for the analysis. The results indicated that non-oil export positively and significantly affected economic growth in the country in the short run and in the long run.

Igwe, Ede and Ukpere (2015) examined the effect of non-oil exports on Nigeria's economic growth in the period 1981-2012 using the methodology of Johansen cointegration and VECM analysis. The empirical evidence indicated that non-oil exports positively affected economic growth in the short- and long-run. The evidence therefore validated the ELG hypothesis for non-oil exports in the country.
The effect of agricultural export on economic growth in Nigeria was investigated in Verter and Bečvářová (2016) using annual time series data that spans 1980-2012. The OLS estimator, Granger causality and other time series analysis techniques were employed for the analysis. Result from the OLS estimation and the vector autoregression (VAR)-Granger causality test upheld the ELG hypothesis for agricultural export as agricultural export was found to positively and significantly affect economic growth, and two-way causation was found between agricultural exports and economic growth.

Akanegbu and Chizea (2017) employed OLS estimator to estimate a linear regression model in a study to investigate the growth effect of real export in Nigeria. The empirical evidence indicates that real exports positively and significantly affected economic growth in the country. It was also found that the nation's economic growth was positively and significantly affected by capital stock and labour.

Badejo *et al*. (2018) employed the methodologies of Johansen cointegration and VECM to investigate the effects of non-oil export commodities and other factors on economic growth in Nigeria during the 1980-2016 period. The results of the analysis indicated that non-oil exports positively affected economic growth. While the short run effect was reported to be significant at 5% level, the long run effect was reported to be significant at the 10% level. Thus, from the study, the ELG hypothesis holds for non-oil export in the country.

Ighodaro and Ovenseri-Ogbomo (2018) applied time series econometrics techniques of VAR-based Granger causality and impulse response function (IRF) analysis in a study to investigate the dynamic relationship between exports and economic growth in Nigeria during the period from 10970-2017. The study found unidirectional causality (significant at the 10% level) running from exports to economic growth in the country. The IRF analysis indicated that positive shock to exports engenders a rise in economic growth. The study therefore validates the ELG hypothesis in Nigeria.

3.2. Services Exports and Economic Growth: Empirical Evidence on the SELG Hypothesis

A common strand in the literature is that services export is critical to long run economic growth especially in the LDCs. Some of the previous studies are reviewed in this section. Gabriele (2006) examined the effects of services exports on economic growth in 114 developed and developing countries during the periods 1980-2000, 1980-1990 and 1990-2000 using least squares technique for estimation of panel regression model. The study found that services export positively affected economic growth in developing countries, but to a less extent than its impact in developed countries. The researcher attributed this observation to dominance and control of services export in developing countries by foreigners whose activities are not fully integrated with the domestic economy.

The growth effect of service trade liberalization was examined by Mattoo, Rathindran and Subramanian (2006) using heteroskedasticity-corrected panel least squares estimation technique .The study sample was 60 countries, and the scope was 1990 to

1999. The study found that liberalization of trade in services, particularly telecommunications and financial services significantly enhanced economic growth. Similar cross country study was conducted on OECD countries by Briggs and Sheehan (2019). It was also found that the growth effect of trade in services was positive and significant.

Mishra, Lundstrom and Anand (2011) examined the growth effect of service export sophistication in a sample of 103 countries during the period from 1990 to 2007 using fixed effect and system GMM regressions. The study found that service export sophistication is a key requirement for economic growth. The study by Stojkoski, Utkovski and Kocarev (2016) on the impact of service export sophistication on economic complexity and economic growth in selected countries during the period from 1988 to 2008 found that service export sophistication and diversification are viable routes to economic growth.

Karam and Zaki (2015) studied the effects of goods and services exports on economic growth during the period from 1960 to 2011 in the MENA region. The analysis involved estimation of fixed and random effect models. The study found that both services and goods exports contributed positively and significantly to the growth of the region. It was also found that economic growth was adversely affected by population growth in the region during the period.

The development effects of services exports and imports in sub-Sahara Africa (SSA) during the period from 1990 to 2010 were investigated in a study by Alege and Ogundipe (2015). The analysis involved pooled, fixed and random effect model estimations. The study found that services exports and imports positively affect economic growth in SSA.
Adeve (2016) studied the growth effects of goods and services exports in Togo during the period from 1970 to 2010, using cointegration and error correction technique. The study found that exports of goods and services positively and significantly affected economic growth.

Gyimah-Brempong *et al*. (2018) examined the growth and unemployment effects of service exports in 30 African countries during the period from1974 to 2014 by estimating dynamic panel models. The analysis revealed significant positive growth effect of service export, and negative unemployment effect of service export in Africa. This implies that service exports have the potential to promote job-creating (inclusive)

growth – economic growth characterized by reduction in unemployment in the continent.

Priyankara (2018) examined the relationship between services exports and economic growth in Sri Lanka between 1984 and 2013. The study employed VAR based Toda-Yamamoto approach to Granger non-causality test. It found unidirectional causality running from services exports to GDP in the country. On the strength of this finding, it was concluded that the export-led growth hypothesis holds for services export in the country.

Sermcheep (2019) examined the effect of services exports (disaggregated into modern and traditional services exports) on economic growth of ASEAN countries during the 1980-2014 period. The analysis which involved estimation of fixed and random effects models showed that both components positively affected growth, though the growth effect of modern services exports was not statistically significant. Additionally, it was found that goods exports had a robust positive effect on economic growth in the region.

3.3. Gap in Literature

From the review of the literature, it can be observed that most of the previous studies on the growth effect of services exports are grouped (panel) studies. Quite a few studies have tested the SELG hypothesis using single country data. Country-specific study is quite important considering that the effect of (services) exports on economic growth could vary across countries as noted by Medina-Smith (2001). To my knowledge based a wide search of the literature, the SELG hypothesis is yet to be tested using Nigeria data in spite of the fact that the sector contributes the most to the nation's GDP, though its contribution to total export has been pitiably low. This leaves a gap in the literature which this study intends to fill. The study therefore intends to investigate the effect of services exports on economic growth in Nigeria with a view to exploiting the export potentials of the nation's services sector if the effect of its exports on economic growth is found to be significant.

4.0 DATA AND METHODOLOGY

4.1 The Data

Data used for the study are annual time series data spanning the period from 1981 to 2018. They were all sourced from the World Bank's World Development Indicators

(2019). The variables of the study are real GDP per capita, services exports, real gross capital formation, FDI, net domestic credit and import openness.

4.2 Theoretical Framework and Methodology

The validity of the export led-growth hypothesis is tested for services exports in Nigeria. The new growth theory developed over the years by Romer (1986, 1990), Lucas (1988), and Grossman and Helpman (1990) which relates economic growth to trade openness and exports externalities (Sengupta, 1994) forms the theoretical basis for the study. The theoretical model of the study is an augmentation of the Solow (1956) growth model to incorporate relevant policy variables in line with empirical applications (Mankiw, Romer and Weil, 1992). The model to examine the growth effect of services exports is specified functionally:

$$RGDPPC = f(SERVEX, DINV, FDI, NDC, MY) \quad [1]$$

Where RGDPPC represents Real GDP per capita, proxy for economic growth; RGCF represents real gross capital formation (proxy for domestic investment, in line with CBN, 2012 and World Bank, 2020); SERVEX represents services exports in US$; NDC represents Net domestic credit (in local currency unit, ₦); MY represents import openness measured by import-GDP ratio.

The ARDL approach to cointegration and error correction modeling developed by Pesaran, Shin and Smith (2001) is adopted for the investigation. The choice of this methodology was informed by the facts that it is quite flexible in usage, in that it can be applied in cases of small and finite data sizes; in cases involving variables that are stationary at level (I(0)), at first difference (I(1)), mixed order of integration (I(0) and I(1)) and fractionally integrated variables, so long as none of the variables is I(2). Moreover, it yields consistent and efficient estimates of the long run regression model with valid t-ratios even in the presence of regressor endogeneity which is peculiar with cointegrated regressors (Harris and Sollis, 2003). Application of the methodology begins with the unit root test to ascertain the stationarity properties of the variables and ensure that none is I(2) as the method breaks-down in the presence of I(2) variables. For this, the ADF test was applied. Next step is to test for cointegration. This involves specification of an unrestricted error correction model version of the underlying ARDL (UECM-ARDL). For this study, the model is specified as:

$$\Delta \mathrm{LnRGDPPC_t} = \gamma_0 + \sum_{j=1}^{p}(\delta_{1j}\Delta \mathrm{LnRGDPPC_{t-j}}) + \sum_{j=0}^{p}(\delta_{2j}\Delta \mathrm{LnSERVEX_{t-j}}) + \sum_{j=0}^{p}(\delta_{3j}\Delta \mathrm{LnDINV_{t-j}}) + \sum_{j=0}^{P}(\delta_{4j}\Delta \mathrm{LnFDI_{t-j}}) + \sum_{j=0}^{P}(\delta_{5j}\Delta \mathrm{LnNDC_{t-j}}) + \sum_{j=0}^{P}(\delta_{6j}\Delta \mathrm{MY_{t-j}}) + \lambda_1 \mathrm{LnSERVEX_{t-1}} + \lambda_2 \mathrm{LnDINV_{t-1}} + \lambda_3 \mathrm{FDI_{t-1}} + \lambda_4 \mathrm{LnNDC_{t-1}} + \lambda_5 \mathrm{MY_{t-1}} + \mu_t \quad [2]$$

The variables retain their previous definitions. Ln represents natural logarithm. Parameters λ_1 to λ_5 correspond to the long run relationships, while the parameters δ_{2j} …δ_{6j} correspond to the short run relationships. Δ is the first difference operator, μ is the error term, j is the optimal lag order of the ARDL to be empirically determined. μ is the error term of the UECM-ARDL model. The model (equation 2) is estimated using the OLS technique, and then the Wald's F-test is used to test the joint significance of the regressors. The cointegration test involves formulation and test of null hypothesis of "no co-integration" ($\gamma_1 = \gamma_2 = \gamma_3 = \ldots\gamma_6 = 0$) against the alternative hypothesis of existence of co-integration ($(\lambda_1 \neq \lambda_2 \neq \lambda_3 \neq \ldots\lambda_8 \neq 0$). Pesaran *et al*. (2001) provides two sets of asymptotic critical values for the F-statistic at different levels of statistical significance (1%-10%). One set comprises the lower bound critical values which assume the variables are I(0), and the other comprises the upper bound critical values which assumes the variables are I(1). The null hypothesis of no co-integration is rejected if the estimated F-statistic is greater than the upper bound critical value at the chosen level of statistical significance, signifying existence of long run (cointegrating) relationship. The null hypothesis is not rejected if the estimated F-statistic is less than the lower bound critical value, implying the variables are not co-integrated. The test is inconclusive if the estimated F-statistic is between the lower and upper bound critical values.

The error correction model (ECM) is derived from the UECM-ARDL model (equation 5) and specified as:

$$\Delta \mathrm{LnRGDPPC_t} = \beta_0 + \sum_{j=1}^{p}(\Gamma_{1j}\Delta \mathrm{LnRGDPPC_{t-j}}) + \sum_{j=0}^{p}(\Gamma_{2j}\Delta \mathrm{LnSERVEX_{t-j}}) + \sum_{j=0}^{p}(\Gamma_{3j}\Delta \mathrm{LnDINV_{t-j}}) + \sum_{j=0}^{P}(\Gamma_{4j}\Delta \mathrm{FDI_{t-j}}) + \sum_{j=0}^{P}(\Gamma_{5j}\Delta \mathrm{LnNDC_{t-j}}) + \sum_{j=0}^{P}(\Gamma_{6j}\Delta \mathrm{MY_{t-j}}) + \varphi \mathrm{ECT}_{t-1} + \xi_t \quad [3]$$

The Γs represents estimates of short run effects of the respective explanatory variables on the dependent variable. $\mathrm{ECT_{t-1}}$ is the error correction term. Its coefficient *inter alia* measures the speed of adjustment to equilibrium in the event of short run deviation

from the long run (equilibrium) relationship. To play the role of error correction, the coefficient (φ) is expected to be negatively signed and statistically significant. The negative and significant coefficient further confirms that the variables are co-integrated. ξ is the error term of the ECM.

The long run model is derived from the UECM-ARDL model and specified as:
$LnRGDPPC_t = \Psi_0 + \Psi_1 LnSERVEX_t + \Psi_2 LnDINV_t + \Psi_3 FDI_t + \Psi_4 NDC_t + \Psi_5 MY_t + \varepsilon_t$ [4]
The Ψs represents estimates of the long run effects of the explanatory variables on the dependent variable. **ε** is the error term of the long run model.
The *a priori* expectations are: $\Psi_1 > 0$, $\Psi_2 > 0$, $\Psi_3 > 0$, $\Psi_4 > 0$, $\alpha_5 < 0$

The ELG hypothesis and the new growth theory predict positive effect of exports on economic growth. Hence, the coefficient of this variable is expected to be positive, *a priori*. Various growth theories (neo-classical and endogenous) highlight the relevant of investment or capital formation and domestic credit to output or economic growth. The coefficients of these variables are therefore expected to be positively signed. Whereas the import-led growth hypothesis predict positive effect of import openness on economic growth, it can be argued that for less developed countries, import openness could adversely affect economic growth in the long run, though its temporary (short run) effect may be positive as it allows access to goods and services not available in the home economy.

For robustness the fully modified OLS (FMOLS) developed by Philips and Hansen (1990) and the dynamic OLS (DOLS) developed by Stock and Watson (1993) which are both designed to correct the problems autocorrelation and regressor endogeneity peculiar with cointegrated regressors (Phillips, 1995), as well the VECM were employed to estimate the long-run growth effect of services export and other policy variables. The pairwise Granger causality test was also performed to determine existence or otherwise of short run causality between services exports and economic growth in the country.

5.0 RESULTS AND DISCUSSIONS

In this section, the estimation results are presented and discussed. The section begins with the unit root test for the variables. This was followed by the Bounds test for cointegration. The test indicates that the variables are cointegrated. In view of this, the ECM and long run models are estimated. The diagnostic tests and the model stability tests are also performed to ascertain the reliability of the results. Thereafter, the robustness check is performed using FMOLS, DOLS and VECM.

5.1 Unit Root and Cointegration Test

The results of the unit root test conducted on the variables of the study are presented in Table 2.

Table 2. ADF Unit Root Test

Levels				First Difference			
Variables	ADF test stat	Critical Value (5%)	Inference	Variables	ADF test stat	Critical Value (5%)	Inference
Ln(RGDPPC)	-1.51	-3.54	Nonstationary	Ln(RGDPPC)	-3.74	-3.54	Stationary
Ln(RGCF)	-0.60	-2.95	Nonstationary	Ln(RGCF)	-4.00	-2.95	Stationary
Ln(FDI)	-3.10	-3.54	Nonstationary	Ln(FDI)	-9.82	-3.54	Stationary Stationary
Ln(SERVEX)	-0.91	-2.95	Nonstationary	Ln(SERVEX)	-4.89	-2.95	Stationary
Ln(NDC)	-2.75	-3.54	Nonstationary	Ln(NDC)	-5.49	-3.54	
MY	-2.94	-3.54	Nonstationary	MY	-7.50	-3.54	Stationary

Source: Author's Estimations using EVIEWS 9

The result shows that the variables are all integrated of order 1 [I(1)], that is they are non-stationary at level, but stationary at first difference. The variables were tested for long run relationships using the Bounds test. The result of the test is presented in Table 3.

Table 3 ARDL Bounds Test

Included observations: 36		
Null Hypothesis: No long-run relationships exist		
Test Statistic	Value	K
F-statistic	4.21	5
Critical Value Bounds		
Significance	I0 (Lower) Bound	I1 (Upper) Bound
10%	2.26	3.35
5%	2.62	3.79
2.5%	2.96	4.18

k represents number of explanatory variables
Source: Author's Estimation using EVIEWS 9.

The cointegration test result indicates that the null hypothesis of no cointegration is rejected by the F-statistic which is greater than the upper critical bounds value even at the 2.5% level. Thus, it can be inferred that a long run relationship exists between the dependent variable and the explanatory variables. Given that the variables are cointegrated, the short-run and long run models can be estimated.

5.2 Model Estimation Results

The results of estimation of the ECM (short-run model) and the long-run model are presented and discussed in this section. The estimated ECM which shows the short-run effects of the services exports and other explanatory variables on real per capita income is presented in Table 4.

Table 4 Error Correction Model

Dependent Variable: LOG(RGDPPC)

Selected Model: ARDL(2, 0, 1, 0, 2, 2)

Included observations: 36

Variable	Coefficient	t-Statistic	Prob.
DLn(RGDPPC(-1))	0.3540	2.4128	0.0242
DLn(SERVEX)	0.0116	1.2659	0.2182
DLn(DINV)	0.0396	2.0843	0.0484
DLn(FDI)	0.0118	1.1320	0.2693
DLn(NDC)	0.0158	0.8041	0.4296
DLn(NDC(-1))	-0.0317	-1.8333	0.0797
D(MY)	-0.0027	-1.4663	0.1561
D(MY(-1))	0.0047	3.1233	0.0048
ECT(-1)	-0.4606	-4.9426	0.0001

R^2 = 0.68; Adj. R^2 = 0.51; F-stat. = 6.06, p = 0.00; D. W. stat. = 2.28

Source: Author's Estimation using EVIEWS

The result shows that services export positively affects economic growth, but the effect is not significant as it fails the test of statistical significance at the conventional level.

Thus, services export does not affect Nigeria's economic growth significantly. The positive and significant coefficient of lagged per capita income implies that current growth is dependent on previous growth in the short run. The short run growth effects of domestic investment and FDI are also positive, but only the effect of domestic investment is significant at the 5% level. A 1% rise in domestic investment is associated with about 0.04% rise in economic growth in the short run. The effect of domestic credit on economic growth is positive, but not significant contemporaneously. However, its lag effect is negative and significant at the 10% level. This could be attributed to inflation that may ensue from excess credit in the economy. The contemporaneous short run effect of openness on economic growth in the country is not significant. Its lagged effect is positive and significant at the 1% level. Thus, import openness positively affects economic growth with a lag in the short run in Nigeria.

The error correction term is negatively signed and statistically significant as expected. Thus it will rightly act to play the role of error correction in the model, reconciling short-run dynamics with long run relationship. This further confirms that the variables are cointegrated. Its coefficient indicates that about 46% of the short-run deviation from equilibrium is adjusted annually to restore equilibrium in the system.

The coefficient of determination (R^2) shows that the model has a good fit as about 68% of the systematic variation in the dependent variable is explained by the model. The F-statistic of 6.06 which passes the significance test at the 1% level indicates that the variables are jointly significant in explaining variations in the dependent variable. The D. W. statistic of 2.28 indicates absence of the problem of autocorrelation in the model. The long run results are presented in Table 5 and discussed thereafter.

Table 5. Long Run Coefficients

Dependent Variable is LnRGDPPC

Variable	Coefficient	t-Statistic	Prob.
Ln(SERVEX)	0.0252	1.2315	0.2306
Ln(DINV)	0.0860	2.5353	0.0185
Ln(FDI)	0.0702	2.4850	0.0207
Ln(NDC)	0.0593	4.4265	0.0002
MY	-0.0118	-3.1459	0.0045
C	1.8918	3.1645	0.0043

Source: Author's Estimation using EVIEWS 9

As in the short run, the long run effect of services export on economic growth in Nigeria is also positive (conforming to *a priori* expectation), but it is not statistically significant. This suggests that the ELG hypothesis does not also hold in the long run for services exports in the country. Thus services export is not a significant determinant of economic growth in Nigeria. This is not unexpected considering that the sector's export as currently composed is not globally competitive, as seen in its very low contributions to total exports and to GDP.

The long run growth effects of domestic investment and FDI are positive and significant at the 5% level. These conform to *a priori* expectations. A 1% rise in domestic investment is associated with 0.09% increase in per capita income, while a 1% rise in FDI is associated with 0.07% increase in per capita income in the long run. Net domestic credit positively affects economic growth in the long run. The effect is significant at the 1% level. A 1% rise in net domestic credit will engender 0.06% rise in per capita income. Thus domestic credit is favourable to long run economic growth in the country. The long-run growth effect of import openness is negative and significant at the 1% level. This implies that increase in import openness will adversely affect economic growth in the country in the long run. A unit rise in import-GDP ratio is associated with 1.1% decrease in per capita income. The adverse effect of import openness on economic growth in the long run may be attributed to increase influx of imports (especially consumer goods) which it engenders, and this adversely affects domestic production as most of the domestic infant industries do not have the capacity to compete with foreign firms exporting their goods into the economy.

5.3. Diagnostic tests

The diagnostic tests for the underlying ARDL model (see Table A1, Appendix) of the ECM and long run models are presented in Table 6

Table 6 Diagnostics

Test	Test stat	p-value
Residual Normality (Jaque-Bera)	0.1658	0.9206
Serial Correlation (Breusch-Godfrey LM test)	1.4628	0.2542
Heteroskedasticity (Breusch-Pagan-Godfrey)	1.2380	0.3173
Ramsey RESET	1.4931	0.1496

Source: Author's Estimations using EVIEWS 9.

This p-value of the Jarque-Bera statistic for residual normality test is greater than 0.05 (or 5%). Thus it fails to reject the null hypothesis that the residuals of the model are normally distributed. The inference is that the residuals are normally distributed. The B-G LM test for serial correlation also shows that there is no problem of autocorrelation in the model as the p-value of the test statistic is greater than 0.05. The B-G-P test for heteroskedasticity fails to reject the null hypothesis of absence of heteroskedasticity in the model. This is indicated by the p-value of the test statistic which is greater than 0.05. Thus it can be inferred that the residuals of the model are homoskedastic. The p-value of the Ramsey RESET test statistic is also greater than 0.05, failing to reject the null hypothesis of no error in the specification of the regression equation. Thus it can be reasonably inferred that the specification of the model is error-free.

5.4. Stability Test

The study relied on the approach to testing the stability of regression model proposed by Brown, Durbin and Evans (1975). The approach involves use of plots of cumulative sum of residual (CUSUM) and cumulative sum of squared residuals (CUSUMSQ) to test the constancy of the regression parameters over time, (that is the long run stability of the model). The results of the test are presented in Figures 4a and 4b.

Figure 4a. CUSUM Plot

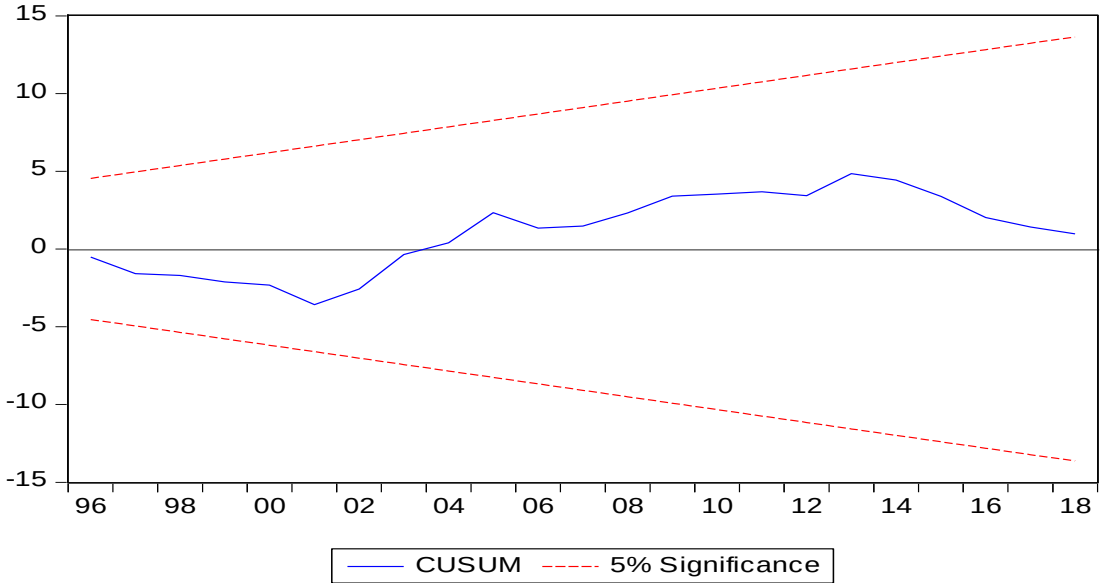
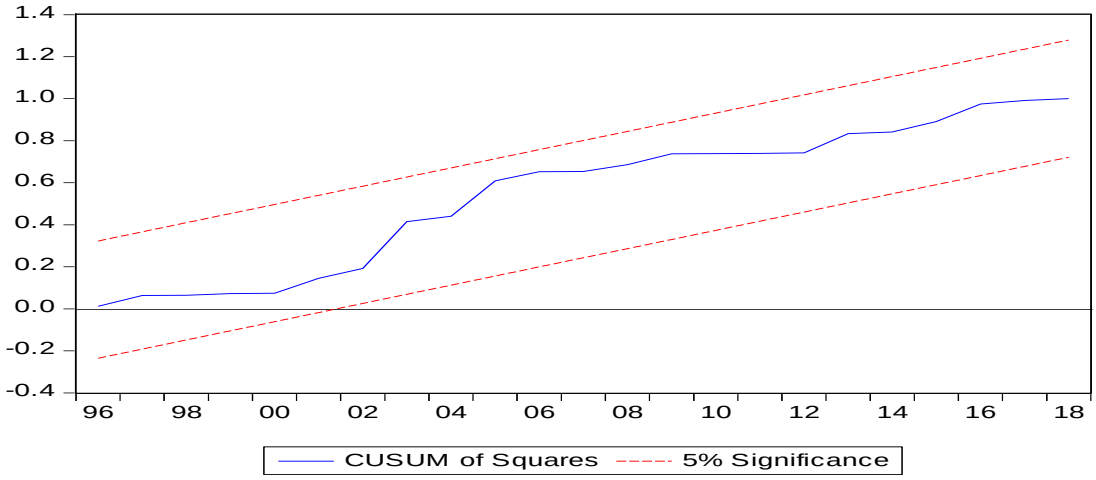


Figure 4b. CUSUMSQ Plot



The CUSUM and CUSUMS plots both lie between the 5% significance bounds. This indicates that the model is structural stable. Hence it can be deployed for policy purposes.

5.5. Robustness Checks

Since the objective of the study is to test the validity of the ELG hypothesis, it is imperative to apply alternative methodologies to check the robustness of the result from the ARDL modeling approach. To this end, the FMOLS, VECM and DOLS techniques were employed to determine the long run effects of services export (and other variables in the model) on economic growth. The results from alternative estimations are presented in Table 7.

Table 7. Alternative Estimation Results

Regressors	Dependent Variable is Ln(RGDPPC)		
	FMOLS	VECM	DOLS
Ln(SERVEX)	0.012 (0.496)	0.020 (0.959)	0.013 (0.569)
Ln(DINV)	0.121*** (3.847)	-0.004 0.185	0.028 (0.744)
Ln(FDI)	0.043* (1.830)	0.138*** (5.193)	0.116*** (3.442)
Ln(NDC)	0.065***	0.052***	0.058***

	(5.090)	(4.908)	(4.325)
MY	-0.009** (-2.517)	-0.014*** (-4.369)	-0.015*** (-3.575)
C	1.667* (2.631)	2.949	2.651*** (4.685)
R^2	0.948	0.551	0.982
Adj. R^2	0.940	0.444	0.959
F-stat	-	4.92	-

Source: Author's Estimations using EVIEWS 9.

From the results of alternative estimations, it is observed that as in the estimated ECM and long run models based on the ARDL model, the long run growth effects of services exports is positive, but not statistically significant. Thus, the findings that the ELG hypothesis does not hold for services export in Nigeria are robust to alternative estimation techniques. FDI and net domestic credit positively and significantly affect economic growth in the long run in all the estimations. Import openness also adversely affects the long run growth of the economy in all results. The FMOLS and DOLS results show that DINV positively affect economic growth though the effect is not significant in the DOLS and VECM estimates.

5.6. Evidence from Granger Causality: Short run prediction

Further confirmation or check of robustness of the results is done by examining the causal relationships between services exports and economic growth. In doing this, we relied on the pairwise Granger causality test. The test shows short run causal relationship between the variables. In essence, it shows whether current values of a variable are predicted by current and past values of the other variable. The test begins by determination of the optimal lag of the two-variable VAR model. The lag selection result is presented in Table 8.

Table 8. VAR Lag Order Selection Criteria

Endogenous variables: LOG(RGDPPC) LOG(SERVEX)
Exogenous variables: C
Sample: 1981 2018
Included observations: 35

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-32.24090	NA	0.024256	1.956623	2.045500	1.987303
1	50.89374	152.0176*	0.000264	-2.565357	-2.298726*	-2.473316
2	56.15296	9.015801	0.000246*	-2.637312*	-2.192927	-2.483910*
3	58.02662	2.997857	0.000280	-2.515807	-1.893668	-2.301044

* 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: Author's Estimation using EVIEWS 9.

The results shows that most of the lag order selection criteria indicate optimal lag of 2. In view of this, the pairwise Granger causality test is performed using 2 lags of the variables involved. The result of the test is presented in Table 9.

Table 9. Pairwise Granger Causality Tests

Sample: 1981 2018
Lags: 2

Null Hypothesis:	Obs	F-Statistic	Prob.
LnSERVEX does not Granger Cause LnRGDPPC	36	0.92696	0.4064
LnRGDPPC does not Granger Cause LnSERVEX		2.02044	0.1497

The causality test results indicate no causal relationship between services exports and real GDP per capita in the short run. The null hypothesis that service export does not Granger-cause real GDP per capita is not rejected as the p-value of the F-statistic is greater than 0.05. Similarly, the null hypothesis that real GDP does not Granger-cause services export is not rejected as the p-value of the related F- statistic is also greater than 0.05. The implications are that Services export is not a significant predictor of real GDP per capita, and real GDP per capita also does not significantly predict services export in the short run in the country.

6.0 CONCLUSION AND RECOMMENDATIONS

The validity of the ELG hypothesis for services exports has been tested in this study. In doing this, the ARDL approach to cointegration and error correction analysis was employed to investigate the short run and long run effects of services exports on economic growth in Nigeria. For robustness, alternative techniques including VECM, DOL, FMOLS and, Granger causality test were also employed. The study found that though the growth effect of services export is positive, yet it is not significant. No short run causal relationships between the variables were also found. This result is quite robust to alternative estimation techniques. On the strength of this, it can be concluded that the ELG hypothesis does not hold for services exports in Nigeria. Other observations from the study are that FDI, domestic investment and net domestic credit positively and significantly affect economic growth, while import openness adversely affects growth in the long run in the country.

Based on the empirical evidence, it is recommended that services exports should not be prioritized by the government in her push towards diversifying the nation's exports, rather efforts should be channeled towards design and implementation of policies and programmes to enhance the capacity of the financial system to extend credits to the productive private sector, encourage domestic investment and foreign direct investment in key growth enhancing sectors of the economy such as manufacturing and solid minerals to boost output from the sectors and improve their global competitiveness, thereby boosting their exports and the contribution of these exports to economic growth. It is also imperative to impose some level of restrictions on imports, especially importation of final (consumer) goods, to protect domestic (infant) industries and encourage demand for locally produced goods.

7.0 LIMITATION AND FURTHER RESEARCH DIRECTION

This study tested the validity of the ELG hypothesis for services exports in Nigeria. It found that the hypothesis does not hold for services exports in the country, and consequently advised that services exports should not be prioritized in the drive towards export diversification in the country. The focus on only services exports may be considered a limitation of the study as data on non-oil goods export was not readily available for the various sources contacted in the course of the research. Future research may investigate the validity of the ELG hypothesis for non-oil goods exports in the country. The outcome of such studies may be of policy relevance to the government in the design of export diversification strategies for the country.

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Appendix:
Table A1. Underlying ARDL model

Dependent Variable: LOG(RGDPPC)
Method: ARDL
Date: 07/05/20 Time: 02:00
Sample (adjusted): 1983 2018
Included observations: 36 after adjustments
Maximum dependent lags: 2 (Automatic selection)
Model selection method: Akaike info criterion (AIC)
Dynamic regressors (2 lags, automatic): LOG(GCF) LOG(FDI)
LOG(SERVEX) LOG(NDC) MY
Fixed regressors: C
Number of models evalulated: 486
Selected Model: ARDL(2, 0, 1, 0, 2, 2)

Variable	Coefficient	Std. Error	t-Statistic	Prob.*
LOG(RGDPPC(-1))	0.893414	0.161795	5.521903	0.0000
LOG(RGDPPC(-2))	-0.354001	0.146716	-2.412827	0.0242
LOG(DINV)	0.039623	0.019010	2.084270	0.0484
LOG(FDI)	0.011780	0.010406	1.132033	0.2693
LOG(FDI(-1))	0.020535	0.010004	2.052585	0.0517
LOG(SERVEX)	0.011606	0.009168	1.265876	0.2182
LOG(NDC)	0.015826	0.019682	0.804096	0.4296
LOG(NDC(-1))	-0.020189	0.024054	-0.839324	0.4099
LOG(NDC(-2))	0.031685	0.017283	1.833344	0.0797
MY	-0.002722	0.001856	-1.466259	0.1561
MY(-1)	0.001990	0.001763	1.129172	0.2705
MY(-2)	-0.004701	0.001505	-3.123371	0.0048
C	0.871317	0.334306	2.606343	0.0158

R-squared	0.990382	Mean dependent var	7.445328
Adjusted R-squared	0.985364	S.D. dependent var	0.244656
S.E. of regression	0.029599	Akaike info criterion	-3.927980
Sum squared resid	0.020150	Schwarz criterion	-3.356153
Log likelihood	83.70363	Hannan-Quinn criter.	-3.728397
F-statistic	197.3587	Durbin-Watson stat	2.180057

Prob(F-statistic)	0.000000

*Note: p-values and any subsequent tests do not account for model selection.

The estimated ARDL model shows services export does not significantly affect real GDP per capita. The effect of domestic investment on real GDP per capita is positive and significant. FDI affects real GDP per capita with a lag of 1 year. NDC affects real GDP positively and significantly with a lag of 2 years and the adverse effect of import openness on real GDP per capita manifest after two years of opening up the economy to global trade. The R-squared indicates the model has very high explanatory power. The F-statistic indicates the explanatory variables are jointly significant in explaning the dependent variable. The Durbin-Watson statistic points to absence of autocorrelation. Since the cointegration test indicated that the variables were cointegrated, we proceeded to estimate the short run and the long run models.

ENERGY PRODUCTION-ECONOMIC GROWTH NEXUS: A CAUSALITY EVIDENCE FROM NIGERIA

Taiwo Akinlo*[1] and O. Olayemi Simon-Oke[2]

Abstract

Using the VECM approach, this study critically investigates the causal connection between energy production and economic growth in Nigeria. The study employs time-series data that span through the period 1975 -2017. First, we confirmed the existence of a long-run relationship using the Johansen-Julius co-integration test. Thereafter, we test for the presence of causality between energy production and economic growth in the short-run, long-run and strong causality. In the short-run and long-run, a unidirectional causality from total energy production to economic growth exists. In the long-run and strong causality, the study found bidirectional causality between hydropower and economic growth and between gas power and economic growth. It confirms that a hypothesis of feedback exists between the two sources of energy production and economic growth in Nigeria. However, in the short-run, the study found no causal association between the two sources of energy production and economic growth, which implies that the neutrality hypothesis exists in the short-run. These findings imply that the government needs to ensure that energy production is sufficient to meet the demand of the economy to ensure constant economic growth.

Keywords: Energy production, economic performance, hydropower, causality

Jel Classification: P28, P47, L71, B41

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1.0 INTRODUCTION

Due to the crucial role of energy in economic development, many studies have investigated the nature of causality between energy consumption and economic growth. Some of these studies that investigated this relationship use either time-series data (e.g. Alam *et al*, 2012; Faisal, Tursoy, Ercantan, 2017; Huang and Huang, 2019), cross-sectional data or panel data (e.g. Herrerias, Joyeux and Girardin, 2013; Esso and Keho, 2016; Destek and Aslan, 2017; Ozcan and Ozturk, 2019). However, according to Alper and Oguz (2016) and Faisal, Tursoy and Ercantan (2017), there is no agreement among the researchers on the nature of the relationship between the variables. However, in other to resolve this disagreement, some studies suggested that the different results obtained in the literature are due to different countries employed in the studies, the period of those studies, and the methods used to estimate the results. Some authors also claimed that the choice of data, such as annual, monthly, aggregate, or disaggregate data, also influences the results of the studies. In recent times, many studies have also considered the contributions of energy consumption to economic growth in conjunction with implications of emission of energy to the environment (e.g., Kivyiro and Arminen, 2014; Esso and Keho, 2016; Mirza and Kanwal, 2017; Appiah, 2018; Gorus and Aydin, 2018). The recent interest in this relationship is based on an attempt to ensure that equilibrium is maintained between economic growth and energy production. Furthermore, policymakers have also discovered that knowing the relationship between the variables is very necessary as it will enable them to formulate appropriate policies.

From the various studies that examined the causal connection between energy consumption and economic growth, four different hypotheses emerged, according to Ahmed and Azam (2016) and Hasanov *et al*. (2017). They are growth hypothesis, conservation hypothesis, neutrality hypothesis, and feedback hypothesis. The growth hypothesis emphasised that the direction of causality is from energy consumption to economic growth. It implies that there is unidirectional causality from energy consumption to economic growth. Therefore, any attempt by the government to reduce the level of energy consumption in the economy will prevent economic growth. The conservation hypothesis is the reverse of the growth hypothesis, as it indicates that causality runs from economic growth to energy consumption. It emphasised that the increase in per capita income causes an increase in the demand for energy in the economy. As a result, policies to reduce the level of energy consumption will not harm economic growth. The third hypothesis, which is the feedback hypothesis, supported a bidirectional causal connection between energy consumption and economic growth. That is, the causality can flow in both directions.

The neutrality hypothesis emphasised no causal connection in energy consumption and growth relationship. Therefore, whether conservative or expansive energy policies are adopted, it will have no impact on economic growth when this hypothesis holds.

According to Azlina (2012), evidence shows that many studies have investigated the causality between energy consumption and economic growth in Nigeria and other countries, however, the causality between energy production and economic growth has been neglected in the literature. The increase in demand for energy without a corresponding increase in energy production has been a significant issue in Nigeria for a while. The increase in population and standard of living account for the upsurge in consumption of energy over the years. Energy production and distribution in Nigeria are unable to satisfy the demand of the population and this has implications on economic growth. Due to insufficient energy production, many firms and industries have left the country because of their high cost of production, which makes their products too expensive for average Nigerians. The increase in the consumption of energy in Nigeria is not a surprise because the economy has grown dramatically in the last three decades. However, the major concern is the failure of energy production to meet its demand over the years.

In Nigeria, we have hydropower and gas power as the two main sources of energy production. Hydropower has been the sole source of energy in Nigeria before the emergence of gas power. Nevertheless, due to lack of maintenance and neglect, the contributions of hydropower have tremendously reduced. Gas power stations are not left out as most of the gas stations are operating below their capacity due to a shortage of gas. The political crisis in oil-producing communities frequently affects the supply of gas to the power stations. As a result, most of the gas power stations cannot operate efficiently and effectively up to their capacities. The current energy shortages in Nigeria need urgent attention from the government. It requires the mobilisation of resources and the implementation of appropriate policies that will ensure an adequate generation of energy to satisfy the need of society.

After critically examining the literature, we observed that no study has investigated the causal link between energy production and economic growth by considering the two sources of energy production in Nigeria. Therefore, this study intends to add to the earlier studies by exploring the causal relationship between energy production and economic growth and also examine the causal link between the two major sources of energy production and economic growth in Nigeria. This study will complement earlier studies; however, it differs from earlier studies in two distinct ways. First, the study

focused on the supply side (energy production) instead of the demand side (energy consumption). Second, this study considers the two sources of energy production in analysing the causal connection between energy production and economic growth. We structure the other parts of the study is this order. Section 2 deals with the literature review. Section 3 highlights the data and econometric techniques. Section 4 shows the empirical analysis. Section 5 concludes the study.

2.0 LITERATURE REVIEW

Many studies attempted to unravel the direction of causality that exists between energy consumption and economic growth (demand side) while studies on causality between energy productivity and economic growth (supply side) are limited for Nigeria. However, to provide a robust review of literature, we review the studies that examined the supply side and the demand side.

Wesseh and Zoumara (2012) focused on the causal association between energy consumption and economic growth in Liberia. The study made use of the bootstrap methodology in the analysis. A bidirectional causal relation was found between energy consumption and economic growth. However, between employment and economic growth, a unidirectional causality flowing from employment to economic growth was found.

Mirza and Kanwal (2014) investigated in Pakistan the causal connection between energy consumption, CO_2 emissions and economic growth. The study used the VECM framework to establish the existence of causal relation in short-run, long-run and strong causalities. The study presented a bidirectional causal relationship between energy consumption and economic growth in both the short-run and long-run. The study, as well, found in the long-run a feedback causality between economic growth and CO_2 emissions.

Awad and Yossof (2016) focused on the relationship that exists between electricity production, economic growth and employment in Sudan. The study used cointegration and causality techniques for the times series, which spanned through 1980 - 2013. After a long-run relationship was confirmed, the study examined the causal connection among the variables. The causality result confirmed a bidirectional connection between energy generation and economic growth in the long-run, short-run and strong causality.

Danish *et al*. (2018) examined the relationship between energy production, economic growth and CO_2 emission in Pakistan. The study focused on the period from 1970 to

2011. After the study established that the environmental Kuznets curve hypothesis holds, it also found that energy produced from fossil gasoline is responsible for increasing CO_2 emission in Pakistan. Using the VECM approach to explore the direction of causality, the study found a feedback hypothesis between energy production and carbon dioxide emission in the long-run. A unidirectional causality from GDP to CO_2 emission was found in the short run. However, the study found a neutral hypothesis between GDP and energy production.

Pinzón (2018), in a study covering the period 1970-2015, used the VAR method that took account of structural breaks and granger causality to investigate the causal connection between energy consumption and economic growth in Ecuador. The study used aggregated and disaggregated data for the analysis. The study found that oil consumption causes economic growth, while economic growth causes hydroelectric consumption. The study also established a hypothesis of feedback between economic growth and the transportation sector.

Appiah (2018) focused on Ghana's economy and used Toda-Yamamoto and Granger causality tests to determine the causal connection existing between energy consumption, economic growth and CO_2 emissions in a period 1960 to 2015. After Johansen and Johansen-Juselius cointegration test affirmed the presence of cointegration, the study subjected the variables to the granger causality test. The test confirmed a feedback hypothesis between energy consumption and CO_2 emissions while the growth hypothesis holds in economic growth and energy consumption relationship. The study stated that conservative energy policies must emanate from energy efficiency and technological advancement so that such policies will not constitute hindrances to economic growth.

Huang and Huang (2019) used an autoregressive distributed lag (ARDL) model to determine both short and long-run relations and the causal connection between individual energy consumption and economic growth. This study was carried out on China's economy while the study covered the period 2004 to 2017. The results of the causality indicate a single-way causality from new energy consumption to economic growth. Also, the study confirmed a bidirectional causal flow from urbanization rate and trade to new energy consumption.

Ozcan and Ozturk (2019) used bootstrap panel data to analyse the casual connection between renewable energy and economic growth. The study spread from 1990 to 2016 and consists of 17 countries. Aside from Poland, where a growth hypothesis was

confirmed, a neutrality hypothesis was found in all the remaining countries. It implies that aside from Poland, energy conservative policies could not in any way produce a harmful effect on economic growth.

3.0 DATA AND ECONOMETRICS TECHNIQUES

3.1 Data

We make use of annual data for Nigeria. The data employed are from the World Development Indicator and covered the period 1975 to 2017. GDP per capita (constant 2010 US$) is used to measure economic growth. GDP per capita is obtained by dividing the total GDP output by the population. Since this study is interested in determining the direction of causality between the total energy production and the two sources of energy production and economic growth in Nigeria, therefore, we include hydropower and gas power as variables. Hydropower (HYD) – this refers to the energy produced from the hydro source. Gas power (GAS) – this refers to energy produced from the gas source. ENE – This refers to the energy generated from all sources of energy. The variables are in logarithms forms and also take their first difference. Table 1 contains a summary of the statistics.

Table 1: Definition of variables and summary of statistics

Variables	Definition of Variables	Obs.	Mean	St. Dev.	Min.	Max.
GDP per capita	GDP per capita, constant 2010 US$	43	3.2401	0.0897	3.1219	3.4089
HYD	Hydropower	43	1.5062	0.1493	1.1252	1.8500
GAS	Gas power	43	1.7338	0.1676	1.1968	1.9159
ENE	Total energy production	43	1.9600	0.0413	1.8895	2.000

3.2 Unit root test

There is a need to confirm the stationarity of the data employed in this study. This is very necessary to avoid spurious regression. Engle and Granger (1987) stated that when a time series that is not stationary is combined with another similar time series, they can be stationary. If they are stationary, it means that the time series are cointegrated and hence, a long-run relationship exists between them. However, the time series must have the same order of integration. In relation to this, the first step of this analysis is to check the stationarity properties of the various time series data employed in this study. Therefore, we employed both the augmented Dickey and Fuller (1979) and Phillips and

Perron (1988) to determine if the series employed in this study are stationary or otherwise. Equation 1 below is used to perform these tests.

$$\Delta y_t = \delta_0 + \theta_{yt-1} + y_1\Delta y_{t-1} + y_2\Delta y_{t-2} + \ldots\ldots\ldots + y_p\Delta y_{t-p} + \eta_t trend + e_t \quad (1)$$

where y_t signifies the series on which stationarity will be tested while e_t refers to the i.i.d error term. Aside from the augmented Dickey and Fuller (ADF), we also performed Philips-Perron test based on the fact that the ADF test will be invalid when there are autocorrelation problems. According to Mirza and Kanwal (2017), the Philips-Perron test produces a robust test even in the presence of heteroskedasticity and autocorrelation because it integrates nonparametric adjustments in the error term. Schwarz-Bayesian information criterion is used to choose the optimal lag length for the tests (see Hayashi (2000) for more details). From equation 1, we test the null hypothesis that $\theta = 0$ against the one-tailed alternative hypothesis that $\theta < 0$. Therefore, if θ *is* negative and also statistically significant, the series y_t is regarded as stationary.

3.2 Cointegration Test

To confirm the presence of a long-run association between the variables, we employed the Johansen-Juselius cointegration test. Following Engle and Granger (1987), the y_t representation of the vector auto-regressive error correction (VECM) may be written in this form.

$$\Delta y_t = \pi y_{t-1} + \sum_{j=1}^{p-1} A_j \Delta y_{t-1} + \vartheta D_t + e_t \quad (2)$$

where $\pi = I - \sum_{j=1}^{p} A_j$ and $A_j = -\sum_{i=j+1}^{p} A_j$. π is a matrix which signifies the long-run relationship between the variables of the VAR system while the rank of matrix π Johansen and Juselius (1998) is used to determine the number of cointegration relations. D_t represents the vector with deterministic elements while e_t indicates the matrix of random errors, which follows a usual Gaussian white noise process and has a zero mean, but its variance is constant. Concerning any specified number of cointegrating vectors *r*, the matrix π is of rank *r* and we can rewrite it as $\alpha\beta'$; where *α* represents the vector of the speed of the adjustment and *β'* indicates the long-run equilibrium vector. From equation 2, we can derive three different cases. The first case is, if the rank *π* (*r* (*π*)) is equal to zero, then there is no linear combination among the variables specified. It means that the speed of adjustment matrix elements is equal to zero and that there is no stationarity in the linear combination of the variables. The second case is, if r(*π*) is equal to *n*, there is a full rank in the matrix and hence makes it invertible. This indicates that at levels, all the variables are stationary and there is no

cointegration. The third case is, if $0 < r(\Pi) = k < n$, the system inherits k linear combinations. But if k is equal to n - 1, that means according to Verbeek (2008) that all variables form a pairwise long-run relationship with each other. As stated by Johansen, we can test $r(\pi) = n$ by two methods of statistics. They are trace test and the maximum eigenvalue statistics which are computed as follows;

$$\lambda_{trace} = -T\sum_{j=r+1}^{n} ln\ (1- \lambda_j\ ) \quad (3)$$

$$\lambda_{max} = -T \ln\ (1-\lambda_{r+1}) \quad (4)$$

Where in equations 3 and 4, λ refers to the estimated eigenvalue derived from the estimated matrix, while T represents the number of observations that are normally used after lag adjustment. In trace tests, we usually test the null hypothesis that "at most" r cointegration vector, with "more than" r vectors being the alternative hypothesis. The maximum eigenvalue tests the null hypothesis that the number of co-integrating vectors equals r against the alternative that it is equal to $r + 1$.

3.3 Granger Causality

Since we used the Johansen cointegration approach to confirmed cointegration relationships, it is now appropriate to use the vector error correction model to analyse the direction of causality between the variables. When there is cointegration either in bivariate or multivariate models, it simply suggests that Granger causality exists in at least or both directions and it can be examined through the Wald test but with some restrictions. Therefore, for the identification of short-run and long-run causality, the bivariate vector error correction models to be tested in this study are written as follows;

$$\Delta \ln GDP_t = a + \sum_{i=1}^{p} \beta_i \Delta \ln GDP_{t-i} + \sum_{i=1}^{p} \delta_i \Delta \ln ENR_{t-i} + \pi_1 ECT_{t-1} + \varepsilon_{1t} \quad (5)$$

$$\Delta \ln ENR_t = a + \sum_{i=1}^{p} \beta_i \Delta \ln GDP_{t-i} + \sum_{i=1}^{p} \delta_i \Delta \ln ENR_{t-i} + \pi_2 ECT_{t-1} + \varepsilon_{2t} \quad (6)$$

where GDP indicates gross domestic products, ENR represents hydropower and gas power, which are the two major sources of energy production in Nigeria since this study is interested in determining the direction of causality between the two sources of energy generation in Nigeria. ECT_{t-1} signifies the lagged error-correction term. From equations 5 and 6, we can test long-run causality in three different ways. Firstly, if $\pi_1 \neq 0$ and $\pi_2 \neq 0$, it signifies that there is a bidirectional causal association between the variables, which also means the existence of feedback long-run causal relationship between economic growth and hydropower or between economic growth and gas power. In a second way, if $\pi_1 = 0$ and $\pi_2 \neq 0$, it means that there is a single way causality emanating from economic growth to hydropower or gas power. Thirdly, if π_1

$\neq 0$ and π_2 = 0, it shows that unidirectional causality exists and it flowing from either hydropower or gas power to economic growth. However, the condition where $\pi_1 = 0$ and $\pi_2 = 0$ is not possible immediately cointegration is established among the concerned variables. Aside from testing for a long-run causal relationship, a short-run causality can also be tested from equations 5 and 6 through the Wald test. This is possible if we test the significance of all lagged dynamic terms of independent variables in each equation. For instance, in equation 5, if the null hypothesis i.e., δ_i = 0 is not rejected, it means that energy production through hydro or gas does not granger cause economic growth in the short-run and the null hypothesis β_i = 0 in equation 6 means that economic growth does not granger cause energy production through hydro or gas. Besides long-run and short-run causality, we can equally test for the existence of strong Granger causality by using standard F-test. This involves the combined significance of the lagged explanatory variables and the error correction term (null hypothesis $H_o: \delta_i = \pi_1 = 0$ and $\mathrm{H_o}: \beta_i = \pi_2 = 0$) for Equations (5) and (6) respectively.

4.0 EMPIRICAL ANALYSIS

A proper examination of the stationarity tests in table 2 below, where ADF and PP units root tests are used to determine the stationarity of the variables, we observe that from the ADF results, that none of the variables are stationary at level. However, at the first difference, the result clearly shows that all the variables are stationary. Likewise, the PP test indicates that all the variables are non-stationary at level. Nevertheless, the stationarity of all the variables is established at the first difference. Therefore, from the two tests, we can say that our variables are I(1) variables. This implies that variables meet the condition for testing for a long-run relationship using the Johansen-Juselius co-integration test.

Table 2: Unit root results

	Variables	ADF	P-values	PP	P-values
At level	Hyd	-1.9419	0.0558	-1.8023	0.0683
	Gas	1.8498	0.9830	1.4200	0.9590
	GDP	0.5589	0.8329	0.3535	0.7825
	ENE	0.4948	0.4948	0.8935	0.8935
At first difference	Hyd	-6.2006	0.0000***	-4.2031	0.0000***
	Gas	-5.5187	0.0059***	-5.5559	0.0000***
	GDP	-2.8250	0.0000***	-6.3422	0.0000***
	ENE	-6.5229	0.0000***	-8.5023	0.0000***

Note: the probability values are in the bracket
*** implies significance at 1%

A suggestion from the theoretical framework states that the cointegration can be tested between the variables. We, therefore, test for our estimates in bivariate settings. By using the trace test and maximum eigenvalue, the results of the cointegration test are presented in table 3. The trace and maximum eigenvalue tests confirmed that there is one cointegrating vector between economic growth (GDP) and energy production from gas since the statistics of the trace (0.4266) and maximum eigenvalue (0.4265) tests are below the critical values (3.8415) and (3.8414) respectively. The null hypothesis of at most one cointegrating relation is accepted. The tests also indicate a cointegrating vector between economic growth (GDP) and energy production through hydro source. Likewise, between total energy production and economic growth, the test indicates a cointegrating vector. These results show that one linear combination of the variables is stationary. It, therefore, means that a long-run relationship exists between total energy production and economic growth and also between the two sources of energy production and economic growth. Nevertheless, the existence of a long-run relationship between the variables does not imply causality. Therefore, there is a need to apply the Granger causality test to able to confirm the direction of the causality.

Table 3: Cointegration results

GDP VS Gas power					
Trace Test	**Critical Value**	**Hyp.**	**Max-Eng**	**Critical Value**	**Hyp.**
24.0372	15.4947	r = 0	23.6106	14.2646	r = 0
0.4266	3.8415	r ≤ 1	0.4265	3.8415	r ≤ 1
GDP VS Hydropower					
Trace Test	**Critical Value**	**Hyp.**	**Max-Eng**	**Critical Value**	
19.5819	15.4947	r = 0	19.4970	14.2646	r = 0
0.0849	3.8414	r ≤ 1	0.08489	3.8414	r ≤ 1
GDP VS TOTAL ENERGY PRODUCTION					
Trace Test	**Critical Value**	**Hyp.**	**Max-Eng**	**Critical Value**	
12.8729	12.3209	r = 0	12.2647	11.2248	r = 0
0.6082	4.1299	r ≤ 1	0.08489	4.1299	r ≤ 1

The validation of a long-run association is an indication that a causal relationship exists in at least one direction. The causality results based on the VECM approach are presented in tables 4 and 5. Specifically, the long-run causal results of total energy production and economic growth and that of the two sources of energy production in Nigeria and economic growth are presented in table 4. Table 5 contains both the short-run and long-run results of the causal connection between the two sources of energy production and economic growth as well as that of total energy production and economic growth. The result from table 4 indicates that there is unidirectional causality flowing from total energy production to economic growth. This implies that in the long-run, total energy production leads economic growth in Nigeria. We can deduce from this finding that the increase in energy production is a catalyst for economic expansion in Nigeria. In the short-run, the same unidirectional causality from total energy production to economic growth is also obtained. This means that in both the short-run and long-run, a growth hypothesis is confirmed between total energy production and economic growth in Nigeria. However, in the strong causality, a bidirectional causality exists between total energy production and economic growth. Also, from the long-run causality results, there is bidirectional causality between

economic growth and energy production through gas. That is, economic growth and energy production through gas Granger cause each other. In the strong causality result, likewise, we found bidirectional causality between economic growth and energy production through gas. These results imply that adequate provision of energy through gas and its efficient uses will stimulate rapid economic growth in Nigeria. The results further mean that expansion in economic activities contributes to the expansion in the production of energy through gas. However, in the short-run, there is an absence of causality between economic growth and energy production through gas.

Table 4: Long-run causality results

Models	Long-run causality		Causal Decision
	H_0: π_1= 0 VS H_1: $\pi_1 \neq 0$	H_0: π_2= 0 VS H_1: $\pi_2 \neq 0$	
GDP versus Gas	0.0596(0.0559)*	0.2848(0.0000)***	GDP ↔ Gas
GDP versus Hyd	0.0978(0.0358)**	0.2506(0.0000)***	GDP ↔ Hyd
GDP versus ENE	0.0669(0.0109)**	-0.0284(0.7729)	GDP ← ENE

Note: the probability values are in bracket. VS represents versus
* infers significance at 10%
** infers significance at 5%
*** infers significance at 1%

In the long-run, there is bidirectional causality between economic growth and energy generation through hydro. It means that an increase in energy production through hydro will lead to a rise in economic growth and vice versa. The result of the strong causality test is not different from that of the long-run result as two-way causality exists between energy production through hydro and economic growth. This implies that energy through hydro and economic growth is crucial to each other in Nigeria. Concerning the short-run result, the result obtained between energy production through hydro and economic growth is the same as what we obtained between gas power and economic growth. That is, a neutral hypothesis is confirmed between hydropower and economic growth.

The unidirectional causality from total energy production and economic growth found in the short-run and long-run is consistent with Huang and Huang (2019) who found unidirectional causality from new energy consumption and economic growth in China. However, our finding is the reverse of the direction of causality found by Faisal,

Tursoy and Ercantan (2017) and Gorus and Aydin (2018). These studies found that economic growth leads energy production.

The finding of bidirectional causality between hydropower and economic growth, also between gas power and economic growth in Nigeria, confirmed a feedback hypothesis between the two sources of energy production and economic growth in Nigeria. The finding is consistent with Ozkan, Ozkan and Kuyuk (2012) in Turkey, Awad and Yossof (2016) in Sudan and Shahbaz and Lean (2012) in Pakistan. This study also consistent Swith other studies that examined the demand side (i.e., energy consumption and economic growth). These include Wesseh and Zoumara (2012) in Liberia, Ogundipe and Apata (2013) in Nigeria, Osman, Gachino and Hoque (2016) in Gulf Corporation Council (GCC) countries. However, it contrasts Danish *et al.* (2018), who found no causal relationship between energy production and economic growth in Pakistan and studies like Ozturk and Acaravci (2010) and Esso and Keho (2015) who found no causal relationship between energy consumption and economic growth in Turkey and Nigeria respectively. The feedback hypothesis is possible as the availability of energy will enable small and medium scale businesses, firms and business enterprises to operate at the lower cost rather than when they are using alternative sources of energy. This will have a significant effect on the profitability of the investments. The increase in profits will lead to an expansion of investment, which in turn will lead to an increase in employment and output. The availability of sufficient energy also has a significant impact on the output as industries, firms and investments will able to operate efficiently at the optimum capacity. The expansion of output will boost the export base of the country and thereby increase the income capacity. In another way, expansion in the economic activities of a country can also cause expansion of the energy sector. When economic activities increase, there will be an increase in demand for energy, which will necessitate increases in energy supply. The attempt to meet the demand for energy will force the government to expand the supply of energy.

In the short-run, the no causal relationship found between economic growth and the two sources of energy production in Nigeria implies that there are no causality linkages. The implication of this is that any policy introduced in Nigeria to reduce energy consumption due to emissions might not have any impact on economic growth in the short-run. Evidence shows that the energy sector in Nigeria is underdeveloped and the supply of energy is not sufficient to meet the demand. The government has been making serious efforts to reverse this situation. However, their effort only produced little results. The rapid increase in population, the standard of living and industrialisation are some of the factors that lead to an increase in demand

for energy. The increase in demand for energy without a corresponding increase in the supply of energy has been the major issue in the country over a decade. More effort and development are needed in the energy sector until it gets to a threshold level where energy production will begin to boost economic growth in the short-run.

Table 5: Short and Strong Granger Causality results

Models	**Short-run Causality**		**Strong causality**	
	χ^{2-stat}	Decision	F-statistics	Decision
GDP VS Gas ΔGDP ΔGas	 0.7076(0.7020) 0.2154(0.8440)	$GDP \neq Gas$	 7.7078(0.0525)** 26.0116(0.000)***	$GDP \leftrightarrow Gas$
GDP VS Hyd ΔGDP ΔHyd	 1.8786(0.3909) 1.1332(0.5674)	$GDP \neq Hyd$	 7.4113(0.0578)* 22.1574(0.0001)***	$GDP \leftrightarrow Hyd$
GDP VS ENE ΔGDP ΔENE	 0.1175(0.0004)*** 0.3831(0.8257)	$GDP \leftarrow ENE$	 19.2495(0.0002)*** 28.4704(0.000)***	$GDP \leftrightarrow ENE$

Note: the probability values are in the bracket. VS represents versus
* implies significance at 10%
** implies significance at 5%
*** implies significance at 1%

5.0 CONCLUSION AND IMPLICATION OF FINDINGS

Using the VECM approach, this study considered the causal relationship between total energy production and economic growth and between the two sources of energy production and economic growth in Nigeria. We used augmented Dickey-Fuller (ADF) and Philips-Perron unit-root tests to determine the stationarity of the series and found that they are integrated of order one. For the cointegration test, the Johansen-Juselius cointegration approach is used to verify if the variables are cointegrated and both the trace and maximum eigenvalue confirmed that the variables are cointegrated. The Vector Error Correction (VECM) approach was used to determine the Granger causality between the variables.

In the short-run and the long-run, the result confirmed a growth hypothesis between total energy production and economic growth in Nigeria while in the strong causality,

a feedback hypothesis is established. It implies that insufficient energy production will cause great harm to the economic growth of Nigeria.

The result of the Granger causality test indicates that in the long-run and strong causality, there is bidirectional causality between the two sources of energy production in Nigeria and economic growth. This is a confirmation of the feedback hypothesis for Nigeria's economy. This finding implies that the government must avoid any policy or threats that can cause a reduction in energy production in Nigeria, as this will have great consequences on economic growth. In another way, the government must also be aware that any shock in the economy will also affect energy production in the economy.

In the short-run, the study found no causality between the two sources of energy production and economic growth as neither hydropower and gas power show any linkages with economic growth. It implies that the neutrality hypothesis is confirmed for the Nigeria economy in the short-run. This finding implies that the current energy production could not support the expansion of economic growth due to its insufficiency. Both the two sources of energy production in Nigeria are not operating at their full capacity due to various problems. For instance, hydropower has been suffering from inadequate maintenance and neglect, which results in constant collapse over the years. This has decreased the contributions of hydropower to total energy production. Gas power, on the other hand, has failed many times due to insufficient gas for the power plants as a result of constant vandalization of the pipelines and militancy resurgence.

Based on the findings from this study, therefore, we first recommend that there is a need for the government to improve energy production to meet the growing population and economic growth. Evidence shows that the current energy supply cannot meet the total demand of the country, which implies that the rate of economic growth is severely affected. A fast-growing economy requires adequate energy supply to maintain constant growth over a long period because of the high demand for energy. Second, we recommend that the government need to increase allocation to the energy sector, upgrade the facilities and employ competent technical manpower to manage the sector to meet the demand of the citizens. Third, the government needs to review the current privatisation policy in the energy sector to attract more investors. The recent privatisation in the sector has done more harm than good to the economy as the firms under the current privatisation are not developing the sector as expected. Fourth, we recommend that the government should consider other

alternative sources of energy production, particularly renewable energy, to augment the current production level. Nigeria's economy is currently depending on non-renewable sources of energy production, while renewable sources are yet to be explored. This will require massive investment; however, it will help to diversify the energy mix in addition to improvement in environmental quality. Renewable energy sources have the advantage of reducing carbon dioxide emissions and protecting the environment. The government should also consider the benefits of renewable energy sources on economic activities as it will increase employment opportunities in the economy.

Compliance with ethical standards

Conflict of interest: We declare that there is no conflict of interest.

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Appendix A

Optimal Lag length

Model	**Lags**	**Lag**	**selected**	**criteria**
		AIC	SC	LR
HYD VS GDP	0	-3.5598	-3.4754	-
	1	-7.9649	-7.7116	170.3908
	2*	-8.1452	-7.7229	13.3080
	3	-8.0850	-7.4939	4.6144
GAS VS GDP	0	-3.6541	-3.5697	-
	1	-8.2197	-7.9664	176.3274
	2*	-8.2758	-7.8536	8.9639
	3	-8.1616	-7.5704	2.8295
ENE VS GDP	0	-5.5539	-6.4695	-
	1	-9.6888	-6.4356	160.3949
	2*	-9.6056	-9.1834	4.0877
	3	-9.7615	-9.1705	11.7472

Appendix B

Diagnostic tests result

Model	**LM**	**WH**	**J-B**	**AR polynomial**
HYD VS GDP	1.5197(0.9924)	30.0973(0.2049)	1.1959(0.5499)	Inside
GAS VS GDP	1.4440(0.9936)	43.3181(0.0549)	0.9588(0.6191)	Inside
ENE VS GDP	2.1854(0.7017)	47.7663(0.0209)	0.3053(0.5805	Inside

IMPACT OF NON-PERFORMING LOANS ON THE BANKING SYSTEM OF THE WEST AFRICAN MONETARY ZONE COUNTRIES: A PANEL REGRESSION APPROACH

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ABSTRACT

The study examined the impact of non-performing loans (NPL) on the banking sector of countries of the West African Monetary Zone (WAMZ). In essence, it investigates the connection between NPLs and banking sector performance in the WAMZ. Two measures of performance or profitability - return on assets (ROA) and return on equity (ROE) - as the dependent variables were modelled against NPLs alongside other prudential indicators and macroeconomic variables. The models were estimated using panel regression analysis - pooled, fixed effect and random effect with data running from 2007 to 2019. The study selected fixed effect over random effect based on the Hausman test.

Both models showed an inverse and significant relationship between NPL and performance which is in line with a priori expectation. Similarly, the study found evidence that cost income ratio and exchange rate movement impacts bank performance, negatively and positively, respectively.

Generally, we recommend the strengthening of banks risk management practices, greatly emphasizing improvement in loan administration and underwriting standards on the part of practitioners. To this end, banks should articulate clearly their credit culture, including basis for targeting types of borrowers, and an objective assessment criteria of their capacity and willingness to repay in their credit policy. The competent regulatory authority should drive the process, by prescribing appropriate risk management guideline and enforcing adherence.

Keywords: Non-Performing Loans (NPLs), return on assets (ROA), return on equity (ROE), fixed effect, random effect, WAMZ.

JEL Classification: C23, G21 E51.

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1.0 INTRODUCTION

Non-performing Loans (NPLs) have in recent times taken center stage in credit risk management. The buildup NPL is largely attributed to a number of factors, including macro-economic volatility and general economic downturns, deterioration in trade, high and unsustainable interest rate structure, expensive inter-bank borrowings, insider loan abuses, poor credit underwriting standards by banks and moral hazard.

The West African Monetary Zone (WAMZ) countries, comprising The Gambia, Ghana, Guinea, Liberia, Nigeria and Sierra Leone, have in recent years been weighed down by high levels of NPLs thereby exposing the sub-region to significant threat of financial system instability. It is noteworthy that a systemic banking sector NPLs problem can considerably impede financial intermediation by hindering credit, which in turn hinders a country's growth potentials. In all, banks with high NPLs experience low growth, reduced profitability, and capital erosion, which in most cases take an extended period to resolve. High NPLs therefore, remain a supervisory concern in the sub-region given the huge presence of cross-border banks in the Zone.

A snapshot of NPLs position in the sub-region in the last few years, reveals an oscillatory scenario. For instance, the Zone-wide average ratio of NPL to gross loans stood at 14.15, 13.85, 13.95, and 12.94 percent in 2015, 2016, 2017 and 2018, respectively. While NPL limits are set by national regulations, NPLs at a range of 12.94 and 14.15 percent as observed in the WAMZ between 2015 and 2018 can be considered as excessive. This is more so as Nigeria with the largest economy and financial system (with high network of cross border banks) in the Zone has an NPL threshold of 5.0 percent.
It is usually difficult to do a cross-country assessment of the magnitude and severity of NPLs because of divergent definitions of NPLs among countries, which heightens and weakens the efforts of cross border policy makers at resolving the problem at the regional level. In recognition of the necessity for comparability, the Basel Committee on Banking Supervision (BCBS) published a guidance paper (BCBS (2017)), which provides guidelines to promote harmonisation in the treatment of non-performing exposures and forbearance, thus promoting consistency in supervisory reporting and resolution of NPLs.

The high incidence of NPLs in the WAMZ has led to the resolution of problem banks in most Member States of the Zone in the last few years. In light of this development, Member States of the WAMZ have enacted far reaching policies to curb high NPLs with measures such as loan write-offs, improving risk assessments and underwriting standards, ring-fencing problem banks, as well as strengthening the necessary

legislation in credit reference systems, in order to reduce the incidence of default and improve the NPLs situation. Others include the introduction of a Model Act for Banks and Financial Holding Companies in the sub-region, a legislation adopted to harmonise the legal and regulatory frameworks of the WAMZ banking sector.

Despite the plethora of reforms, NPLs in most countries of the Zone remain high and a major threat to financial stability. This development calls for an urgent need to investigate, identify and manage problem assets, and make adequate policy adjustments and provisions in this regard. Failure or delays in such intervention could lead to further deterioration in the balance sheets of banks and increase the risk of insolvency and its attendant higher resolution costs.

An important requirement for countries considering entering an economic union is the transformation of their financial systems alongside addressing other structural and institutional bottlenecks in their economies. In a monetary union, there is need for convergence in regulatory and supervisory processes, as well as accounting treatment, particularly where a group of countries aim at sharing a common banking regulation. Evaluating an NPL problem requires accurate estimates, in order to enable precise response by the monetary authorities and banks. Imprecise estimates of the situation may result in enormous and ineffective application of taxpayers' money, which in time will become a credibility issue for the monetary and fiscal authorities.

Equally important is the need to ascertain the impact of NPL on the performance of banks in the WAMZ since credit delivery and credit quality are not only fundamental to banking business but also, a significant contributor to banks' income. Therefore, NPL, as a measure of portfolio quality, represents either a potential income for banks if recovered, or a substantial drain on profitability if unrecovered. It is a known fact that a couple of research {(Nyarko-Baasi (2018), Bentum (2012), Alshatti (2015) and Panta (2018)} had been carried out on the relationship between NPLs and profitability of banks, yet very limited literature exists on this for the WAMZ. A panel study of this nature on the WAMZ would not only add to the cross-country literature but also provide insights on the influence of NPLs on profitability of WAMZ' banking system, its implications for financial stability in the sub-region, and shape upcoming policy-oriented studies. Information about the impact of NPLs on banks will influence the attention, which supervisors and regulators in these countries pay to NPLs minimization. The core aim of this article is to investigate the connection between NPLs and banking sector performance in the WAMZ. Hence, the set aims include: to access the effect of NPLs on banks profitability proxied by Return on Assets and Return on Equity; to

determine a long run association between NPLs and banking sector profitability in the WAMZ; and to measure the effects of other prudential ratios and macroeconomic variables on the WAMZ banking system.

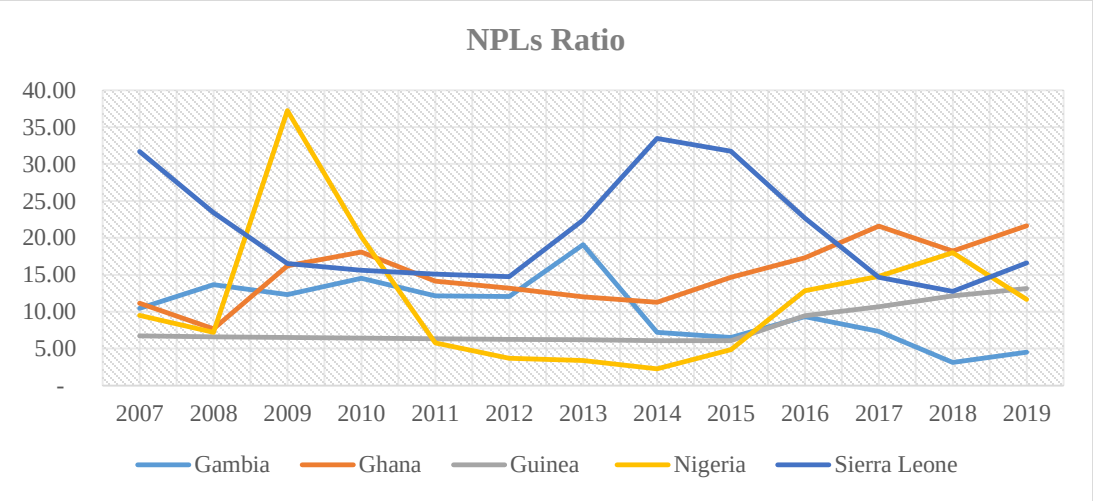
Following this introductory section, section 2 reviews the stylized facts while the theoretical and empirical literature is presented in section 3. The methodology and data analysis are explained in section 4, while section 5 concludes the paper with some policy recommendations.

2.0 STYLISED FACTS ON THE BANKING SECTOR OF THE WAMZ

The financial system of the WAMZ which is made up of six (6) countries, namely The Gambia, Ghana, Guinea, Nigeria, Liberia and Sierra Leone is largely bank-based, with banks accounting for more than 70 percent of the market. The sector has seen tremendous improvement in terms of size, reach and product developments. At end-December 2017, the total assets of the WAMZ banking sector stood at US$130.48 billion, peaking at US$186.03 billion in 2014 from US$146.02 billion in 2012. The decline in total assets reflected economic challenges, depreciation of WAMZ Member States currencies against the US Dollar over the period, the 2008/2009 global financial crisis aftershock and the Ebola Virus Disease (EVD) in some Member States. About a quarter of banks' assets are denominated in foreign currency and, credit and investment lines dominate the asset composition of banks in the WAMZ. Banks in the WAMZ generally rely on traditional funding sources, owing to underdeveloped investment banking options. For the period 2007-2019, total deposits accounted for over 60 percent of banks financing requirements.

The Nigerian banking sector dominates the WAMZ, accounting for nearly 80 percent of the asset size, followed by Ghana (16.0 percent). Nigeria's dominance was boosted by its 2005 banking sector consolidation policy, which created, 25 sizeable banks (now 23) from the then existing 89. The Central Bank of Nigeria (CBN) revised upward banks' minimum capital requirement, which forced mergers and acquisitions, and the excess liquidity created, compelled banks, beyond financing the oil-reach sector, to internationalise. This increased the presence of Nigerian banks in the Zone. Ghana in 2018 concluded its recapitalisation programme, reducing the number of banks from 33 to 23. There are 12, 14 and 16 banks in The Gambia, Sierra Leone and Guinea, respectively. Over the years, the outpacing growth of WAMZ economies has shrank the level of penetration of the banking sector. Zone-wide, assets to real GDP and credit to GDP ratios for instance declined from 30.40 percent and 14.51 percent in 2016 to 28.87 percent and 12.06 percent in 2019, respectively.

Figure 1: Non-Performing Loans Ratio in the WAMZ (2007 – 2019)



Data source: Global economy data, World Bank

The banking sector remained generally safe and sound, bolstered by recent steady recovery of the WAMZ economy and strong regulatory and supervisory reforms. The quarterly meetings of the College of Supervisors of the WAMZ (CSWAMZ), a technical setup comprising heads of banking supervision departments of WAMZ central banks has been instrumental in encouraging compliance with key international standards and the Model Act for Banks and Financial Holding Companies. Besides sharing of information and experiences, other CSWAMZ arrangement such as joint examination exercises between home and host supervisors has improved cross-border supervision in the Zone.

Key financial soundness indicators – capital adequacy ratio (CAR), liquidity, asset quality and profitability – though satisfactory WAMZ-wide, are mixed in Member States. For the period 2007-2019, CAR averaged at 39.89 percent in the Zone, well above international norm and national minimum benchmarks. Over the same period, return on assets and return on equity averaged 3.46 percent and 31.62 percent, respectively.

The level of impaired assets is, however, high and remains a key supervisory concern in the Zone. Recent efforts to address NPLs through aggressive loan write-off policies are cosmetic and weak in garnering recovery. The high NPL ratio highlights weak credit risk management processes and inadequacy of safeguards and financial infrastructures to support the lending functions. In Nigeria, banks faced severe credit

risks in 2008 as a fall out of the global financial crisis and oil price fall occasioned an equity market crisis. Due to the high bank exposure to the oil sector, NPL ratio rose to 37.3 percent in 2009 (see figure 1), necessitating the creation of the Asset Management Corporation of Nigeria (AMCON) – a special purpose to assume these toxic assets. The Central Bank of Nigeria (CBN) further restrained banks from financing delinquent borrowers including facilities under the AMCON arrangement. The intervention reduced NPL ratio drastically to about 5 percent in 2011 and continued declining until 2014. NPL begun to rise from 2015 thereafter due to challenges in the economy resulting from oil price shocks, leading the economy into a recession by 2016.

In Ghana, recent deterioration in asset quality resulted from economic challenges and the effect of the protracted energy crisis during the 2013-2016 period. The asset quality review, conducted by the Bank of Ghana in 2015/2016 to determine the state of banks loans and investment portfolios, highlighted high credit risk levels in the oil and SME sectors, general deterioration in banking asset quality, substantial provisioning shortfalls and undercapitalization in some banks. Hence, NPL ratio rose between 2013 to 2017 (see figure 1) and begun to improve thereafter in response to the banking sector clean-up exercise, which in addition to the recapitalisation programme, saw the resolution of 9 banks. The high NPL situation in Sierra Leone particularly for the periods 2013-2016 and 2018-2019 is attributable to the debilitating effect of the EVD on the economy and the abysmal performance of the iron-ore industry, respectively. In The Gambia and Guinea, the level of financial intermediation is very low. High government borrowing appetite and high interest rates offered on government securities have attracted bank investments relative to credit to the private sector.

3.0 LITERATURE REVIEW

3.1 Theoretical Literature

A non-performing loan is when settlement of interest and or principal is past due by 90 days, or, interest payments due in 90 days or more have been delayed, refinanced or capitalized, or payments are less than 90 days overdue (IMF, 2005). In essence, NPLs are credits that are pending repayment in both interest and principal for an extended time as against the contractual agreements.

Asymmetric information theory, developed by Akerlof (1970), perhaps provides the theoretical framework that explains the problem of NPLs. Asymmetric Information is a situation in which parties to a financial contract do not possess the same level or quality of information. Often, borrowers have perfect information concerning the risks

and returns from the investment projects for which the loan is taken out than the lender does. Mishkin (1997) identified adverse selection and moral hazard as two major problems associated with asymmetric information.

Adverse selection which usually occurs before the contract is entered into, exists when the parties most likely not to repay a loan or generate the most unacceptable (adverse) outcome are the most likely to get loan approval. High net worth high-risk debtors are keener to borrow even when they do not intend to pay back the loan. Under such circumstance, financial institutions wary of bad credit risks may decide not to grant loans even to reliable borrowers in the market. This is one way in which the fear of NPL could cripple financial intermediation and economic development.

On the other hand, moral hazard is an asymmetric information problem which arises later in the contract. This emanates when the lender is exposed to the borrower's engagement in very risky activities (immoral) which makes the loan repayment from the point of view of the lender very unlikely. The high-risk choices of the borrower could lead to the loss of the loan in the event of project failure causing the lender significant financial losses. Similar to the case of adverse selection, the conflict of interest between the borrower and the lender emanating from moral hazard (the agency problem) could make many risk averse lenders to decide not to make loans and allow lending and investment to abysmally decline to the detriment of the economy.

Moral hazards could still take place, even when the lender is informed about the borrower's activities where enforcement cost to prevent moral hazards is unaffordable. To recover incurred losses on past loans, financial institutions under monopolistic and oligopolistic banking markets, charge higher rates of interests. However, higher rates of interest in such situations not only repress lending activities but make it harder for low quality firms and borrowers to repay their loans which results in additional moral hazard and adverse selection problems.

Levine (1997) citing Stiglitz and Weiss (1981) notes that apart from reducing information acquisition costs ex ante, financial contracts, intermediaries and markets may arise to lessen the information acquisition and enforcement costs of exercising surveillance on firm managers and ensuring adherence to sound corporate governance ex post i.e., after financing the project.

The foregoing discussion of asymmetric information, adverse selection and moral hazards leaves no doubt that these factors have implication for asset quality which in

turn has consequences for the soundness and stability of the banking system, level of financial intermediation and economic growth. A number of studies which analyzed bank failures and concluded that asset quality is an indicator of insolvency includes Demirguc-Kunt (1989), Barr and Siems (1994), Tseganesh, (2012). Often times, the huge sum of impaired loans in the banking system lead to bank failures. In essence, NPLs are among the critical causes of financial system distress and economic downturns.

3.2 Empirical Literature

Nyarko-Baasi (2018), attempted to establish a relationship between credit risk and banking sector performance in Ghana with a panel data spanning 2006 to 2015. To account for heterogeneity among the banks, the author employed panel regression to ascertain the relationship between NPLs and profitability. The fixed and random effects result with selection based on Hausman test, revealed banks profitability are negatively affected by NPLs, while capital adequacy ratio (CAR) had a direct and significant impact on profitability. Bank Size also showed a positive association with profitability. The study underscored the importance of capital adequacy ratio with banks performance.

Macroeconomic performance has implications for banking sector stability, particularly on NPLs and therefore guides policy makers on the direction of policy. Mazreku et al. (2018), employing data on a sample of countries in transition from 2006 and 2016, and using panel static and dynamic methodology, found that inflation and GDP growth rate had inverse and significant effect on NPLs, while unemployment rate had direct influence on credit risk.

Kingu et al. (2018) investigated the effect of credit risk on banks' performance in Tanzania from 2007 to 2015. The study used a panel Fixed Effects (FE) and Random Effects (RE) techniques on sixteen (16) Tanzanian commercial banks to test the asymmetry theory and bad management hypothesis. The results revealed that credit risk had inverse effect on Tanzanian bank's performance within the period of study and as such the theory was extended by the findings.

Gizaw et al. (2015) also in their paper examined how far the profitability of commercial banks' in Ethiopia had been affected by NPLs. Employing descriptive analysis and a panel data model on eight banks on 12-years data spanning 2003 – 2014, and using Return on Equity (ROE) and Return on Assets (ROA) as measures of profitability, their results showed that NPLs, loan loss provisions and capital adequacy were significantly related with Ethiopia's commercial banks performance.

In an evaluation of the effect of bank-specific, industry and macroeconomic variables on performance of commercial banks, Bentum (2012) conducted an empirical assessment of the determinants of banks' performance in Ghana from 2001 to 2011. Adopting the fixed effects model (FEM), the study revealed that profitability was explained by all the explanatory variables. Specifically, ratio of capital and reserves to total assets, ratio of non-interest income to gross income and the natural log of total deposits (bank variables) influenced banks' performance. On the other hand, inflation growth, money supply growth and real GDP growth rate (as macroeconomic variables) impacted profitability.

Alshatti (2015) investigated the effects of credit risk management factors such as capital adequacy ratio (CAR) and NPL on Jordanian banks performance from 2005-2013. Employing panel regression technique, their findings indicated among others that NPLs was positively related to financial performance, while CAR had no effect on banks profitability. Nevertheless, bank profitability may also indicate the risk appetite of bank managers. Banks with high performance are usually under no pressure for revenue creation, hence, are not obliged to undertake risky credit transactions. In like manner, poorly performing banks are exposed to high rate of loan loss, which attunes to bad management hypothesis propounded by Berger and Mester (1997). High NPLs, therefore, can imply high information acquisition cost and weak monitoring of quality of customers that apply for credit, which will bring about high levels of capital losses.

Atoi (2018) examined credit risk and its impact on the soundness of Nigerian banks with foreign and local authorization. Employing a panel vector autoregressive technique in the analysis of a quarterly data ranging from 2014:Q2 to 2017:Q2, he found that the drivers of NPLs vary across the two groupings, although, a vital driver of NPLs for both categories was weighted average lending rate. The risk-return trade-off of efficient market theory and the moral hazard hypothesis were confirmed by the results. In addition, foreign banks survive the shocks associated with credit risk in the long run, irrespective of temporary fluctuation in the short term, while the stability of local banks is vulnerable to credit risk shocks in the long term. Hence, the performance of international banks in the model supported the widespread view that international ownership influences bank's stability directly. Thus, Levine (1996, as cited in Lensink and Hermes, 2004) opined that international ownership enhances the quality and supply of credit facility, overall supervisory environment and creates access to foreign financial markets, human capital and technologies.

Ozili (2019), more recently investigated the effect of financial development on credit risk using a 96-country 6-region dataset. The results showed that two proxy variables of financial development i.e., foreign bank presence and financial intermediation had direct and significant impact on NPLs, meaning that better developed banking systems measured by greater international bank presence and financial intermediation, experienced higher NPLs. In the regional analysis, NPLs were inversely related to regulatory capital and bank liquidity, suggesting that the higher the regulatory capital and liquidity, the lower the NPLs.

Panta (2018) examined the effect of non-performing loan on profitability and also the bank and macro-specific determinants of NPL in Nepal with panel data of seven ventures spanning 2006 to 2017. Adopting fixed effect method, the findings revealed that NPL has inverse and significant impact on both ROA and ROE (bank profitability). Using a quarterly data ranging from 1991Q1 to 2015Q4, Kimberly, Alla and Shemnel (2016) analyze NPL and its macroeconomic impact on thirty-four commercial banks of the Eastern Caribbean Currency Union. The study employed both static and dynamic regression and the result revealed that an inverse relationship exist between NPL and ROA.

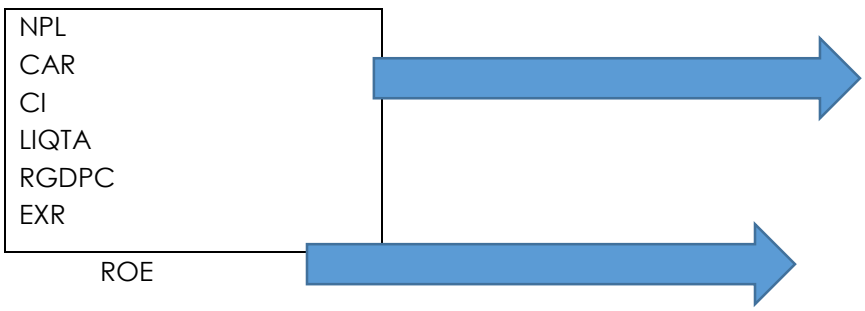
There is evidence that in developing countries government owned banks tend to have higher NPLs than privately owned ones. This is based on the belief that publicly owned banks have more capacity to finance developmental projects and take greater risks than their private counterparts, which results in higher amount of NPLs. Micco et al. (2004) noted that this is so because of their ineffectiveness to recover loans compared with privately owned banks. Other studies submitted that the level of risk a bank takes is influenced by the joint ownership structure between public and private shareholders in a bank.

4.0 METHOD OF DATA ANALYSIS

4.1 Model Specification

The study considers an association between NPL and banking system performance proxied by return on assets (ROA) and return on equity (ROE) while controlling for the models with other bank-specific and macroeconomic variables (such as capital adequacy ratio (CAR), cost/income ratio (CI), liquid asset to total assets (LIQTA), gross domestic product per capita growth rate (RGDPC) and exchange rate (EXR)). Schematically, Figure 2 shows the model formation.

Figure 2: Schematic Representation of the Model



With the major objective of determining the influence of NPL on bank performance in WAMZ region, this study draws from the methodology employed by other researchers (such as; Panta, 2018; Gizaw et al., 2015; Kimberly, Alla and Shemnel, 2016: and Nyarko-Baasi, 2018), that adopted the fixed/random effect modelling.

Thus, the general functional relationship of the model is written as:

$$ROA = f(NPL, CI, CAR, LIQTA, RGDPC, EXR) \quad (1a)$$

and

$$ROE = f(NPL, CI, CAR, LIQTA, RGDPC, EXR) \quad (1b)$$

Equation 1a and 1b states that profitability (ROA and ROE) is a function of NPL, CI, CAR, LIQTA, RGDPC and EXR. The econometric model for the static panel is then formulated as;

$$Yit = \alpha i + \beta Xit + \varepsilon it \quad (2)$$

Where i = cross-sectional dimension, t = time-series dimension, Yit = dependent variable in the model (ROA and ROE), Xit = vector of the explanatory variables (NPL, CI, CAR, LIQTA, RGDPC, EXR), α = constant, β = coefficients of the explanatory variables, and εit = stochastic term.

Using our variables to fit in the regression model, we have;

$$ROA=\alpha it + \beta 1NPLit + \beta 2CIit + \beta 3CARit + \beta 4LIQTAit + \beta 5RGDPCit + \beta 6EXRit + \varepsilon it \quad (3a)$$

$$ROE=ait + \beta1NPLit + \beta2CIit + \beta3CARit + \beta4LIQTAit + \beta5RGDPCit + \beta6EXRit + \varepsilon it \quad (3b)$$

where, ROA= Return on Assets, ROE= Return on Equity, NPL=Non performing loan ratio, CI = cost/income ratio, CAR= Capital Adequacy Ratio, LIQTA = Bank liquid assets to deposits and short-term funding, RGDP= Real Gross domestic product per capita growth rate, and EXR = Official exchange rate

The a priori expectations are that: $\beta1, \beta2, \beta4, \beta5>0, \beta3>$ or $<0, \beta6>$ or<0

4.2 Estimation Techniques

The models specified above were estimated using panel regression analysis of both pooled, fixed effect and random effect. In our study, fixed effect was selected over random effect based on Hausman test. Fixed effect model is better than pooled regression because fixed effect considers heterogeneity among cross-sectional data, while pool regression assumes homogeneous units. Pre-test was conducted using descriptive and correlation tests to observe the nature of the data. Finally, Stata 15 was used to estimate our models.

4.3 Sources of Data and Measurement of Variables

The decision on the period of coverage of data and countries used in this study was based on the availability of panel data ranging from 2007 to 2019. Thus, the data for the work were collected from the Global economy database for five (5) WAMZ countries namely: The Gambia, Ghana, Guinea, Nigeria, and Sierra Leone.

The study considered the ratio of return on equity (ROE) and return on assets (ROA) as measures of banking system (profitability/performance) and as the dependent variables. While Non-performing loan ratio (NPL), Cost-income ratio (CI), Bank liquid assets to deposits and short-term funding ratio (LIQTA), Banking system regulatory capital to risk-weighted assets (CAR), growth rate of real gross domestic product per capita (RGDPC) and exchange rate (EXR) are the explanatory variables. The variables were measured as discussed below.

Choice and Definition of Variables

4.3.1 Dependent Variables

Return on Assets (ROA) and Return on Equity (ROE). ROA is calculated by dividing net profits after tax to total assets at the end of the financial year. ROA is an indicator of

performance and measures how the banks are profitable relative to their assets, meaning how management is efficient in utilizing the company's assets to generate profit. On average, higher ROA indicates effective and efficient use of a firm's assets to generate profits.

ROE is also a proxy for banking system performance, and it is the ratio of the net profit after tax to the average total equity for the financial year. A bank's key tool of protection against unanticipated losses is profitability, as it reinforces its capital status and future performance via reinvested earnings. A bank that continuously makes losses will eventually erode its capital base to the detriment of its equity and debt holders. Since one of the objectives of any bank is to create and preserve its owner's wealth, the bank's ROE is expected to be larger to enhance its owner's worth.

4.3.2 Independent Variables

Non-Performing Loans (NPL) ratio. This is calculated by dividing NPL by total loans and advances; it is used as an indicator of credit risk. The higher the NPL ratio, the poorer the credit quality and, therefore, the higher the risk that more loan loss will be charged against income. NPL ratio is expected to have an inverse relationship with profitability.

Bank cost to income ratio (*denoted as* ***CI***): This is a measure of efficiency and it stands for the operating expenses incurred by banks as a share of the sum of net-interest revenue and other operating income. This variable is also expected to have negative effect on performance.

Bank liquid assets to deposits and short-term funding (*denoted as* ***LIQTA***). This is a measure of liquidity and it is expressed as the ratio of the value of liquid assets to short-term funding plus total deposits. Liquid assets consist of cash due from banks, trading securities and at fair value through income, loans and advances to banks, reverse repos and cash collaterals while deposits and short-term funding comprises total customer deposits and short-term borrowing. By a priori, LIQTA is expected to have inverse relationship with profitability.

Banking system regulatory capital to risk-weighted assets (denoted as CAR): this is the capital adequacy of deposit takers measured as the ratio of total regulatory capital to its assets, weighted according to the risk of those assets. It is a measure of solvency. Solvency can be directly or indirectly related with profitability.

Control Variables

Gross domestic product (GDP) is used to proxy the cyclical behaviour of economic activity. A similar measure was used as a proxy in other studies (Athanasoglou et al., 2006 and Sufian, 2011) on the relationship between macroeconomic activities and bank profitability

Official exchange rate (EXR) is defined as rate of exchange determined in the official exchange market and measured as an annual average based on monthly averages (that is, local currency units relative to the U.S. dollar).

5.0 EMPIRICAL RESULTS AND DISCUSSION OF FINDINGS

5.1 Descriptive Statistics

Table 1 shows mean values of 3.46 and 31.62 for ROA and ROE (dependent variables), with standard deviations of 2.96 and 18.35, respectively. These mean values indicate that investments in the banking sector returns was high in the sub-region, which could suggest efficient utilisation of assets and value addition for shareholders or a possible less competitive markets dominated by a few players. Besides, the standard deviations show the existence of high earning volatility, which is corroborated by their minimum and maximum values (-15.10— 10.73 for ROA and 4.25 – 104.72 for ROE). The mean values for the explanatory variables namely NPL, CI, CAR, LIQTA, RGDPC and EXR are 13.15, 63.66, 39.89, 47.84, 2.40 and 5.31, with standard deviations 7.50, 8.13, 39.87, 19.05, 4.98, and 3.12, respectively. Also, NPL, CI, CAR, LIQTA, RGDPC and EXR ranged between 2.27 - 37.25, 47.62 - 81.37, 1.75 - 149.80, 17.32 - 85.72, -22.31 - 18.05 and -0.06 - 9.11, respectively.

While there is no threshold for NPLs in the Zone (apart from Nigeria, where the Central Bank has prescribed a 5 percent prudential benchmark), the average NPL of 13.15 percent with a standard deviation of 7.50 look relatively high and volatile. Credit risk remains a major supervisory concern in the Zone and varies in degree among Member States. Banks are generally solvent in the Zone, as evidence by average CAR of 39.89 percent, which is above both international (8 percent) and national minimum benchmarks (10 - 15 percent). However, the minimum CAR value of 1.75 percent signals undercapitalization of some banks during the review period. The result shows that CI and CAR recorded the highest mean and standard deviation Also, CAR has the highest maximum values of 149.8.

Table 1: Summary of the result of the Descriptive Statistics

Variables	*Mean*	*Std. Dev*	*Min*	*Max*
ROA	*3.46*	*2.96*	*-15.10*	*10.73*
ROE	*31.62*	*18.35*	*4.25*	*104.72*
NPL	*13.15*	*7.50*	*2.27*	*37.25*
CI	*63.66*	*8.13*	*47.62*	*81.37*
CAR	*39.89*	*39.87*	*1.75*	*149.80*
LIQTA	*47.84*	*19.05*	*17.32*	*85.72*
RGDPC	*2.40*	*4.98*	*-22.31*	*18.05*
EXR	*5.31*	*3.12*	*-0.06*	*9.11*

Source: Author's computation using Stata 15

5.2 Correlation Analysis

We checked for multi-collinearity problem using correlation test and the results are shown in Table 2. The results revealed that all the explanatory variables in both specifications (i.e., ROA and ROE) are not linearly dependent on one-another because none of the variable coefficients is up to 0.8. Thus, all the variables passed the multi-collinearity test. Hence, the correlation analysis suggests that the regressors do not have perfect or exact linear representations of one another.

Table 2: Results of the correlation Analysis

SPEC 1	*ROA*	*NPL*	*CI*	*CAR*	*LIQTA*	*RGDPC*	*EXR*
ROA	*1.0000*						
NPL	*-0.314*	*1.000*					
CI	*-0.443*	*0.113*	*1.000*				
CAR	*0.158*	*-0.201*	*0.200*	*1.000*			
LIQTA	*-0.021*	*-0.138*	*0.530*	*0.276*	*1.000*		
RGDPC	*-0.052*	*-0.052*	*0.212*	*-0.176*	*-0.003*	*1.000*	
EXR	*0.152*	*0.004*	*0.213*	*-0.315*	*0.304*	*0.039*	*1.0000*
SPEC 2	*ROA*	*NPL*	*CI*	*CAR*	*LIQTA*	*RGDPC*	*EXR*
ROE	*1.0000*						
NPL	*-0.195*	*1.000*					
CI	*-0.248*	*0.113*	*1.000*				
CAR	*0.135*	*-0.201*	*0.200*	*1.000*			

LIQTA	***0.051***	***-0.138***	***0.530***	***0.276***	***1.000***		
RGDPC	***-0.044***	***-0.052***	***0.212***	***-0.176***	***-0.003***	***1.000***	
EXR	***0.330***	***0.004***	***0.213***	***-0.315***	***0.304***	***0.039***	***1.0000***

Source: Author's computation using Stata 15

5.3 Panel Regression Result

The results of fixed effect and random effect for our static model are shown in Table 3. Selection between them was done through the Hausman specification test. Based on the Hausman test, - 0.000 and 0.54 for ROA and ROE models, respectively, the null hypothesis which states that random effect is the most appropriate model was rejected. Hence, the fixed effect model is more appropriate and subsequently reported.

For the ROA model, the fixed effect estimates for NPL and CI are -0.211 and -0.201, respectively. This means that a unit increase in NPL and CI will bring about 21.1 percent and 20.1 percent reductions in ROA. The coefficients of CAR, LIQTA, RGDPC and EXR are 0.001, 0.027, 0.011 and 0.0004, respectively; implying that a unit rise in these variables (CAR, LIQTA, RGDPC and EXR) will increase ROA by 0.1, 2.7, 1.1 and 0.04 percent, respectively. Statistically, only NPL and CI (at 1 percent level) are significant.

In the ROE model, the fixed effect estimates for NPL, CI, CAR, LIQTA and RGDPC are -0.690, -0.629, -0.053, -0.018 and -0.032, which indicates that a percentage increase in NPL, CI, CAR, LIQTA and RGDPC reduces ROE by 69, 62.9, 5.3 , 1.8 and 3.2 percent, respectively. While a percentage rise in EXR will lead to 0.5 percentage increase in ROE. Statistically, only NPL and EXR are significant at the 5 percent level of significance, while CI is significant at the 10 percent level of significance. The overall statistics of F-probability for all the estimates in both models are statistically significant. This indicates a good fit.

Table 3: Summary Results of fixed effect and Random Effect Estimates

	MODEL 1-ROA			MODEL 2-ROE		
Variables	***POLS***	***FE***	***RE***	***POLS***	***FE***	***RE***
NPL	***-0.058***	***-0.211***	***-0.058***	***-0.140***	***-0.690***	***-0.140***
	0.167	0.000	*0.162*	0.614	0.053	0.612
CI	***-0.239***	***-0.201***	***-0.239***	***-1.047***	***-0.629***	***-1.047***
	0.000	0.000	0.000	0.001	0.076	0.001
CAR	***0.028***	***0.001***	***0.028***	***0.185***	***-0.053***	***0.185***
	0.002	0.957	0.002	0.003	0.729	0.002
LIQTA	***0.014***	***0.027***	***0.014***	***0.013***	***-0.018***	***0.013***
	0.481	*0.239*	0.478	0.924	*0.918*	*0.923*
RGDPC	***0.075***	***0.011***	***0.075***	***0.421***	***-0.032***	***0.338***
	0.237	0.844	0.232	0.359	0.941	0.418
EXR	***0.0003***	***0.0004***	***0.0003***	***0.003***	***0.005***	***0.003***
	0.002	0.104	0.001	0.000	0.015	0.000
Diagnostic Test						
Hausman		***0.000***			***0.054***	
Prob>F	***0.000***	***0.000***	***0.000***	***0.0002***	***0.0007***	***0.000***
R-squared						
Within		***0.58***	***0.4871***		***0.339***	***0.2835***
Between		***0.0138***	***0.217***		***0.128***	***0.7367***
Overall	***0.3021***	***0.3021***	***0.4433***	***0.357***	***0.174***	***0.3568***
No of obs.	***65***	***65***	***65***	***65***	***65***	***65***

Source: Authors' computation from stata 15

Note: *POLS means Pooled Ordinary Least Squares; FE means Fixed Effect; and RE is Random Effect*

5.7 Discussion of Findings

The study made use of panel regression of static nature to empirically analyze the effect of credit risk on bank performance in five WAMZ countries. For the models specified (that is ROA and ROE), the fixed effect panel regression was selected based on the Hausman test.

In both models and consistent with a priori expectation, NPL had an inverse and significant relationship with banks' profitability. This result is in tandem with the results of Nyarko-Baasi (2018), Mazreku et al. (2018), Kingu et al (2018), but contrary to the work of Alshatti (2015). The result confirms the criticality of improving asset quality, given its importance in the lending-profitability relationship in the sub-region. Asset impairment increases banks provisioning requirement and exerts a dampening effect on banks profitability, hence the need to initiate measures to reduce loan default. The WAMZ banking sector is primarily traditional and heavily reliant on the credit function for growth, hence NPL reduction would free-up a sizeable amount of loanable funds. This notwithstanding, in addition to the rising fee-based income, banks profit results from, among others, the high interest rate regime in the sub-region - high lending rate and interest rate on risk free treasury instruments - which compensate for the inefficiencies associated with NPL induced income loss.

The coefficient of the efficiency indicator, on the other hand, was appropriately signed and significant in both models. High cost reduces ROA and ROE. Banks thus need to review their operations and cost structures downward in order to maximise profit and shareholder value.

The solvency (CAR) and liquidity (LIQTA) measures showed mixed results - positively signed in ROA model and negatively related to ROE. CAR's positive sign is consistent with the findings of Alshatti (2015) and suggests a relatively higher dependence on banks' own capital (rather than external funding sources) to fund assets growth. On the other hand, the negative sign could result from banks holding of capital far beyond the optimal level. From table 1, average CAR of 39.89 percent appears rather high, underscoring the urgency for banks to recalibrate their internal models to determine the required economic capital commensurate with their assumed risk. In this scenario, any reduction in CAR from the current average level born out of such exercise, all things being equal could imply improvement in efficiency, financial intermediation and ultimately performance. This result is in line with the findings of Nyarko-Baasi (2018).

Similarly, the negative relationship between liquidity and ROE reinforces the a priori liquidity-profitability trade-off, while the positive sign could reflect the high component of government treasury instruments in banks liquid assets and its high interest offering. However, we found no evidence to support these hypotheses as CAR and LIQTA turned out to be insignificant in both models. For the macroeconomic variables, we found no evidence that an upswing in the economy (RGDPC) boost the performance of banks. Usually, most projects become profitable and generate positive net present

values during better economic conditions, hence reducing the propensity to default (Kashyap et al., 1993). Thus, growth in the economy turns to lower credit risks and enhance returns from the lending functions. This result is not consistent with the findings of Bentum (2012).

However, Exchange rate, EXR in all models and estimation techniques has positive and significant impact on profitability. Foreign currency trading is increasingly become a vital non-interest income source, as banks strive to diversify their income streams. About a quarter of banks assets are denominated in foreign currency making currency fluctuations both directly and indirectly impactful in the Zone. Banks treasurers have been highly sensitive and responsive to currency movements (usually currency depreciation), keeping generally long net open positions.

6.0 SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

This paper examined the impact of NPLs on the banking sector of the countries of the WAMZ. Two measures of performance or profitability, ROA and ROE as the dependent variables, were modeled against NPL as the main independent variable alongside other prudential indicators and macroeconomic variables. Both models showed an inverse and significant relationship between our choice variable, NPL and performance (ROA and ROE) which is in line with a priori expectation. Similarly, the study found evidence that cost income ratio and exchange rate movement impacts bank performance, negatively and positively, respectively.

Generally, we recommend the strengthening of banks risk management practices, greatly emphasizing improvement in loan administration and underwriting standards on the part of practitioners. To this end, banks should clearly articulate their credit culture, including basis for targeting a type of borrower and the objective assessment criteria of their capacity and willingness to repay in their credit policy. The competent regulatory authorities should drive the process, by prescribing appropriate risk management guideline and enforcing adherence.

Regulatory authorities should put measures in place to enhance the functionality of credit delivery safeguards such as collateral registry, credit reference system, perfection of collaterals and improvement in the legal regimes on foreclosures, to reduce incidences of default. Besides, poor credit referencing system impairs banks abilities to properly profile customers, hence the need to innovatively implement a unique identity system. To this end, WAMZ Member States could learn from the

experience of Nigeria in the implementation of the Central Bank's Bank Verification Number (BVN) system.

Finally, to correct default behaviour, the competent regulatory authorities should strengthen the sanctioning regime on loan delinquency, including blacklisting willful and serial defaulters and circulating their profiles in the industry in a bid to deny them access to credits.

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ASYMMETRIES AND THE ROLE OF UNCERTAINTIES IN MONETARY POLICY REACTIONS: EVIDENCE FROM NIGERIA

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ABSTRACT

In an attempt to further enrich the literature with insights on the role of uncertainties as the underlying source of asymmetries in monetary policy reaction function, we consider an augmented nonlinear SVAR model (i.e. SVAR-X) to exogenously accommodate the role of political uncertainty as fixed regressor in a three variable monetary policy reaction function of the Taylor's rule. Essentially, we find the potential of monetary policy exhibiting greater sensitivity to shocks due to output growth than they do to shocks due to inflation in recession periods, but the reverse appears to be the case for a contractionary monetary policy. We also find the asymmetric response of monetary policy to be relatively more pronounced when political uncertainty is captured as the underlying source of asymmetries. It is therefore, recommended that monetary policy action(s) takes cognizant of not only the effectiveness or otherwise of monetary policy instruments, but also the fact that policy instruments such as expansionary and contractionary monetary policies are not likely to react in the same direction to shocks due to output growth and inflation, particularly in the context of political uncertainty.

JEL Classification: E44, E52, E58

Keywords: Monetary Policy Shocks; Asymmetry Response; Uncertainty; SVAR-X

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1.0 INTRODUCTION

The world over, monetary policy objective invariably includes price stability, external balance and sustainability of output growth (Anwar & Nguyen, 2018). That the central banks in most countries are traditionally responsible for the conduct of monetary policy for the actualization of these goals is only a common knowledge. From the very inception of its establishment, Central Bank of Nigeria (CBN) has been tasked with the responsibility of implementing monetary policy in accordance with the macroeconomic policy objectives of the Nigerian government. However, while a number of the extant studies appear to have proven monetary policy in Nigeria as crucial for explaining output growth and inflation (see for example, Obafemi & Ifere, 2015; Babatunde & Olatunji, 2017; Ekong & Ukoha, 2018; Ezeaku et al., 2018), yet debatable though is whether the response of monetary policy to these fundamentals is linear (symmetric) or nonlinear (asymmetric). In his modest monetary policy reaction function, Taylor (1993) assumes the response of the monetary policy to be linear (symmetric) such that; positive and negative inflation and output gaps are met with equally weighted policy responses.

The Taylors linear monetary policy rule is essentially based on two assumptions (see Güney, 2018). The first is that central bank reaction has a quadratic loss function, and the second is that, the Phillips curve is linear. Deciphered from the first assumption is the potential of central banks reacting symmetrically; indicating that the same magnitude of positive and negative deviations of inflation rate and output gaps from their target values has similar effect on monetary policy. However, there have been emerging theoretical issues suggesting that monetary policy respond asymmetrically to inflation and output gaps (see Bec et al., 2002; Cukierman, 2000, 2002; Goodhart, 1999). Despite the increasing evidence challenging the view that central banks use simple linear interest rules (see Gerlach, 2000; Bec et al., 2002; Surico, 2003, 2007;), the bulk of the literature on monetary policy in Nigeria has continued to rely on the Taylors' rule as the workhorse for explaining monetary policy reaction function (see Uma et al., 2014; Adeoye et al., 2014; Obafemi & Ifere, 2015; Babatunde & Olatunji, 2017; Ekong & Ukoha, 2018). But since same size of monetary contractions and expansions could result in different magnitudes of policy effects, then it might be erroneous to assume that the policy goal variables such as output growth and inflation would respond symmetrically to monetary shocks.

Further questioning the reliability of the Taylors rule assumption of linearity, is the assertion that the short-term inflation –output trade-off is likely to be nonlinear. Consequently, there has been growing effort towards understanding whether

contractionary and expansionary monetary shocks generate different magnitudes of policy response (see Kilinc & Tunc, 2019; Güney, 2018; Abdelsalam, 2018; Gogas, et al., 2018; Zhu & Chen, 2016; Lee & Yoon, 2016; Georgiadis, 2015; Santoro et al., 2014; Zakir & Malik, 2013; Karas, 2013; Komijani et al., 2012; Tan et al., 2010; Surico, 2007; De Grauwe & Senegas, 2006; Dolado et al., 2005; Kim et al., 2002; and Kim et al., 2002). It is instructive however, that these extant studies predominantly focused on the case of developed and emerging economies. To put it differently, there has been dearth of literature on the probable asymmetric response of monetary policy from the perspective of developing Africa countries. Notable exceptions in this regard particularly in the context of Nigerian economy include Olayiwola & Ogun (2019); Olayiwola (2018); Apanisile, (2017); and Akanbi & Dada (2018).

On the whole, deciphered from the aforementioned studies is unanimous inference of asymmetric effects of monetary policy shock on output growth, inflation and other macro fundamentals. The novelty in the context of this present study is therefore, to unravel the underlying factor(s) that constitute source of asymmetries in monetary policy. Both academics and policymakers agree that monetary policy is made in an environment of substantial uncertainty regarding the current and future economic conditions as well as the functioning of the economy (see Monte, 2010). Taking cognizant of these exogenous conditions, this present study finds it innovative to further enrich the literature with insights on the role of uncertainties as the underlying source of asymmetries in monetary policy reaction function. Essentially, the appeal to improve on the study of Olayiwola & Ogun (2019) justifies our resolve to consider the role of uncertainties in the analysis of asymmetries in monetary policy reaction function in Nigeria.

However, unlike the study by Güney (2018) where uncertainty was measured via variability in output and inflation, this present study takes a step further to accommodate the fact that monetary authorities in developing economies are highly vulnerable to political uncertainty. Thus, uncertainty in the context of this study was described from the view point of the vulnerability of decision –making process such as central bank's decision to political pressure. Going forward, we deviate from the prominent single equation approaches such as the nonlinear ARDL model of Shin et al. (2014), GMM (see Bec et al. 2002; Guney, 2018), logistic smooth transition regression (Bruggemann & Riedel, 2011), Regime Switching approach (see Komlan, 2013), to favour an augmented version of a structural vector autoregressive with exogenous variable (SVAR-X) approach. Relative to the alternative mentioned models, the SVAR-X allows relationships among variables from economic theories and stylized facts,

which in turn allow us to identify the orthogonal monetary shocks (See Bernanke and Milov, 1998).

In addition to this introductory section, the remainder of this paper is structured as follows: Section 2 presents a brief literature review both from theoretical and empirical perspectives. Section 3 explains the model. Section 4 explains the data and offers some preliminary analysis. Section 5 presents and discusses the empirical findings, while section 6, concludes the paper and offers some recommendations.

1.1 Literature Review

1.1.1 Theoretical Foundation

There are several theoretical reasons why monetary policy could respond asymmetrically to deviation in output and inflation rate from target (see Zakir & Malik, 2013). The first possible reason for asymmetric response of monetary policy relates to firms' menu cost. Propounded by Caballero & Engel (1993), Tsiddon (1993), and Ball & Mankiw (1994), the menu cost hypothesis assumes that the economy is composed of a continuum of monopolistic competitors. Hence, it is posited that half of the competitors set their prices during even periods, while the others set theirs during odd periods. To this end, each producer can make additional price adjustment by paying a fixed menu cost which is uniformly distributed across firms. Thus, if a positive (negative) aggregate demand shock occurs, the profit maximizing relative price should go up (down) under the aggregate demand externality assumption (see Wooheon, 1995; Zakir & Malik, 2013). To put it differently, the profit maximizing relative price and the actual relative price widens when positive aggregate demand shocks occur, and there would be more producers who want to adjust their prices by paying a fixed menu cost.

Gleaned from the above is the fact that prices respond more to positive aggregate demand shocks (or monetary shocks) than to equivalent negative shocks thus implying that price adjustments are asymmetric. Intuitively, if price adjustments are asymmetric, the effects of monetary policy shocks on inflation are also likely to be asymmetric (see Wooheon, 1995; Zakir & Malik, 2013). Similar to the menu cost hypothesis is the New Keynesian model which move a step further to posits that as average inflation rises, the relative price of each product declines more rapidly, and price adjustments become more asymmetric. In the literature, this is often described as 'Asymmetry Hypothesis B' implying that rising average inflation aggravates the asymmetric effects of money on inflation.

1.2 Brief Review of Empirical Literature

In attempt to validate or refute some of the aforementioned theoretical foundations, there has been large volume of empirical literature concerning the asymmetric responses of monetary policy shocks. Using the case of Federal Reserve in the U.S., Kim et al. (2002), Dolado et al. (2005), Surico (2007), among others, finds evidence of asymmetry in the Fed's responses to variations in output and inflation (see also Bouabdallah & Olmedo; 2000). Bec et al. (2002) employed GMM method to show that monetary policy reacts asymmetrically not only in the United State but also in France and Germany, and particularly over the business cycle. By employing the Markov-switching model, Tan et al. (2010) examine if real output asymmetrically responds to monetary policy shocks in Indonesia, Malaysia, the Philippines and Thailand. This study finds that a contractionary monetary policy has a larger absolute impact than an expansionary policy. For Karras (2013), the paper used quarterly U.S. data to strongly support sign asymmetry in monetary policy with or without quantitative easing. Ulkea & Berument (2016) relied on the nonlinear VAR model introduced by Kilian and Vigfusson (2011) to investigate the asymmetric effects of monetary policy shocks using the case of Turkey.

To examine asymmetries in the transmission of monetary policy, Georgiadis (2015) utilizes a global VAR model and reveal that the transmission of monetary policy across euro area economies displays asymmetries. Estimating a forward-looking threshold Taylor rules, Zhu & Chen (2016) find that the U.S. monetary policy operations are asymmetric across the periods of expansion and recession. For Güney (2018), the study explored the generalized method of moments (GMM) to investigate whether asymmetries matter in monetary policy reaction function over the business cycle and find that, the central bank in Turkey reacts more aggressively to any inflation gap during recession than it does during expansion. Giving preference to Logistic Smooth Transition Autoregressive (LSTAR) forward looking model of the Taylor rule, Gogas et al. (2018) used the case of U.S. and Brazil to reveal asymmetries between anticipated and unanticipated monetary policy shocks, as well as, between effects of positive and negative shocks. In their investigation of asymmetric effects of monetary policy on economic activity in Turkey, Kilinc & Tunc (2019) implement Markov Switching model to show that monetary policy have stronger effects during contractionary periods compared to expansionary periods.

Thus far, the vast of the extant studies as reviewed herein seems to support the hypothesis that monetary policy react asymmetrically in their response to shocks to inflation and output (see also, Abdelsalam, 2018; Lee & Yoon, 2016; Zakir & Malik, 2013;

Aye & Gupta, 2012, among others). There has been dearth of literature on whether asymmetries matter in the analysis of monetary policy function in Nigeria. Closer to this present study is Olayiwola & Ogun (2019) whose paper utilizes nonlinear ARDL model, to conclude that monetary policy shocks have asymmetric effects on output and prices in Nigeria both in the short and long run period (see also, Akanbi & Dada, 2016). However, beyond the paucity of empirical studies on the asymmetric response of monetary policy in Nigeria, the bulk of the extant literature have continued to ignore the likelihood of the asymmetric response of monetary policy under the influence of exogenous conditions.

2.0 MODEL SPECIFICATION

To reflect the contribution of this paper without introducing unnecessary complication, we consider a three-variable structural VAR (SVAR) model as follows:

$$A_0 Y_t = \Pi_0 + \Pi_1 Y_{t-1} + \Pi_2 Y_{t-2} \cdots + \Pi_p Y_{t-p} + \varepsilon_t \quad (1)$$

The SVAR specification in equation (1) follows the traditional Taylor's rule which assumes that a typical monetary policy authority respond to variations in inflation and output. Such that; $y_t = \begin{bmatrix} g_t & \pi_t & \Delta i \end{bmatrix}'$ is a 3x1 vector of endogenous variables, A_0 is a 3x3 matrix of contemporaneous effects, the term Π_0 on the one hand denote 3x1 vector of constant, while Π_t on the other hand is a 3x3 matrix of coefficients for lagged variables. The term ε_t is a 3x1 vector of error terms, which from the technical point of view can be described as a structural innovation or structural shock with a mean zero and also serially uncorrelated; while the p term on the other hand indicates the optimal lag obtained using the Schwartz Information Criterion (SIC).[1]

To circumvent the problem of unit root in the specification, the endogenous variables, namely; output growth (g_t); inflation rate (π_t) and interest rate (Δi) are measured as first difference of the log of industrial production index, first difference of the log of consumer price index, and changes in nominal interest rate, respectively. To make the terms expressed in equation (1) conformable, we construct parameters for the fixed regressors in the form of a diagonal matrix as below.

[1] In general, different orders can be assumed for the distributed lag functions associated with the endogenous and exogenous variables. Alternatively, p can be viewed as the maximum lag order of the distributed lag function on y_t and x_t.

$$\lambda X_t = \begin{bmatrix} \lambda_1 & 0 & 0 \\ 0 & \lambda_2 & 0 \\ 0 & 0 & \lambda_3 \end{bmatrix} \begin{bmatrix} X_{1t} \\ X_{2t} \\ X_{3t} \end{bmatrix} \quad (2)$$

However, the fact that analyzing with SVAR also depends on the identification of the model, we further impose some restrictions based on the $\left[n(n-1)/2\right]$ condition and also follow the recursive approach to estimating the SVAR model as indicated in Table 1 below.

Table 1: Restrictions on the A matrix

	Contemporaneous variable		
Endogenous variable	g_t	π_t	Δi
g_t	*	0	0
π_t	1	*	0
Δi	1	1	*

The fundamentals behind the recursive story in table 1 is that: (i) inflation and interest rates have no effect on the output gap in the current period; (ii) there is no direct effect of current interest rates upon inflation; and (iii) there is an interest rate rule in which the monetary authority responds to the current output growth and inflation. To capture the nonlinearity (asymmetry) in the response of monetary policy, the change in interest rate (Δi) was further decomposed into positive and negative monetary policy shocks as below.

$$\Delta i_t^+ = \max(\Delta i_t, 0)$$

and

$$e^{\Delta i^+} \Delta i_t^- = \max(\Delta i_t, 0)$$

where the series Δi_t^+ indicates positive (contractionary) monetary policy shock while Δi_t^-, on the other hand, denotes negative (expansionary) monetary policy shock.

To capture the role of uncertainty as the underlying source of asymmetries in monetary policy, we further modify the standard SVAR model in equation to include an X factor.

$$A_0 Y_t = \Pi_0 + \Pi_1 Y_{t-1} + \Pi_2 Y_{t-2} \cdots + \Pi_p Y_{t-p} + \lambda X_t + \varepsilon_t \quad (3)$$

Equation (3) is our proposed SVAR-X model such that an important component of the specification is $\forall i > 0; X_t$ which is a 3x1vector of fixed regressors which capture the role of uncertainty via political pressure measure as log of the first difference of government borrowing. The term λ is a 3x3 diagonal matrix of coefficients for the fixed regressors.

The SVAR-X model is indeed structural in the sense that it explicitly allows for instantaneous interaction between the endogenous variables through contemporaneous coefficient matrix, *A*. Thus, the model can be further re-specified as follows:

$$Y_t = B(L)Y_t + e_t \quad (4)$$

where L is a polynomial lag operator and it must be pointed out that the omission of the fixed term in equation (3) is mainly for notational convenience, such that; $B(L)Y_t = A_0^{-1}(\Pi_1 L Y_{t-1} + \Pi_2 L_2 Y_t + \cdots + \Pi_p L_p Y_t)$ and $e_t = A_0^{-1}\varepsilon_t$. Since the recursive structure embodied in table 1 is rooted in economic theory using the Taylor rule, the "orthogonalization" of the reduced-form residuals involving Cholesky decomposition can be regarded as relevant in this case. Thus, the initial impulse response of output growth and inflation to monetary policy shock can, therefore, be represented in matrix form as follows:

$$\text{For positive } (\text{contractionary}) \text{ monetary policy shock } = \begin{bmatrix} e_t^g \\ e_t^\pi \\ e_t^{\Delta i^+} \end{bmatrix} = \begin{bmatrix} a & 0 & 0 \\ b & c & 0 \\ d & e & f \end{bmatrix} \begin{bmatrix} \varepsilon_t^{\text{supply}} \\ \varepsilon_t^{demand} \\ \varepsilon_t^{monetary} \end{bmatrix} \quad (4a)$$

$$\text{For negative } (\text{expansionary}) \text{ monetary policy shock } = \begin{bmatrix} e_t^g \\ e_t^\pi \\ e_t^{\Delta i^-} \end{bmatrix} = \begin{bmatrix} a & 0 & 0 \\ b & c & 0 \\ d & e & f \end{bmatrix} \begin{bmatrix} \varepsilon_t^{\text{supply}} \\ \varepsilon_t^{demand} \\ \varepsilon_t^{monetary} \end{bmatrix} \quad (4b)$$

The shocks in this system are given the names supply shock (e_t^g), demand shock (e_t^π) and asymmetric monetary policy shock ($e^{\Delta i^+}$) and/or ($e^{\Delta i^-}$). The underlying intuition behind equation (4) is that output does not respond contemporaneously to shocks due to the deviation of inflation from equilibrium path and/or changes in interest rate. While this could be justified by operational rigidities in the production of goods and

services, price on the other is expected to respond to changes in output since such rigidities as in the production case are not applicable. However, the impact of changes in interest rate on the general price level usually comes with some lags, particularly if it is expected to impact through the production channel.

Thus, it is expected that both the demand and supply shocks will give rise to unanticipated policy actions by the monetary policy authority in order to mitigate their long term consequences, but whether such intervention by monetary policy is symmetric or asymmetric is the concern of this study. More importantly, we are also interested in the extent to which uncertainty such as the vulnerability of central bank's decision to exogenous condition constitutes the underlying source of asymmetries in monetary policy response.

3.0 DATA AND PRELIMINARY ANALYSIS

Variables used in this study are selected based on their theoretical importance, as well as, their uses and findings in the previous empirical literature. The data frequency is quarterly ranging from the first quarter of 1981 to the fourth quarter of 2017. The data sources include CBN statistical bulletin and the International Financial Statistics (IFS) database. For monetary policy reaction indicator, we find the short term nominal interest rate proxy via bank lending rate as the most prominent in the empirical literature. Essentially, we measured monetary policy shocks as a change in nominal interest rate (Δi), while output growth (g_t) and inflation rate (π_t) are measured as first difference of the log of industrial production index and first difference of the log of consumer price index, respectively. We used log of the first difference of government borrowing as a measure for political uncertainty.

Presented in Table 2 is the summary statistics with all the series expressed in their level units of measurement, the average interest rate for the period under consideration is 17.92 and 55.60 for consumer price index while the mean value for the country industrial production index is 89.15. However, the standard deviation statistics for the individual variables cannot be compared in absolute term and that is because the variables are expressed in varying unit of measurement. For the purpose of comparative therefore, we normalize the standard deviation statistics and a cursory look at the table shows that inflation measure via consumer price index and government borrowing a proxy for internal uncertainty are the most volatile given the comparatively higher value of their respective standard deviation statistics. With respect to the statistical distribution of the variables, all the series appears to be

positively skewed but the industrial production index (output growth), while the kurtosis statistic also appears to be mainly platykurtic for all the variables. On the whole, the computed probability values associated with the Jarque-Bera normality test statistic appears to be less than 0.05 implying the rejection of the hypothesis that the series are normally distributed at 5% level of significance.

Table 2: Summary Statistics

	Mean	**Std. Dev.**	**N-Std. Dev.**	***Skewness***	***Kurtosis***	***JB stat.***	***Obs***
i_t	17.92	5.19	0.29	0.34	4.80	22.95(0.00)	148
g_t	89.15	21.60	0.24	-0.43	2.31	7.40(0.02)	148
π_t	55.60	63.37	1.14	1.18	3.45	35.72(0.00)	148
gb_t	3531.98	3957.32	1.12	1.32	4.07	50.33(0.00)	148

Note: STDV represent standard deviation while N-STDV is the normalize standard deviation computed as: STDV/mean, while the values in parenthesis are the probability values associated with the Jaque-Berra (JB) statistic.

4.0 EMPIRICAL RESULTS

4.1 Contemporaneous effects

Although, the focal point of this study is on the probable asymmetric response of monetary policy to output growth and inflation, we however, begin our analysis with the Taylor's rule assumption of linear monetary policy response for the sake of robustness and consistency. Thus, presented in the following tables are empirical estimates on the contemporaneous responses of monetary policy to changes in output and inflation, as obtained from linear and nonlinear SVAR systems.

A cursory look at Table 3 shows that monetary policy in Nigeria measured via nominal interest rate do not respond contemporaneously to shocks due to output growth and inflation. The fact that this evidence also holds for the nonlinear (asymmetric) model tends to contradict Bec et al. (2002), Dolado et al. (2005), Surico (2007), and Güney (2018) whose empirical findings favour the view that policymakers react asymmetrically in their response to changes in output and inflation.

However, when we extend the nonlinear model to exogenously capture political uncertainty as a fixed regressor, then we find significant evidence of monetary policy

responding contemporaneously to both output growth and inflation. What this portends as evidently revealed in Table 4, is that the extent to which monetary policy respond asymmetrically to output growth and inflation cannot be in isolation of the exogenous conditions that constitute the underlying source of the asymmetries in monetary policy for instance 'political uncertainty'.

Table 3: Contemporaneous effect results without the role of political uncertainty

Response variable	Contemporaneous variable								
	Linear (Symmetric) Monetary Policy Response			Nonlinear (Asymmetric) Monetary Policy Response					
				Contractionary MP			Expansionary MP		
	g_t	π_t	Δi	g_t	π_t	Δi^+	g_t	π_t	Δi^-
g_t	-	0	0	-	0	0	-	0	0
π_t	0.1276** (0.0670)	-	0	0.1362** (0.0683)	-	0	0.1421 (0.0681	-	0
Δi	2.2912 (3.1696)	3.0164 (3.8619)	-						
Δi^+				0.1307 (0.1060)	-0.0126 (0.1266)	-			
Δi^-							0.0046 (0.0946)	0.1073 (0.1138)	-

Note: The value in parenthesis are standard error, while ***. ** and * represents 1%, 5% and 10% level of significance with the term MP denoting monetary policy.

Table 4: Asymmetric contemporaneous effect results with the role of political uncertainty

Response variable	Contractionary MP			Expansionary MP		
	g_t	π_t	Δi^+	g_t	π_t	Δi^-
g_t	-	0	0	-	0	0
π_t	0.1462** (0.0686)		0	0.1438** (0.0681)	-	0
Δi^+	0.4749*** (-0.0249)	-1.5274 (-3.5938)	-			
Δi^-				-2.3201* (1.2217)	-0.5595*** (0.1841)	-

Note: The value in parenthesis are standard error, while ***. ** and * represents 1%, 5% and 10% level of significance with the term MP denoting monetary policy.

4.2 Impulse response analysis

In attempt to determine the overall dynamic response of monetary policy shocks due to output growth and inflation, we estimate impulse response function within the 95% confidence interval. Starting with the contemporaneous impulse –response in Figure 1, we report impulse response of both symmetric and asymmetric monetary policy (i.e. interest rate) to a one standard deviation shock to output growth (see Fig. 1.1) and inflation (see Figure 1.2). Starting with the symmetric monetary policy, a shock to output growth tends to prompt a short run negative response from monetary policy in the first and second periods, positive response in the third period and the respond became neutral all through the remaining period. For a shock due to inflation, the symmetric is though negative in early period but appears predominantly positive for the larger path of the period.

To understand the extent to which the impulse response results vary for contractionary and expansionary monetary policies; we relax the linear assumption that contractionary and expansionary monetary policies respond symmetrically to economic shocks. For instance, while the direction of the CBN response to output growth appears same for contractionary and expansionary monetary policies, the magnitude of the response yet appears relatively higher for the contractionary monetary policy. This, though, contradicts the assertion that central banks react more aggressively to negative output gaps, but act passively when the situation is that of over-employment, yet notable however, is the philosophy of trade-off in the asymmetric responses of the Central Bank of Nigeria to shocks due to output growth relative to shocks due to inflation. For instance, while a shock to inflation tends to prompt positive response from both contractionary and expansionary monetary policies, the magnitude appear to be relatively more pronounced for expansionary monetary policy.

Figure 1: Impulse responses of monetary policy without the role of uncertainty

Figure 1.1: Response to output growth (Shock 1)

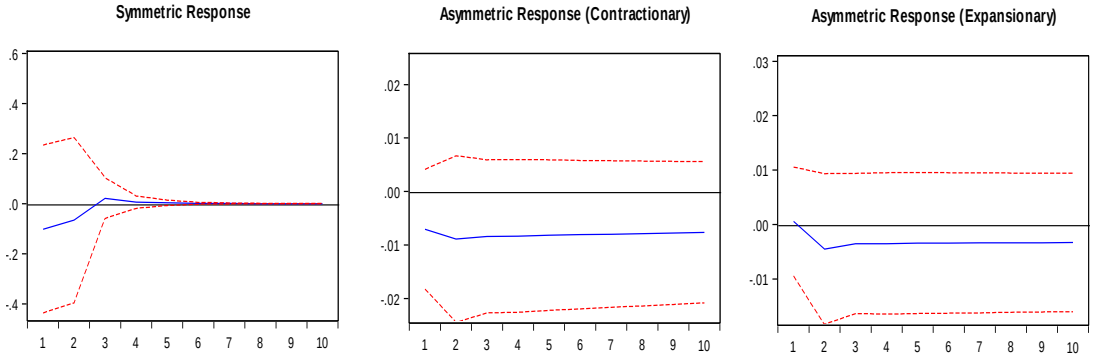
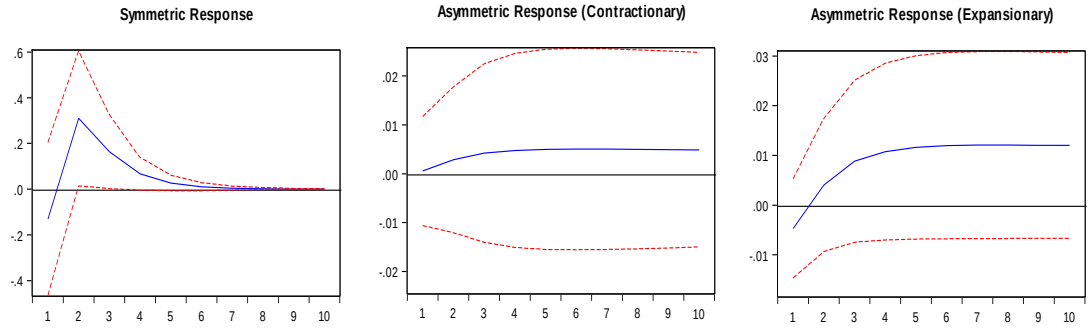


Figure 1.2: Response to inflation (Shock 2)



4.3 Variance decomposition

Presented in Table 5 are the variance decomposition results and the essence is to determine the proportion of the response of monetary policy (i.e. movements in interest rate) that is due to shocks to output and inflation, respectively. Starting with the empirical estimates from the linear model, the central bank appears to be more aggressive in their respond to shocks due to inflation when compared to the magnitude of their respond for shocks due to output. But when the model is non-linear, the CBN tends to exhibit greater sensitivity to shocks due to output growth than they do to shocks due to inflation say in recession periods as observed when the monetary policy is expansionary and the reverse appears to be the case for a contractionary monetary policy. Güney (2018), Surico (2007) and Dolado et al. (2005) are some of the previous studies whose findings have also offered support to the assertion that central banks tend to exhibit asymmetric preference in their response to changes in output and inflation.

Table 5: Variance decomposition without the role of uncertainty

Period	Linear (Symmetric)			Non-linear (Asymmetric)					
				Contractionary MP			Expansionary MP		
	S.E	Shock1 (g_t)	Shock2 (π_t)	S.E	Shock1 (g_t)	Shock2 (π_t)	S.E	Shock1 (g_t)	Shock2 (π_t)
1	0.0534	0.2522	0.4151	0.0534	1.0871	0.0067	0.0533	0.0089	0.6123
2	0.0547	0.3499	2.6822	0.0547	1.4181	0.0925	0.0547	0.2859	0.5331
3	0.0548	0.3581	3.2982	0.0548	1.4807	0.1930	0.0547	0.3031	1.0729
4	0.0548	0.3583	3.3981	0.0548	1.5122	0.2725	0.0548	0.3117	1.6070
5	0.0548	0.3585	3.4139	0.0548	1.5293	0.3323	0.0548	0.3144	2.0344
10	0.0548	0.3585	3.4167	0.0548	1.5611	0.4737	0.0548	0.3167	3.0703

To further ascertain the potential of political uncertainty as the underlying source of asymmetries in the response of monetary policy to output and inflation, we also extended the variance decomposition analysis on the asymmetric response of monetary policy to include the role of political uncertainty captured exogenously. For a contractionary monetary policy for example, the empirical report in Table 6 seems to suggest that the magnitude of the response is comparatively higher for shocks due to output when political uncertainty was captured as the underlying source of the asymmetries in monetary policy. For an expansionary monetary policy however, the decomposition of the variance is rather higher for shocks due to inflation. This among others, further confirms the robustness of our earlier findings thus pointing out the consistency of the empirical estimates obtained from impulse –response function and that of variance decomposition function.

Table 6: Asymmetric –based variance decomposition with the role of uncertainty

Period	Contractionary Monetary Policy			Expansionary Monetary Policy		
	S.E	Shock1 (g_t)	Shock2 (π_t)	S.E	Shock1 (g_t)	Shock2 (π_t)
1	0.0535	1.0420	0.0115	0.0534	0.0073	0.6287
2	0.0548	1.3334	0.0708	0.0547	0.3020	0.5602
3	0.0548	1.3911	0.1379	0.0548	0.3226	1.1430
4	0.0549	1.4210	0.1908	0.0548	0.3336	1.7243
5	0.0549	1.4377	0.2308	0.0548	0.3376	2.1931
10	0.0549	1.4694	0.3261	0.0548	0.3425	3.3411

5.0 CONCLUSION

The appeal to further enrich the literature with insights on the role of uncertainties as the underlying source of asymmetries in monetary policy reaction function was motivated by the widespread assertion that monetary policy is made in an environment of substantial uncertainty regarding the current and future economic conditions as well as the functioning of the economy. Essentially, we improved on the study of Olayiwola & Ogun (2019) by considering an augmented nonlinear SVAR model (i.e. SVAR-X) to exogenously accommodate the role of political uncertainty as fixed regressor in a three variable monetary policy reaction function of the Taylor's rule. Garnered from the empirical finding is an indication that monetary policy exhibits greater sensitivity to shocks due to output growth than they do to shocks due to inflation in recession periods, while the reverse appears to be the case for a contractionary monetary policy. We also find the asymmetric response of monetary policy to changes in output and inflation as relatively more pronounced when we control for political uncertainty as the underlying source of asymmetries. It is, therefore, recommended that monetary policy action(s) in Nigeria must henceforth take cognizant of not only the effectiveness or otherwise of monetary policy instruments, but also the fact that policy instruments such as expansionary and contractionary monetary policies are not likely to react in the same direction to shocks due to output growth and inflation, particularly in the context of political uncertainty.

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THE DEMAND FOR MONEY IN NIGERIA: A VAR/VECM APPROACH

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ABSTRACT

This paper examines the determinants of the demand for money in Nigeria during the years spanning 1981 through 2017. In order to fully account for feedbacks, a VAR/VECM regression model is utilized. The empirical results show that there is a stable, long- run relationship between the real demand for money, real income, the rate of interest and inflation. The variance decomposition results show that the predominant sources of variations in Nigeria's demand for money are due largely to "own shocks" and real GDP innovations. The interest rate and inflation apparently have only weak influence on the demand for money, presumably due to under-development of the money market. The study therefore recommends greater attention to developing the money market in Nigeria with the aim of making monetary policy more efficacious.

Key words: Demand for money, real income, interest rate, vector auto regressions (VAR), vector error correction model (VECM), Nigeria

JEL: E41, E43, E51, C13, C40

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1.0 INTRODUCTION

Demand for money plays a vital role in macroeconomic analysis, especially in selecting appropriate monetary policy actions. A stable money demand function is a core aspect of monetary policy formulation, (Sriram, 1999). Also, a good understanding of the demand for money and its main determinants is important in the conduct of monetary policy, (Goldfeld, 1994). Hence, the specification and analysis of an appropriate demand for money function is vital for monetary authorities in determining the optimal quantity of money to be supplied in the economy at any given time, to ensure macroeconomic stability. It is important to examine the determinants and stability of money demand, as well as, understand the transmission mechanism of monetary policy in the economy since the effectiveness of monetary policy implicitly assumes a stable money demand function. (Epaphra, 2017; Dritsaki and Dritsaki, 2012).

The demand for money is an important link between monetary policy and the real sector of an economy; hence the level and stability of the demand for money have received enormous attention by economists, researchers and policy makers in developed and developing countries. As a result, modelling, estimating and examining the determinants and stability of money demand function in the economy has continued to be a fertile area for research (see for example, Iyoha, 1976; Ajayi, 1977; Arinze et al., 1985; Nwaobi, 2002; Anoruo, 2002; Valadkhan et al., 2003; Nwafor et al., 2007; Owoye and Onafowora, 2007; Azim et al., 2010; Kumar, et al., 2010; Bitrus, 2011; Doguwa et al., 2014; Bassey et al., 2017; Epaphra, 2017).

For instance, Iyoha (1976) estimated the demand for money equation for Nigeria from 1950 – 1965, using linear and log-linear specifications. The result indicates that current real income predicts demand for real balances than permanent (real) income during the period of study. Ajayi (1977) used time series data from 1960-1970 to ascertain the determinants of money demand in Nigeria and employed OLS estimation technique. The result reveals that demand for money is inelastic with respect to income and price changes expectation. Arinze et al (1985) estimated demand for money equation for Nigeria from 1960 to 1983, using OLS technique. The result shows that income and expected inflation affect the demand for money. Nwaobi (2002) examined the determinants of the demand for money in Nigeria from 1960 to 1995, using the VAR approach, and finds income to be a suitable scale variable. Owoye et al (2007) identified more efficient proxies for opportunity cost of holding money in Nigeria, like expected exchange rate depreciation and equity yield, using OLS/ECM methodology. The result shows that real broad money, inflation rate, real income,

interest rate, and foreign interest rate determine the demand for money during the period of study, from 1986-2001. Bitrus (2011) examined the demand for money in Nigeria using the OLS method for data covering the period 1985 to 2007. The result indicates that income is the most significant determinant of the demand for money, and the money demand function is stable. Iyoboyi et al (2013) estimated a narrow money demand function for Nigeria during 1970 to 2010, using autoregressive distributed lag bounds test approach to cointegration. The results reveal the existence of cointegrating relationship among narrow money demand, real income, short term interest rate, real expected exchange rate, expected inflation rate and foreign real interest rate. Also, real income and interest rate were found to be significant variables explaining the demand for money in Nigeria. Bassey et al (2017) used the liquidity preference to determine the demand for money in Nigeria during the period 1986 to 2013. The result reveals that real income, interest rate and expected inflation rate are the major determinants of money demand. Apere et al., (2014) adopted the partial adjustment model and the OLS technique to analyze the long-run and short-run demand for real money balances in Nigeria using data from 1971 to 2012. The results indicate that real income and interest rate are important determinants of real money balances in Nigeria. These results are similar to that of Bassey et al (2012), Nduka et al (2013), and Doguwa et al., (2014).

Similar results were obtained from the study for other countries. For example, Valadkhan et al (2003) examined the major determinants of the demand for real money balances in eight developing countries, using seemingly unrelated regression estimation technique for the period 1979 to 1999. The results reveal that the demand for money is positively related to real income and negatively related to interest rate, inflation rate and the US long-term interest rate. Azim et al (2010) estimated a dynamic demand for money in Pakistan employing autoregressive distributed lag (ARDL) approach and cointegration analysis using data from 1973 to 2007. Their result shows a unique cointegrated long-run relationship among money demand, income, inflation rate, and exchange rate. Epaphra (2017) examines the determinants of demand for money and its stability in Tanzania, using Johansen cointegration, vector autoregressive and vector error correction model (VAR-VECM), and variance decomposition for the period 1966 to 2015. The cointegration results reveal the existence of long-run relationship between real money balances and the explanatory variables, namely, real GDP, deposit interest rate, real exchange rate, and inflation rate. The VECM result show that the demand for real money balances is positively related with real GDP and real exchange rate, but inversely related to interest rate and inflation rate.

The determinants of money demand include income or GDP, interest rate, inflation rate, return on foreign assets, degree of openness, financial innovations on the economy, exchange rate, etc. Variables such as expected exchange rate depreciation and equity yield have emerged as useful proxies for the opportunity cost of holding money in money demand models for Nigeria (see for example Bassey et al. (2017); Owoye and Onafowora (2007); and Yamden (2011). Virtually all the studies found income as a determinant of the demand for money in Nigeria. They, however, differed on interest rate. Some of the studies found interest to be insignificant and they defended this finding by arguing that the hugely underdeveloped financial market and the attendant dearth of alternative financial assets provided credence to the result. (Yamden, 2011; Tule et. al., 2018).

The mixed conclusions on the determinants of money demand in different economies might be attributed to the fact that the factors that affect money demand vary in accordance to the realities of different economies. Darrat (1986) and Adam (1992) show that monetary aggregates are stable in African countries and hence support the perspective favouring monetary targeting by central banks. Thus, central banks in many developing economies have switched towards monetary policies directed at the interest rate (Kumar, et al., 2013). According to Kumar et al. (2013), this policy switching is mainly grounded on the view that financial market reforms and liberalization might have contributed to the instability in money demand functions. However, other studies raise concern about the validity and strength of central bank interest rate targeting in developing economies (see for example Bahmani-Oskooee & Rehman, 2005; Rao et al., 2009; Rao & Kumar, 2009a and 2009b).

These important controversies in the findings call forth a further investigation with recent data and methods, to explore the determinants of money demand function and the extent to which variables such as real GDP, inflation rate, and deposit interest rate determine the demand for real money balances. In this perspective, it is important to examine the determinants of the real money demand in Nigeria covering data spanning from 1981 to 2017.

In this paper, an attempt is made to contribute to the important subject of the determinants of the demand for money in Nigeria using the technique of vector auto-regressions (VAR) and vector error correction model (VECM, a restricted VAR model). The main advantage of using the vector auto regression technique is that it permits us to analyse the dynamic effects of the interrelationships that exist between demand for money and real income, and between demand for money and other key

macroeconomic variables like interest rate and inflation. In particular, vector auto regressions enable us to analyze the dynamic impacts of the multivariate system using the forecast error variance decompositions and the impulse response functions, as well as Granger Causality. The empirical results of this paper are expected to contribute to the on-going debate concerning the robust determinants of money demand and optimal monetary policies.

The rest of the paper is structured thus: section two reviews existing literature, while section three examines the theoretical framework and methodology, Section 4 presents and analyses the empirical results and section 5 concludes the paper.

2.0 REVIEW OF LITERATURE

2.1 Theoretical Literature

Money demand theories have evolved overtime. This section briefly discusses the theories and models of demand for money. Fisher (1911) provides the earliest quantity theory of money demand through the equation of exchange. He argues that the demand for money is solely a function of income, and assumes that money supply is exogenous and the income velocity of money is constant, as a result, the demand for money is stable. The most important feature of this theory is its suggestion that interest rates have no effect on the demand for money. In the long run, the price level depends upon the quantity of money in the economy, and the relationship is direct and proportional, (see Fisher's equation of exchange, Fisher, 1911) and Cambridge approach, Pigou, 1917; Marshall, 1923). However, it is worth noting that the concept of money holdings started to take a formal shape in the quantity theory by Pigou (1917). The neoclassical theory postulates that the primary role of money is seen as a medium of exchange, and interest rate does not play any role in determining the demand for money, (Marshall, 1926; McCallum and Goodfriend, 1987). In contrast, Lavington (1921), Fischer (1930), and Hicks (1935) argue that interest rate plays an important role in influencing the demand for money. In the classical theory, money is held for transaction purposes or seen as a medium of exchange, store of value, unit of account, and means of deferred payment. Money is perceived to be 'neutral', that is, it does not influence the determinants of relative prices, real interest rates, equilibrium quantities of commodities, and hence, aggregate income (Sriram, 1999).

In another development, Keynes (1936) develops the liquidity preference theory of money demand. Laidler (1977) averred that this was the most important innovation in the theory of demand for money. The general argument under liquidity preference is

that people hold money for transaction, precautionary and speculative motives and, money demand depends on income and interest rate. The speculative theory suggests an inverse relationship between money demand and the rate of interest, thus, individuals would like to optimize the amount of money they hold by weighing the interest rate viz-a-viz the cost of being illiquid. (Dornbusch and Fischer, 1990). Similarly, inventory theories of money demand (Baumol, 1952; and Tobin, 1956) hypothesize that transaction demand for money is positively associated with income but inversely related to nominal interest rate earned on alternative assets. In other theories, for example portfolio theories of money demand, money is treated like any other asset and therefore assets' demand theory is used to derive the money demand theory. Since money offers different combination of risk and return than other assets, people hold money as part of their portfolio of assets.

The portfolio theory of the demand for money was developed by Friedman (1956) and Tobin (1958). According to Friedman (1956) velocity of money is highly predictable and that the demand for money function is highly stable and insensitive to interest rates. This implies that the quantity of money demanded can be predicted accurately by the money demand function (Kumar et al., 2013). At a lower rate of interest or rate of return on bonds, individuals will hold more money and fewer bonds in their portfolio. On the other hand, the increase in the rate of interest or rate of return on bonds, will attract wealth holders to hold a greater fraction of their wealth in bonds and thus reduce their holding of money. In addition, since the size of wealth determines the amount of the portfolio to be allotted between money and the alternative assets, demand for money is also a function of wealth (Jammeh, 2012). This is also in tandem with the cash balance approach which postulates the role of wealth and the interest rate in determining the demand for money, and the overlapping generations models that ignore the role of money as a medium of exchange, but emphasize only the asset role of money, that is, the store of value function. (Wallace, 1977, 1988; Sargent and Wallace, 1982).

One of the most appealing insights of these models is that the income and interest elasticity of money demand are constant. Thus, income elasticity and interest elasticity are the key parameters for determining the demand for money. ((Barro and Fischer, 1976; Akerlof, 1999; Cuthbertson and Barlow, 1991).

2.2 Empirical Literature

The earliest studies on the demand for money in Nigeria were; Tomori (1972), Ajayi (1974), Teriba (1974), Ojo (1974), and Odama (1974). This is referred to as the TATOO

debate which focused on the determinants, their relative importance and the stability of the demand for money in Nigeria. (TATOO is simply a coinage of the first letters of the last names of the pioneers (Tomori, Ajayi, Teriba, Ojo and Odama). These scholars intensely debated the determinants, their relative importance and the stability of the demand for money in Nigeria, including Iyoha (1976). Virtually, all the studies found income as a major determinant of the demand for money in Nigeria. However, they differed on the role of interest rate. While some of the studies found interest rate to be an important determinant of demand for money, others like Yamden (2011) and Tule et. al. (2018), found it to be insignificant and they defended this finding by arguing that the hugely underdeveloped financial market and the attendant dearth of alternative financial assets provided credence to the result.

A plethora of studies has been carried out to examine the demand for money in the literature. A lot of these studies posited a stable co-integrating relationship between real money balance and its determinants. (see for example Epaphra, 2017; Doguwa et al., 2014; Nduka et al., 2013; Yamden, 2011; Bitrus, 2011; Azim et al., 2010; Owoye et al., 2007; Nwafor et al., 2007; Valadkhani et al., 2003; Nwaobi, 2002; Anoruo, 2002; Adam et al., 2001; and Darrat, 1986.

In particular, Epaphra (2017) examined the determinants of demand for money and its stability in Tanzania, using Johansen cointegration, vector autoregressive and vector error correction model (VAR-VECM), and variance decomposition for the period 1966 to 2015. The cointegration results reveal the existence of long-run relationship between real money balances and the explanatory variables, namely, real GDP, deposit interest rate, real exchange rate, and inflation rate. The VECM result shows that the demand for real money balances is positively related with real GDP and real exchange rate, but inversely related to interest rate and inflation rate. Bassey et al., (2017) used the liquidity preference to determine the demand for money in Nigeria during the period 1986 to 2013. The result reveals that real income, interest rate and expected inflation rate are the major determinants of money demand. Apere et al., (2014) adopted the partial adjustment model and the OLS technique to analyze the long-run and short-run demand for real money balances in Nigeria using data from 1971 to 2012. The results indicate that real income and interest rate are important determinants of real money balances in Nigeria. Doguwa et al (2014) employed the Gregory and Hansen residual based test cointegration method, using quarterly data for 1992 to 2013, and focused on the impact of financial crisis on the money demand function. The result provides evidence of a stable money demand function. Iyoboyi et al (2013) estimated a narrow money demand function for Nigeria during 1970 to 2010, using

autoregressive distributed lag bounds test approach to cointegration. The results reveal the existence of cointegrating relationship among narrow money demand, real income, short term interest rate, real expected exchange rate, expected inflation rate and foreign real interest rate. Also, real income and interest rate were found to be significant variables explaining the demand for money in Nigeria. Bitrus (2011) examined the demand for money in Nigeria using the OLS method for data covering the period 1985 to 2007. The result shows that income is the most significant determinant of the demand for money, and the money demand function is stable. Azim et al (2010) estimated a dynamic demand for money in Pakistan employing autoregressive distributed lag (ARDL) approach and cointegration analysis, using data from 1973 to 2007. The result shows a unique cointegrated long-run relationship among money demand, income, inflation rate, and exchange rate. Kumar et al (2010) utilized the ECM approach to estimate the demand for money for Nigeria from 1960 – 2008. The result reveals a stable demand for money function, and suggest that targeting monetary aggregates (M2) is key to boosting economic activity, and hence, a viable monetary policy instrument in Nigeria

Nwafor et al (2007) applied cointegration test for time series data covering the period 1986 to 2005 to determine the stability of money demand in Nigeria. The results reveal that money demand function is stable and established cointegration among the series. Owoye et al (2007) identified more efficient proxies for opportunity cost of holding money in Nigeria, like expected exchange rate depreciation and equity yield, using OLS/ECM methodology. They reported co-integration among real broad money, inflation rate, real income, interest rate, and foreign interest rate. Also, the result show that a stable demand for money exist during the period of study. Valadkhan et al (2003) examined the major determinants of the demand for real money balances in eight developing countries, using seemingly unrelated regression estimation technique for the period 1979 to 1999. The results reveal that the demand for money is positively related to real income and negatively related to interest rate, inflation rate and the US long-term interest rate. Nwaobi (2002) examined the determinants of the demand for money in Nigeria from 1960 to 1995, using the VAR approach. The results show that income is a suitable scale variable for the demand for money during the period of study. Anoruo (2002) utilized data for the period 1986–2000 for Nigeria, and examined the stability of money demand during and after SAP. He finds cointegration among M2, income, real discount rate, and concludes that M2 is a viable monetary policy tool to stimulate economic activity in Nigeria. These results are similar to that of Bassey et al (2012), and Nduka et al (2013). Arinze et al (1985) also estimated demand for money

equation for Nigeria from 1960 to 1983, using OLS technique. The result reveal that income and expected inflation affect the demand for money.

However, Ajayi (1977) and Adejugbe (1989) find an unstable relationship between the demand for money and the determinants. The determinants of money demand include income or GDP, interest rate, inflation rate, return on foreign assets, degree of openness, financial innovations on the economy, and exchange rate. Variables such as expected exchange rate depreciation and equity yield have emerged as useful proxies for the opportunity cost of holding money in money demand models for Nigeria (see for example Owoye and Onafowora (2007) and Yamden (2011).

3.0 THEORETICAL FRAMEWORK AND METHODOLOGY

Money demand is positively related to income and inversely related to interest rate or rate of return on earning assets, (Valadkhan et al., 2003). Further, implicitly, the liquidity preference function captures the effect of inflation on the demand for money. Fisher (1930) hypothesized that the nominal interest rate in any period is equal to the sum of the real interest rate, and the expected rate of inflation. This is referred to as the 'Fisher Effect', which postulates a one-to-one relationship between expected inflation and nominal interest rates, with real interest rates being unrelated to the expected rate of inflation, and determined entirely by the real factors in the economy, such as the productivity of capital and investor time preference. But the Keynesian money demand captures the effect of inflation on real money demand.

Both inflation rate and interest rate are cost of holding money. In this case, the demand for real money balances also depends negatively on the expected rate of inflation. Hence, demand for real money balances is an increasing function of income and a decreasing function of both interest rate and expected rate of inflation. However, a problem arises due to lack of any direct measure of the expected rate of inflation. For this reason, a proxy variable for inflationary expectations is employed. Some studies utilise some form of distributed lag on past inflation rates as a proxy for inflationary expectations (see for example Cagan, 1956; Meiselman, 1962; Sargent, 1969; and Gibson, 1970).

According to Friedman (1956), money demand function assumes that there is a stationary long-run equilibrium relationship between money balances, real income, and the opportunity cost of holding real money balances that formulate the demand for money function. The explanation is that the demand for real money balances is positively related with permanent income. Higher wealth implies larger portfolio.

Equally important, the incentive to hold money depends on the attractiveness of bonds, stocks and goods assets compared to holding money. These assets measure the opportunity cost of holding money. Thus, expected returns on these assets are negatively related to the demand for real money balances.

3.1 The Model and choice of Variables

Narrow money (M1) consists of those assets that are readily available and transferable in every day transactions. This includes currency in circulation plus demand deposits. Broad money (M2) is made up of wide range of assets with portfolio opportunity to holders of such assets. In other words, it contains less liquid assets like time deposits, savings as well as, M1.

Narrow money is more amenable to control by monetary authorities (Goldfield, 1973; Mehra, 1992; Moosa, 1992; Ramos-Francia, 1993; Hossain, 1994). But the use of broad money is better because it yields a stable money demand function (Laidler, 1966), and is suitable for evaluating long run economic impact of any change in monetary policy (Hafer and Jansen, 1991). Also, there is the fact that narrow money, though easier to control, is not very useful in policy issues. (Ericsson and Sharma, 1996). As for the scale variables like income or GDP, interest rate, and inflation, the relationship between money demand and inflation is negative, but increases with real assets. So, economic agents can switch from holding cash balances to real assets during inflationary periods. Also, we include nominal interest rate to capture the variations in the expected rate of inflation, especially where moderate inflation prevails in an economy (Heller and Khan, 1979). To summarize, the opportunity cost of holding money include own-rate of money and return on alternative assets for money, which include return on domestic financial and real assets, proxied by expected inflation rate.

3.2 Methodology

In recent years, researchers have started to study the determinants of the demand for money by using the powerful technique of vector auto regressions (VARs) pioneered by the Nobel Laureate, Christopher Sims (1986). Also, see Nwaobi (2002) and Weliwita and Ekanayake (1998). The VAR technique is attractive because it facilitates the study of the interrelationship among time-series variables, treating all as endogenous. VARs have also been shown to be powerful for time-series forecasting, for the analysis of short-run and long-run dynamics, impulse response functions, and forecast error variance decomposition. This study has therefore opted to adopt this versatile tool by employing VECM (a restricted VAR model) to investigate the determinants of the demand for money in Nigeria.

In particular, the study carries out Unit roots tests of all variables and Granger Causality Tests. Additionally, Forecast Variance Decomposition is applied to closely examine the interrelationships between the variables in the VAR/VECM system. This study posits a four variable VAR/VECM model in which the demand for money, real gross domestic product, interest rate and the inflation rate are simultaneously interrelated. Thus, the model specified is:

$$V_t = \alpha + \sum_{i=1}^{k} A_i V_{t-1} + U_t$$

V_t = (MD/P, Y/P, INTR, INFL), is the vector of MD/P (nominal stock of money divided by price), Y/P (nominal GDP divided by price), INTR (the nominal rate of interest) and INFL (the rate of change of the price level}.

a = intercepts of autonomous variables.

A_i = matrix of coefficients of all the variables in the model.

V_{t-1} = vector of the lagged variables.

U_t = vector of the stochastic error terms.

This study employs annual time series data on money stock, nominal GDP, prices, interest rate and inflation rate for the period from 1981 through 2017. The data set used was sourced from various issues of the Central Bank of Nigeria Statistical bulletin and estimated with Eviews 9.0 econometric software.

4.0 EMPIRICAL RESULTS

Below we present the descriptive statistics, unit root tests, Johansen co-integration test, Granger Causality Tests, and Forecast Error Variance Decomposition results for this study. The unit root test provides information on the stationarity properties of the variables and it was conducted using the Augmented Dickey- Fuller (ADF) test. The co-integration test provides information on the existence of a long run relationship between the dependent and explanatory variables. The Granger causality test examines the causal relationships between the real demand for money, real income, interest rate and inflation rate in Nigeria. To analyse the short-run dynamic properties of the variables, we employ the forecast error variance decomposition analysis.

Table 1: Descriptive Statistics

	MD/P	Y/P	INTR	INFL
Mean	3219.526	931.5872	7.439	25.19496
Median	393.0788	444.649	5.33	20.09029
Maximum	41664.54	3080.317	18.8	65.71668
Minimum	9.9153	153.076	1.4105	-4.976077
Std. Dev.	7176.113	921.5633	5.0899	20.3996
Skewness	4.351712	1.199187	0.76397	0.500841
Kurtosis	23.60272	2.915807	2.20574	2.084935
Jarque-Bera	771.1753	8.878904	4.57174	2.837761
Probability	0	0.011802	0.101686	0.241985
Sum	119122.5	34468.73	275.2446	932.2134
Sum Sq. Dev.	1.85E+09	30574043	932.6647	14981.17
Observations	37	37	37	37

Source: Authors' computation using Eviews 9.0

Summary descriptive statistics of MD/P, Y/P, INTR and INFL are reported in Table 1. Normality test uses the null hypothesis of normality against the alternative hypothesis of non-normality. If the probability value is less than the Jarque-Bera chi-square at the 5% level of significance, the null hypothesis of the regression is not rejected. All the variables are normally distributed since all the probabilities are less than the Jarque-Bera chi-square distribution.

Table 2: Correlation Matrix

	MD/P	Y/P	INTR	INFL
MDP	1	0.578606	-0.361208	0.3719126
YP	0.578606	1	-0.637426	0.7053257
INTR	-0.361208	-0.637426	1	-0.157526
INFL	0.3719126	0.7053257	-0.157526	1

Source: Authors' computation using Eviews 9.0

Table 2 displays the results of the pairwise correlation matrix. An examination of the contents of Table 2 shows that all the coefficients are within the standard range. All the correlation coefficients exhibit the expected signs.

Unit Roots Test Results

Table 3: Augmented Dickey Fuller Unit Roots Test Results

Augmented Dickey Fuller at levels					Augmented Dickey Fuller at first difference			
Variables	**ADF test statistics**	**95% ADF test**	**Order of integration**	**Remarks**	**ADF test statistics**	**95% ADF test**	**Order of integration**	**Remarks**
MD/P	3.199	-2.975	I(0)	Non-stationary	11.452	-2.976	I(1)	Difference Stationary
Y/P	-0.365	-2.946	I(0)	Non-stationary	-5.319	-2.948	I(1)	Difference Stationary
INTR	-1.013	-2.945	I(0)	Non-stationary	-6.097	-2.948	I(1)	Difference Stationary
INFL	-2.163	-2.163	I(0)	Non-stationary	-3.880	-2.948	I(1)	Difference Stationary

Source: Authors' Computation using Eviews 9.0

Testing for the stationarity of variables cannot be downplayed when analyzing macroeconomic time series data. The unit root tests presented in Table 3 reveal that real demand for money, real gross domestic product, interest rate and inflation rate are all stationary after first differencing. Thus, they are all integrated of order 1, that is, they are I(1) variables. The uniformity of the order of integration after first difference implies that the unit root test results provide the rationale for conducting the Johansen Co-integration test.

Table 4: Johansen Co-Integration Test

Unrestricted Cointegration Rank Test (Trace)

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None *	0.689862	80.74876	47.85613	0.0000
At most 1 *	0.515192	40.94362	29.79707	0.0018
At most 2 *	0.334018	16.32756	15.49471	0.0374
At most 3	0.071077	2.506804	3.841466	0.1134

Trace test indicates 3 cointegrating eqn(s) at the 0.05 level; * denotes rejection of the hypothesis at the 0.05 level

**MacKinnon-Haug-Michelis (1999) p-values

Unrestricted Cointegration Rank Test (Maximum Eigenvalue)

Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	0.05 Critical Value	Prob.**
None *	0.689862	39.80514	27.58434	0.0008
At most 1 *	0.515192	24.61606	21.13162	0.0155
At most 2	0.334018	13.82075	14.26460	0.0587
At most 3	0.071077	2.506804	3.841466	0.1134

Max-eigenvalue test indicates 2 cointegrating eqn(s) at the 0.05 level; * denotes rejection of the hypothesis at the 0.05 level

**MacKinnon-Haug-Michelis (1999) p-values

The Johansen tests for co-integration entail both the trace and maximum eigen values of the unrestricted co-integration ranks. This leads to a rejection of the hypotheses of no co-integrating equations by at least two of the absolute values of the trace and maximum eigen statistics greater than their respective critical values at 5 percent significant level. (See table 4 above). This implies that real demand for money, real GDP, interest rate and inflation are co-integrated. This finding confirms the existence of a long-run relationship among the aforementioned variables, and that any divergence in their respective behavior in the short run will disappear in the long run. Given that the variables are co-integrated, use of VECM is now indicated.

VAR Estimates

The vector auto regression estimates enable us to examine the behavioral and technical disposition of the various variables in their respective period lags - in this case, 1 to 2 period lags - using the Ordinary Least Square techniques to examine each of the equations in their Unrestricted VAR nature, and drawing out various diagnostic statistics for policy analysis. (See Table 5 below). Results of the VAR Granger Causality/Block Exogeneity Wald tests are reported in Appendix II.

Table 5: VAR results

Sample (adjusted): 1983 – 2017; Included observations: 35 after adjustments
Standard errors in ( ) & t-statistics in [ ]

	MD/P	Y/P	INTR	INFL
MDP(-1)	4.359763	-0.166238	-0.000291	0.003251
	(1.15390)	(0.06766)	(0.00075)	(0.00318)
	[3.77828]	[-2.45701]	[-0.38861]	[1.02333]
MDP(-2)	0.284656	0.396834	-0.000384	-8.15E-06
	(1.76640)	(0.10357)	(0.00114)	(0.00486)
	[0.16115]	[3.83148]	[-0.33515]	[-0.00167]
YP(-1)	-8.828526	0.453393	0.000140	0.006725
	(2.52941)	(0.14831)	(0.00164)	(0.00696)
	[-3.49035]	[3.05705]	[0.08546]	[0.96570]
YP(-2)	-0.383979	-0.267653	0.003079	-0.007299
	(2.60284)	(0.15262)	(0.00169)	(0.00717)
	[-0.14752]	[-1.75377]	[1.82573]	[-1.01850]
INTR(-1)	250.5214	-7.155012	0.828924	0.655560
	(278.257)	(16.3154)	(0.18031)	(0.76611)
	[0.90032]	[-0.43854]	[4.59727]	[0.85570]
INTR(-2)	-98.73958	-24.09934	0.187050	0.417832
	(323.843)	(18.9884)	(0.20985)	(0.89162)
	[-0.30490]	[-1.26916]	[0.89136]	[0.46862]
INFL(-1)	-81.20592	11.05566	0.030035	1.075750
	(67.1262)	(3.93591)	(0.04350)	(0.18481)
	[-1.20975]	[2.80892]	[0.69051]	[5.82070]
INFL(-2)	83.83948	-6.511404	-0.078610	-0.510960
	(62.2723)	(3.65130)	(0.04035)	(0.17145)

	[1.34634]	[-1.78331]	[-1.94812]	[-2.98022]
C	335.8573	505.7076	-0.482401	-4.145342
	(1855.12)	(108.774)	(1.20210)	(5.10760)
	[0.18104]	[4.64915]	[-0.40130]	[-0.81160]
R-squared	0.874984	0.974166	0.896647	0.884025
Adj. R-squared	0.836517	0.966217	0.864846	0.848341
Sum sq. resids	2.29E+08	787447.8	96.17343	1736.216
S.E. equation	2968.052	174.0300	1.923273	8.171751
F-statistic	22.74657	122.5523	28.19571	24.77340
Log likelihood	-324.3091	-225.0339	-67.35194	-117.9849
Akaike AIC	19.04623	13.37337	4.362968	7.256278
Schwarz SC	19.44618	13.77331	4.762914	7.656224
Mean dependent	3402.922	942.8853	7.478417	25.20545
S.D. dependent	7340.659	946.8343	5.231510	20.98365
Log likelihood		-725.3030		
Akaike information criterion		43.50303		
Schwarz criterion		45.10282		
Number of coefficients		36		

Source: Authors' computation using Eviews 9.0.

The results of the estimates of a single equation in the unrestricted VAR with real demand for money being the dependent variable revealed that the one period lagged value of the dependent variable and the one period lagged value of real income were individually significant at 5 percent significance level, while those of interest rate and inflation were statistically insignificant.

The results of the estimates of a single equation in the unrestricted VAR with real income as the dependent variable revealed that the one period lagged value of the dependent variable, the two period lagged value of real demand for money and the one period lagged value of inflation were statistically significantly different from zero at the 5 percent level. However, the coefficient of the rate of interest was statistically insignificant.

The results of the estimates of a single equation in the unrestricted VAR with the rate of interest as the dependent variable showed that the one period value of the dependent variable was statistically significant at 5 per cent level. However, the coefficients of real demand for money, real income and inflation were not found to be significant at any lag.

The results of the estimates of a single equation in the unrestricted VAR with inflation as the dependent variable revealed that the values of the one period and two period lagged dependent variables, as well as real income for one period lagged were statistically significant at 5 percent. However, the coefficients of real demand for money and interest rate were found to be insignificant at all lags.

Generally, the variables are all collectively significant at 5 percent significant level, although real income was found to be the main determinant of real demand for money in Nigeria. The results also show that the independent variables explained over 87 percent of the systematic variation in the dependent variables within the period under review.

Forecast Error Variance Decomposition Test

The estimates of the forecast error variance decomposition (FEVD) for all the variables during a 10-year horizon are reported in Table 6. The FEVDs of the respective variables enable us to examine the short run dynamical properties of the variables, showing the share of FEVD for each variable that is attributed to its own innovations or shock, and to innovations or shocks in the other variables.

Table 6: Forecast Error Variance Decompositions Estimates

Variables	Quarters	MD/P	Y/P	INTR	INFL
	1	| 100.0000	0.000000	0.000000	0.000000
	5	| 98.27613	1.276344	0.205909	0.241616
FEVD of MD/P	10	| 98.26997	1.278704	0.208583	0.242742
	1	| 13.18572	86.81428	0.000000	0.000000
	5	| 98.09801	1.357368	0.261998	0.282623
FEVD of Y/P	10	| 98.26990	1.278705	0.208638	0.242756
	1	| 4.169286	0.011482	95.81923	0.000000
FEVD of INTR	5	| 98.32366	1.336216	0.146338	0.193785

	10	| 98.26999	1.278741	0.208544	0.242727
	1	| 27.34265	0.604171	1.704841	70.34833
	5	| 98.28208	1.236619	0.236800	0.244493
FEVD of INFL	10	| 98.26995	1.278697	0.208581	0.242747

Source: Authors' computation using E-views 9.0.

Consider Table 6 which gives the forecast error variance decomposition of the four variables in the VAR system. An examination of the contents of Table 6 shows that the amount of variation experienced in real demand for money (MD/P) is largely accounted for by its "own shock" which is as high as 100% in the first period and falls slightly to 98.2% at the end of the 10-year time horizon. The proportion of variation in the shocks accounted for by real income (Y/P), interest rate (INTR) and inflation (INFL) are minor and range between 0% to1.28%, 0% to 0.21%, and 0% to 0.24% respectively.

The forecast error variance of real income is largely dependent on its "own innovations" which accounts for about 86.8% at the beginning of the period but then declines precipitously to approximately 1.3 % at the end of the time horizon. Similarly, the variations in the shocks accounted for by MD/P, INTR and INFL range between about 13 and 98%, 0% and 0.2%, and 0% 0,2% respectively during the horizon. Thus, a substantial proportion of the variation in real income results from its own shock in the first year of the horizon but then fades away during the horizon with real demand for money picking up the slack.

The forecast error variance decomposition in INTR is substantially attributable to the variation in its "own shock" which amounts to 95.8% at the beginning of the period and falls steeply to 0.2% at the end of the time horizon. The other proportion of the innovations is sourced from the variations in the MD/P accounting for about 4.2% at the beginning of the period and rising to 98.3% at the end of the time horizon.

Finally, the forecast error variance decomposition in inflation (INFL) is attributed largely to the contribution of "own shock" of about 70.3% at the start of the period which sharply declined to approximately 2.4% at the end of the time horizon. We note that a reasonable proportion of the innovations in INFL is sourced from the variations in MD/P and INTR. Indeed, the contribution by MD/P rose from 27.3% at the beginning of the period to a high of approximately 98.3% at the end of the period. In sum, the results show that the predominant proportion of variations in the inflation rate is accounted for by its "own shock" and largely by variations in the shock of MD/P while only

marginally explained by the variations in the shock of the other variables. See Appendix I for graphical representations.

5.0 SUMMARY AND CONCLUSION

In this paper, an attempt has been made to contribute to the important subject of the determinants of the demand for money in Nigeria using the technique of vector error correction modelling, which is a restricted vector auto-regression model. A main advantage of using the vector auto regression technique is that it permits us to analyse the dynamic effects of the interrelationships that exist between demand for money and real income, and between demand for money and other key variables like interest rate and inflation. In particular, vector auto regressions enable us to analyze the dynamic impacts of the multivariate system using the forecast error variance decompositions and the impulse response functions. The empirical results showed that the predominant sources of the variations in demand for money are attributable to its "own shocks" as well as those of income, interest rates and inflation. The predictability of demand for money is found to be good and reliable for policy making. Summarily, it was found that real income is one of the main determinants of the demand for money in Nigeria while the interest rate and inflation were found to be weak determinants of demand for money. The finding of a weak influence of interest rates on the demand for money is similar to earlier results by Adekunle (1968) and Iyoha (1976). Clearly, this suggests the urgent need for reforms to widen and deepen the money market in Nigeria in order to improve the efficacy of monetary policy. It is to be hoped that successful reform of the money market would enhance the role of monetary policy as a key driver of economic growth in Nigeria.

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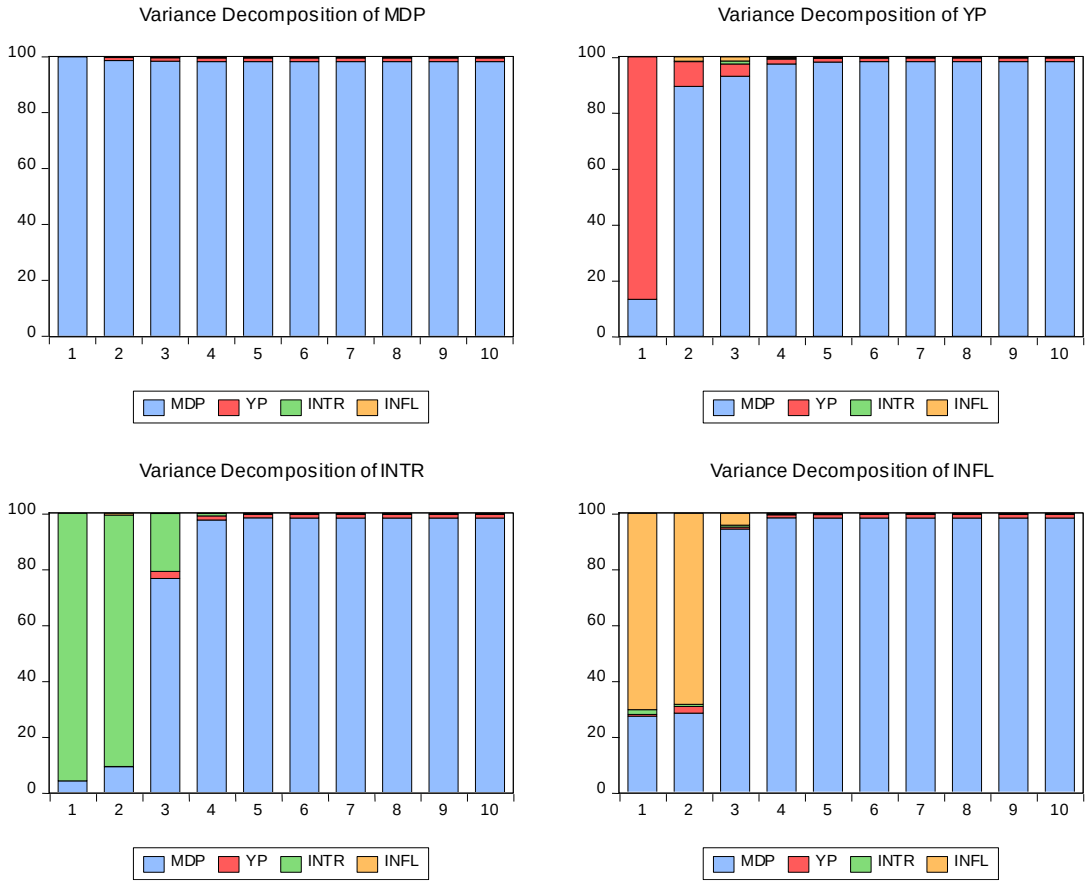
APPENDIX I

Variance Decomposition using Cholesky (d.f. adjusted) Factors



APPENDIX II

VAR Granger Causality/Block Exogeneity Wald Tests
Date: 03/29/20 Time: 19:52
Sample: 1981 2017
Included observations: 35

Dependent variable: MDP

Excluded	Chi-sq	df	Prob.
YP	15.42574	2	0.0004
INTR	1.412817	2	0.4934
INFL	1.968907	2	0.3736
All	23.90980	6	0.0005

Dependent variable: YP

Excluded	Chi-sq	df	Prob.
MDP	18.76063	2	0.0001
INTR	8.537474	2	0.0140
INFL	7.926574	2	0.0190
All	54.71321	6	0.0000

Dependent variable: INTR

Excluded	Chi-sq	df	Prob.
MDP	2.295612	2	0.3173
YP	4.237998	2	0.1202
INFL	4.572959	2	0.1016
All	6.362400	6	0.3838

Dependent variable: INFL

Excluded	Chi-sq	df	Prob.
MDP	4.851170	2	0.0884
YP	1.384015	2	0.5006
INTR	5.061819	2	0.0796
All	11.92034	6	0.0638

THE EFFECTIVENESS OF TRANSMISSION MECHANISM OF MONETARY POLICY IN LIBERIA

Boima S. Kamara*[1] and Dehpue Y. Zuo[2]

ABSTRACT

The aim of this study, the first on monetary transmission mechanism literature in Liberia, is to investigate empirically the effects of monetary policy on real per capita output and inflation. The 3 channels examined were the exchange rate, money supply and bank lending. The study made use of Johansen cointegration technique, the vector error correction model (VECM) framework couched within a vector autoregressive (VAR) system because all of the quarterly time series were found to be integrated of the same order, in this case I(1) for the reviewed period 2006Q1 and 2019Q4.

Monetary operations in Liberia has generally been limited in scope since its establishment in 1999. The use of monetary policy rate (MPR) by the CBL has been absent for most part of its existence rendering the role of interest rate to be mute. The monetary policy framework of the CBL has largely been managed float exchange rate regime—a form of exchange rate targeting based on broad exchange rate stability without a band. In addition to high growth in monetary aggregates, the CBL at times engaged banks by doing US and Liberian placements at commercial banks to influence expansion of credit to the private sector at reduced cost of funds and longer tenor on loans repayment. This investigation is motivated by the fact that there is a gap in the empirical literature in Liberia and is the first empirical research assessing monetary policy transmission mechanism in Liberia; a desire to find empirical evidence that will help inform academic discussions and policy; and to help position Liberia for the inevitable transition from dual currency regime to single as long as it remains a part of the regional economic bloc (ECOWAS) that is about to implement the protocol on monetary union.

Of the 3 channels examined, the paper established evidence for monetary transmission with exchange rate as the effective channel in transmitting monetary policy impulse to domestic prices, explaining an average of 88.0 percent variation in future inflation; but proved a poor predictor of future real per capita output. This outcome is important for the monetary authority suggesting the need to strengthen the exchange rate targeting framework. However, the combined effects of money supply and banking channels were found to be effective in transmitting monetary impulses to output. This calls for better policy coordination between the fiscal and

monetary authorities to ensure macroeconomic stability that guarantees inclusive growth, job creation and low inflation.

Keywords: *Real GDP Per Capita, Monetary Policy, Inflation, Impulse Response Functions, Variance Decomposition*

JEL Codes: *E3, E4, E5, G1, G2*

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1.0 INTRODUCTION

There are varying forms of monetary policy regimes operated by central banks across the world given the environment in which they operate. Monetary policy affects output and prices through its influence on key financial variables such as interest rates, exchange rates, asset prices, credit and monetary aggregates. The yardstick for determining how successful a choice of monetary policy regime has performed would necessitate a rigorous process of assessing how fast the effects of policy reforms are transmitted to other parts of the economy and how large is the magnitude of such transmission effects. Monetary policy is defined as fixing the nominal interest rate to exert influences on macroeconomic outcomes such as output and expected inflation while allowing the money supply to be determined by interest rate and inflation expectations.

According to Taylor 1995, monetary transmission mechanism refers to the process through which changes in monetary policy instruments including monetary aggregates, exchange rate and short-term policy interest rates affect the rest of the economy relative to output and inflation. At the same time, changes in the structure of the economy tend to alter the effects of a given monetary policy measure. This requires central banks to continuously reinterpret monetary policy effects on inflation and the real economy. Results from the empirical literature on monetary transmission mechanisms vary from country to country. Lavally and Nyambe (2019) found no evidence of interest rates, exchange rate and credit as effective channels. A survey conducted by Wang (2018) established monetary adjustment cannot be effective

only through one channel rather through a number of channels at the same time on the overall economy. Babatundi and Alatunji (2017) found both interest rate and exchange rate channels effective in Nigeria and Ogunkola and Tarawalie (2008) confirmed credit in Sierra Leone. Afrin (2017) using Structural Vector Autoregressive (SVAR) and Dynamic Stochastic General Equilibrium (DSGE) found the credit channel more effective in Bangladesh than the exchange rate channel. On the other hand, Philip Abradu et al (2003) confirmed the exchange rate as the main channel to transmit monetary policy impulse to the real economy and Kamati (2014) found interest rate as the effective channel to impact growth and inflation in Namibia.

Monetary operations in Liberia has generally been limited in scope since its establishment in 1999. The use of monetary policy rate (MPR) by the CBL has been absent until September 2019 when the Monetary Policy Advisory Committee was formed and the first committee's meeting held in October setting the stage for the use of MPR by the CBL. The role of interest rate has been mute. The monetary policy framework of the CBL has largely been managed float exchange rate regime—a form of exchange rate targeting based on broad exchange rate stability without a band. The CBL has predominantly used a combination of direct and indirect instruments including reserve requirements, foreign exchange auction, moral suasion, and most recently in 2019 monetary policy rate, CBL securities, and standing credit and deposit facilities. In addition to high growth in monetary aggregates, the CBL at times engaged banks by doing US and Liberian placements at commercial banks to influence expansion of credit to the private sector at reduced cost of funds and longer tenor on loans repayment. The use of reserve requirement remains active but has proven to be ineffective given the humongous holding of currency outside banks.

The purpose of this paper is to investigate monetary policy transmission mechanism (MPTM) in Liberia. The channels to be examined empirically are the exchange rate, money supply, and bank lending to see how they impact inflation and output. This investigation is motivated by the fact that there is a gap in the empirical literature in Liberia and this paper is the first empirical work assessing monetary policy transmission mechanism in Liberia. Also, there is a desire to find empirical evidence that will help inform academic discussions and policy about the direction and implementation of monetary policy. That is, a good understanding of the transmission mechanism in Liberia has a lot of benefits including positioning the monetary authority to clearly understand the financial variable impacted most by policy decisions and know the link between the financial sector and the real economy; providing an appreciable know-how in reading changes in financial variables; and ensuring better timing of

policy changes that supports the effective conduct of monetary policy through an informed choice of targets such as interest rate, exchange rate, and credit channels. Also, it is important to state that this research work is important because it prepares Liberia for a transition from dual currency regime to that of a single currency. This will be a strategic positioning as a member of the economic bloc, the Economic Community of West African States (ECOWAS) that is on the verge of implementing the protocol of a monetary union using a single currency in West Africa.

The structure of presentation of this paper begins with this introductory section followed by Section II, which deals with the theoretical and empirical literatures on the monetary transmission mechanism; Section III focuses on Monetary Developments in Liberia; Section IV deals with preliminary tests and methodology; Section V is on results from estimation techniques and Section VI presents the conclusion and recommendation.

2.0 LITERATURE REVIEW

2.1 Theoretical Review

There are several theories covered in the literature explaining various transmission channels of monetary policy. Macroeconomic theory has developed a great many approaches that explain how such a link works including channels such as interest rate; other asset price, exchange rate and equity price, wealth effects and similar housing and land price effects; and credit such as bank lending, balance sheet, cash flows, unanticipated price level, and household liquidity. A consensus in the literature supports the view that a change in stance of monetary policy somehow translates into growth of aggregate demand that leads to a rise in output. However, the internal microstructure of this transformation is a bit complex, which led economists to search out certain channels of monetary policy mechanism that explains how the process works in stimulating aggregate demand, and therefore real output. A review of these channels can be seen below:

i) **INTEREST RATE CHANNEL**: The traditional theory made use of the Keynesian IS-LM framework utilizing interest rate channels informed by the original works of Hicks (1937), Taylor (1995), Cotarelli and Courelis (1994), Clarida, Gali and Gertler (2000). According to this proposition often referred to as "money view", economic agents hold only two types of assets – money in the form of currency and bonds as a superficial collection of all other financial assets. Loose monetary policy leads to a rise in the amount of bank reserves and therefore to the expansion of deposits. Because money and bonds are the only assets in

the economy, economic agents tend to hold more money and fewer bonds. To attain equilibrium in the asset market, short-term interest rates should fall to induce the agents to hold additional money. A fall in market real interest rates decreases costs of capital needed to finance investments, which then drives growth in investment spending. Therefore, a rise in investment drives aggregate demand and subsequently output upward.

ii) **OTHER ASSET PRICE CHANNEL**: Unlike the traditional interest rate channel that focuses on a single asset price (bond interest rate), there exist alternative theoretical channels (Mishkin (1996)) of monetary transmission mechanism that are incorporated into analysis of prices on other assets, namely on foreign exchange and on equities.

a) **Exchange Rate Effects on Net Exports**: As argued by Mishkin (2001), essentially this channel relies upon interest rate effects too. When central bank loosens monetary policy and real interest rates fall, assets denominated in local currency become less attractive relative to foreign assets. The economy responds by depreciation of nominal exchange rate. This in turn raises the attractiveness of locally produced goods in export markets, thus stimulating net exports and output in the economy.

b) **Tobin's Q Theory**: Another channel of MTM stems from famous Tobin's Q theory of investment. We are not going to describe the details of this theory here, but still we emphasize the essential conclusion relevant for out study. When monetary policy is getting easier, equity prices may (and often do) rise, thereby increasing the market value of firms relative to the cost of replacing their real capital. As Q-ratio goes up, effective cost of real capital falls implying that the firm may issue new equity and purchase new equipment more cheaply than before. Hence, as Q-theory predicts, when stock prices surge, firms then tend to issue more equity and increase investment spending.

c) **Wealth Effects on Consumption**: The key notion for this channel is financial wealth of consumers. One of the most important components of financial wealth is common stocks held by consumers-households. As stock markets surge following the expansionary monetary policy, the market value of financial wealth rises, thus increasing the amount of resources available for consumption. Next, with more resources, consumption spending should grow and stimulate aggregate output. It should be noted that the definition of "equity" here could be rather broad. We may replace equity prices with

prices for housing or land, which are components of wealth too. A rise in these prices stimulates consumption due to increased wealth of households, and therefore promotes output growth.

iii) **CREDIT CHANNEL**: The types of credit channels reviewed are seen below:

a) **Bank Lending Channel**: This channel of monetary transmission mechanism belongs to the broader group of so-called credit channels that deal with information asymmetries in financial markets. The most general interpretation of how all credit channels transmit monetary policy is often referred to as credit view. The lack of proper information leads to information asymmetries in financial markets, both before and after financial transactions takes place. Lack of information before extending the loan leads to the adverse selection, whereas information deficiency after occurrence of transaction creates moral hazard problem. The common feature of the credit channels is the assumption that banks play a distinct role in financial system due to the fact that they are more than anyone else suited to transact with significant class of borrowers, where the problems of asymmetric information can be very high. In terms of how the bank lending channel operates, expansionary monetary policy enhances the reserves of banks, as well as the deposit base of banking system, thereby allowing for loans to increase. Growth of loans causes the investment of bank-dependent firms and to a less extent consumer spending to rise, pushing up aggregate demand and output.

b) **Balance Sheet Channel**: This is derived from the presence of moral hazard and adverse selection problems in financial markets. Usually, if a firm's net worth declines, this implies that moral hazard and adverse selection in lending to this firm intensifies. In other words, ceteris paribus, lenders are now less willing to provide funds to low-net-worth firm, because of smaller collateral. In addition, lenders know that owners of the low-net-worth firm are more prone to engage in risky activities, which may imply that lenders will significantly cut back new loans. In sum, lower net worth of the firm might cause lower lending and thus fall in firm's investment spending, and thus a decline in output; Kryshko (2001).

c) **Cash Flow Channel**: The asymmetric information argument applies to the cash flow channel. In this case, the changes in intensity of adverse selection and moral hazard depends largely on the state of the firm's cash flow.

Suppose monetary expansion first lowers short-term nominal interest rates. Then the firm may find it much easier to serve its short-term debt because interest payments are now lower. This, of course, improves the firm's cash flow and adds certainty to the lender that the loan granted to this firm will be duly repaid. As a result, moral hazard and adverse selection problems diminish, which by itself promotes new lending and thus increases investment spending and output.

d) Unanticipated Price Level Channel: As other credit channels, the unanticipated price level channel also relies on financial market imperfections. However, the source of movement in intensity of adverse selection and moral hazard problems originates from changes in a firm's net worth induced by unanticipated price level shock (positive or negative). Suppose the economy experiences an unanticipated rise in price level after the monetary expansion has occurred. Mishkin (2001) notes that in industrialized countries debt payments are essentially fixed in nominal terms in respective contracts. If this is true, the real value of the firm's liabilities decreases, thus increasing real net worth of the firm.

e) Household Liquidity Channel: Apart from focusing on spending of businesses when examining channels of MTM, credit channel literature pays attention to spending of households too, specifically on residential housing and durable goods. However, there is one channel, meaningfully different from all considered above and connected with liquidity effect on households. If households have relatively large amount of their wealth invested in financial assets compared to the debts they owe, then their expected probability of financial distress is low. This implies that the households are relatively more willing to buy housing and durable goods. These considerations lead us to the following link of causation. Expansionary monetary policy boosts stock prices together with the value of financial assets. As households perceive the probability of getting in financial trouble to be low, consumer durable and housing spending will rise stimulating aggregate demand and output.

2.2 Empirical Literature

The field of empirical literature is highly saturated with various studies examining the transmission channels of monetary policy using varying macroeconomic and financial variables with different estimation and forecasting approaches. To date, the empirical

literature is filled with mix results from country-to-country. Few of these empirical studies are covered in this section, which point to differences in outcomes across central banks of the world.

Lavally and Nyambe (2019) examined the effectiveness of MPTM in Sierra Leone using VECM and found real interest rates, nominal exchange rate and credit channels to be ineffective in terms of impact on output (proxy by real per capita GDP) and inflation (proxy by consumer price index); contrary to Ogunkola and Tarawalie (2008) who conducted similar research on monetary transmission mechanism in Sierra Leone using the VECM approach that established strong evidence of bank lending channel as the transmission mechanism affecting inflation and real GDP growth in Sierra Leone.

Wang (2018), in a survey paper that reviewed theoretical development of monetary policy transmission mechanism and presented at the International Conference on Economic Management and Green Development (ICEMGD 2018) argues that monetary policy adjustment cannot be effective only through one channel but through a number of channels at the same time on the overall economy.

Mentari et al (2018) focus on the effectiveness of MPTM in Indonesia using the vector error correction model (VECM) and found inflation expectation as the most effective channel in managing inflation.

Afrin (2018) examined MPTM, Financial Frictions in Closed and Open Economy using DSGE and SVAR models. The outcomes confirmed bank lending channels as effective in transmitting monetary policy impulse to the real economy in Bangladesh.

Kamati (2014) investigated MPTM and interest rate spreads in Namibia using SVAR. The findings argued in favor of interest rates as being the effective channel to transmit monetary policy impulse on inflation and growth.

Uanguta and Sylvanus (2002) confirmed bank-lending channel as the appropriate transmission mechanism in Namibia. Their study examined the interest rate and credit channels of monetary transmission in the Namibian economy in the context of structural vector autoregressive (SVAR) model. They made use of monthly data for private investment, credit to the private sector, money supply, consumer price index and lending rate.

The study done by Philip Abradu et al (2003) validated a strong evidence of monetary policy instruments affecting inflation and output in the Ghanaian economy in the long run with exchange rate channel as the main channel through which monetary policy is transmitted to the real economy. They used quarterly data for rate of inflation, real GDP, credit to private sector, treasury bill rate, real exchange rate and broad money (M2).

Bernanke and Blinder (1992), a paper on Federal Fund Rate and the Channels of Monetary Transmission, focused on the credit channel using federal funds rate, unemployment rate, logarithm of Consumer Price Index (CPI), deposits, loans and securities. Their results supported the credit channel as the appropriate mechanism for transmitting monetary policy in the US.

3.0 MONETARY DEVELOPMENTS IN LIBERIA

Monetary operations in Liberia has generally been limited in scope since its establishment in 1999 from the defunct National Bank of Liberia (NBL) that came into existence in 1974. According to the Act creating the CBL, the primary objective of monetary policy is to achieve and maintain price stability. The operational objectives of the CBL remains the creation and maintenance of low and stable inflation; encouraging a sustainable capital flow; and ensuring opportunity cost of capital is rightly priced in real interest rates. The monetary policy framework of the CBL has largely been a form of exchange rate targeting based on broad exchange rate stability without a band. Reserve requirements, foreign exchange auction, moral suasion, monetary policy rate, CBL securities, and standing credit and deposit facilities are instruments the CBL uses in the conduct of monetary policy.

Monetary policy rate (MPR) is a recent development in monetary policy implementation by the CBL, which helps to explain the limited role of interest rates in the Liberian financial system. Most of the traditional channels for transmitting monetary policy impulse are in limited use due to size and a seemingly oligopolistic financial market mainly driven by 9 commercial banks accounting for 80 percent of the total assets of the financial system, a nascent money market and no capital market. Interventions in the foreign exchange market through the foreign exchange sales auction by the CBL is its most important transmission mechanism. Also, the CBL at times engages the banking sector by doing US-dollar placements at commercial banks as a way of expanding lending to the private sector especially in US dollars[1] to influence

[1] Although the US dollar is a legal tender for transaction, but technically it is still a foreign currency

banks' balance sheet. The use of reserve requirement by the CBL has proven to be ineffective given the large share of Liberian dollars held outside banks. Thus, in the case of Liberia, monetary aggregates, exchange rate and bank lending are worthy of investigating to assess the effectiveness of monetary policy transmission mechanism.

Liberia is the only West African country with a dual currency arrangement. The US and Liberian dollars co-circulate as legal tender currencies with prices of goods and services largely quoted in US dollars and there is a high pass-through from exchange rate depreciation into higher domestic prices. The lack of grips on the total stock of currency in circulation is a constraining factor to the effective conduct of monetary policy since, on one hand, The CBL has full knowledge of the total stock of Liberian dollars in circulation as the issuer, while on the other hand, does not know the total stock of US dollars in circulation as a user. This is in addition to the fact that over 90 percent of currency in circulation is outside banks in the hands of the public— a reflection of the cash-based nature of the economy.

3.1 Developments in Selected Macroeconomic Indicators

A review of developments in real GDP and inflation to see how they relate to movements in money aggregate, exchange rate and credit to the privates is informative. This helps in gauging the direction of monetary policy to view pictorially whether there is likely transmission effect of monetary policy on the real economy. Over the period, the data generally shows real GDP, inflation, broad money supply (M2[2]), credit and exchange rate exhibiting an upward trending relationship, which does not necessarily translate into causation. The sharp fall in money supply in 2019 as seen in the graph was due to inadequacy of Liberian-dollar currency at the CBL pointing to a serious problem of currency management at the CBL.

[2] Broad money supply is defined as narrow money (M1-currency in banks plus demand deposits, excluding manager's checks from banks) plus time and savings deposits

Figure 1: Movements in Broad Money Supply (M2) and Real GDP (In Billions Liberian Dollars)

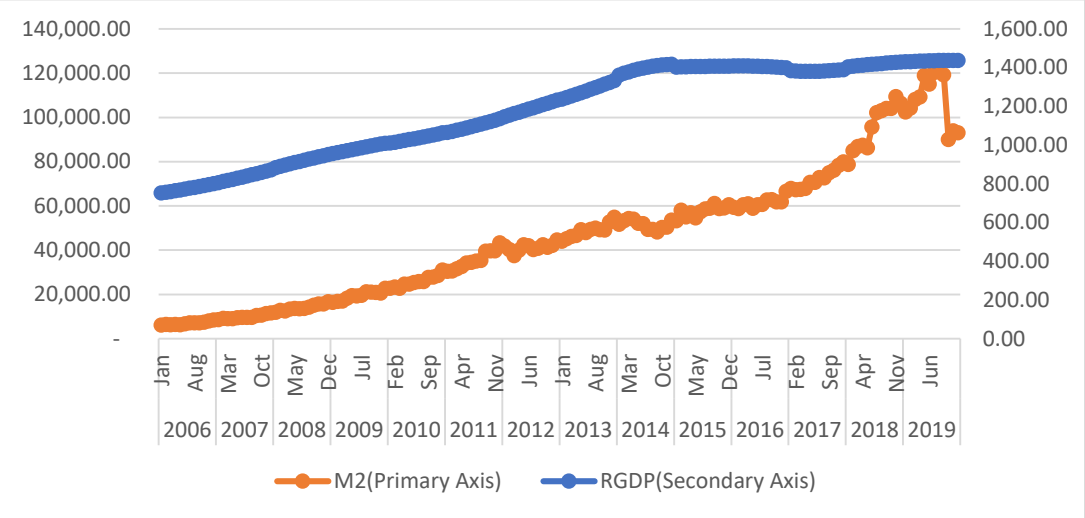
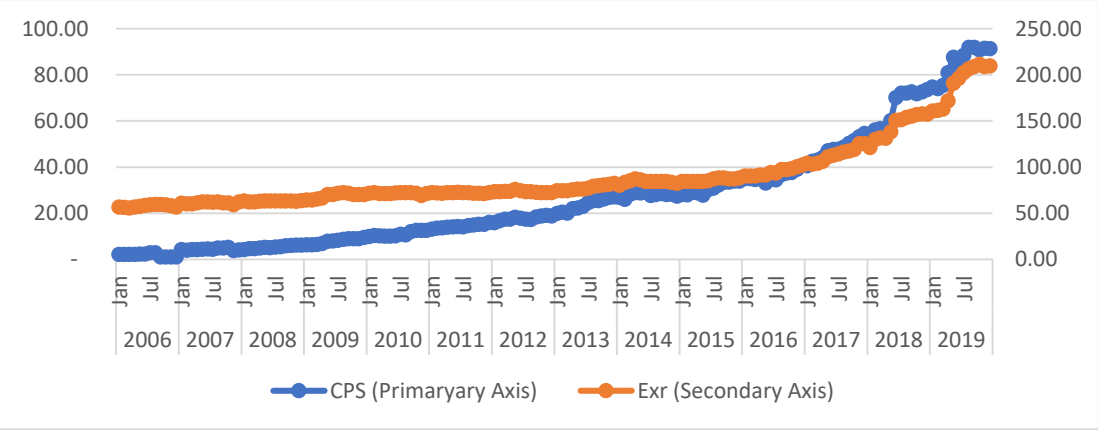


Figure 2: Movements in Credit to the Private Sector and Exchange Rate[3] (In Billions Liberian Dollars)

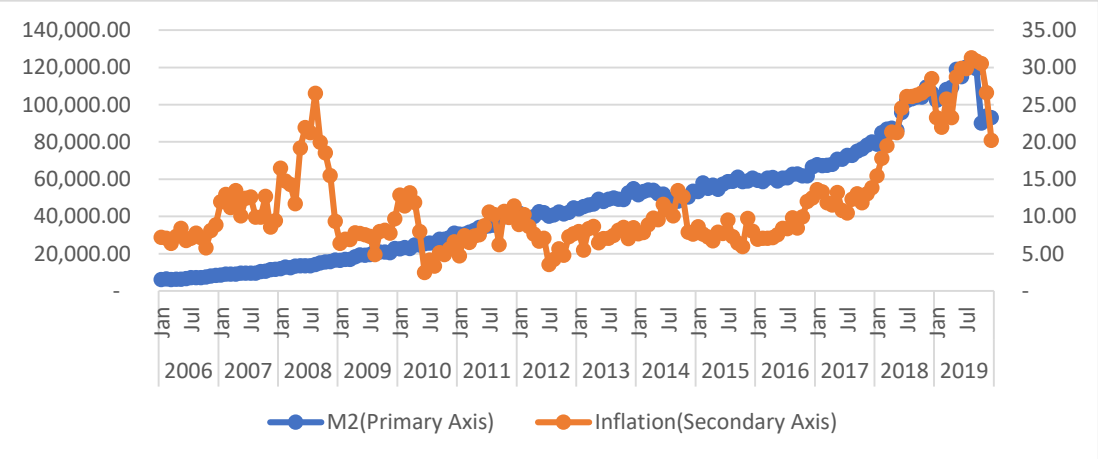


However, growth in broad money supply of about 17 percent at end-December 2019 coupled with about 30 percent exchange rate depreciation reported in CBL's Annual Report of 2019 in a recessionary environment where real GDP growth for the same period was put at negative 1.4 percent do have high likelihood of continued

[3] The nominal exchange rate is L$/US$1. Credit to the Private Sector is in billion Liberian dollars

inflationary pressure. This high growth in money supply necessitated the need to see how inflation and money supply has evolved over the same period as seen in Figure 3:

Figure 3: Movements in Broad Money Supply and Inflation (In Billions Liberian Dollars)



Inflation rate rose significantly from a lower digit rate of 10.47 percent in July of 2017 to over 30.00 percent by end-December 2019 in an environment experiencing decline in economic activities. All of the above provide the context for this study in seeking to model and empirically test for the transmission mechanism that is effective in Liberia. The exchange rate will proxy as monetary policy since the scope of this study was during the period in which the CBL predominantly used exchange rate targeting framework in Liberia, a dual currency nation where there is a strong pass-through from nominal exchange rate depreciation to domestic prices.

4.0 PRELIMINARY TESTS AND METHODOLOGY

4.1 Data and Preliminary Tests

The study quarterly data was collected from two secondary sources, the World Bank database on Liberia and various publications of the Central Bank of Liberia spanning 2006Q1 to 2019Q4. The variables collected comprised real per capita GDP (annual series collected from the World database but decomposed into monthly series[4] by the

[4] Real GDP per capita series under consideration exhibits quadratic pattern, which informed the use of Quadratic-Matched Average method for the conversion of annual data into quarterly series. This approach was used because Liberia's statistical agency is yet to produce annual and quarterly GDP series.

authors), while broad money supply, exchange rate, credit to the private sector, and consumer price index data were collected from the Central Bank of Liberia database. Real per capita GDP and consumer price index will represent the reaction or response variables. Since the general goals of CBL's monetary policy is to achieve low inflation and support economic growth; monetary aggregate (M2), exchange rate and bank lending will be used to assess the effectiveness of monetary policy shocks on the response variables mentioned.

4.1.1 Summary Statistics and Unit Root Test Results

A summary statistic of the quarterly series and associated correlation coefficients were computed. The results show that real GDP per capita, on average, grew by 5.68 percent during the reviewed period with highest growth rate of 5.80 percent and lowest of 5.50 percent. On average, consumer price index rose by 5.30 percent; broad money supply by 10.47 percent; and nominal exchange rate appreciated by 5.17 percent, which means a depreciation of the Liberian dollar against the US dollars and has implication for higher inflation (Table 1). The correlation results reveal strong positive relationship between the monetary variables and the response variables, especially output and broad money supply with a correlation coefficient of 0.98, for .96 exchange rate and consumer price, and .95 for broad money supply and domestic prices.

Table 1: Summary Statistics and Correlation Results

Variables	Observations	Mean	Std Dev.	Minimum	Maximum
lrgdppc	56	5.6793	.0752	5.5038	5.8002
lcpi		5.2951	.4021	4.6085	6.1763
lner		4.4404	.3318	4.2072	6.8435
lm2		10.4727	.8172	8.7557	11.7017
lcps		9.7555	1.0628	7.0269	11.4214
	Correlation Matrix				
	lrgdppc	lm2	lner	lcpi	lcps
lrgdppc	1.0000				
lm2	0.7492	1.0000			
lner	0.3139	0.8416	1.0000		
lcpi	0.5344	0.9491	0.9626	1.0000	
lcps	0.6960	0.9858	0.8754	0.9624	1.0000

Source: *Authors based on STATA Output.*

The time series properties for the quarterly data in their log form were tested for the presence of unit root. The Augmented Dickey Fuller (ADF) and Dickey Fuller-Generalized Least Squares (DF-GLS) tests were employed under the null hypothesis that the series is nonstationary or that the time series has memory of its past, a key statistical assumption about the residuals. Elliot, Rothenberg and Stock (1996) found that DF-GLS has significantly greater power than ADF. The p-values seen in Table 2 below provides the basis for rejection or acceptance of the null hypothesis of the series being nonstationary. That is, the null hypothesis of a unit root cannot be rejected if the test statistic is less than the critical value.

Table 2: Unit Root Test Results

Variables	ADF			DG-GLS		
	Level	1st Difference	Decision	Level	1st Difference	Decision
lrgdppc	-0.276	-4.487	I(1)**	-0.845	-3.321	I(1)**
lcpi	-1.805	-5.328	I(1)**	-2.293	-4.352	I(1)**
lm2	-1.294	-3.284	I(1)*	-1.322	-2.920	I(1)*
lner	1.814	-5.219	I(1)**	-1.837	-4.274	I(1)**
lcps	-8.355	-	I(0)**	-1.064	-4.628	I(1)**

Source: *Authors based on STATA Output. ** and * mean significant at the 5% and 10% values, respectively*

The outcomes of the DF-GLS method was largely in sync with the ADF test results, confirming that all the series are integrated of order (1). However, credit was found to be stationary at levels under ADF but nonstationary under Df-GLS. Given that DG-GLS is believed to have stronger significance power, the outcome from DF-GLS was preferred over ADF. Therefore, based on DG-GLS method, all 6 series are deemed to be integrated of order (1).

4.2 Model Specification and Estimation Techniques

The results from the stationarity tests showing all the variables being cointegrated of the same order provides the basis to adopt the vector error correction model (VECM) technique for this study. This estimation method is derived from a vector autoregressive (VAR) system with p lags. The estimation process involves determining optimal lag selection (p) for the model, Johansen cointegration with (p) lags, VECM estimation with (p-1) lags to capture the short and long run relation among the variables, impulse

response functions, and variance decomposition. According to the STATA-Time Series Reference Manual Release 15, a generalized VAR with p lags is written as:

$$y_t = v + A_1 y_{t-1} + A_2 y_{t-2} + \cdots + A_p y_{t-p} + \varepsilon_t \quad (1)$$ where

y_t is a K × 1 vector of variables, v is a K × 1 vector of parameters, A_1–Ap are K × K matrices of parameters, and ε_t is a K × 1 vector of disturbances; ε_t has mean 0, covariance matrix Σ, and is i.i.d normal over time. Any VAR(p) can be rewritten as a VECM as given below:

$$\Delta y_t = v + \Pi y_{t-1} + \sum_{i=1}^{p-1} \Gamma i \, \Delta y_{t-i} + \varepsilon_t \quad (2)$$

where $\Pi = \sum_{j=1}^{j=p} Aj - Ik$ and $\Gamma_i = -\sum_{j=1}^{j=p} Aj$. The v and ε_t in equations (1) and (2) are identical. Engle and Granger (1987) show that if the variables y_t are I(1), then the matrix Π in (2) has rank $0 \leq r < K$, where r is the number of linearly independent cointegrating vectors. If the variables cointegrate, $0 < r < K$ and (2) shows that a VAR in first differences is misspecified because it omits the lagged level term Πy_{t-1}. The use of this approach captures the interdependence between monetary policy and macroeconomic activities in a simultaneous swoop that allows for the impulse response analysis of residuals within the system models.

The variables, in their log form that constitute the VAR system of equations, are real GDP per capita (lrgdppc); consumer price index (lcpi); broad money supply (lm2); nominal exchange rate (lner); and credit to the private sector (lcps).

4.3 Results from Estimation Techniques

4.3.1 Results

4.3.2 Lag Selection

A determination of the lag order for the VAR system was done using the sequential modified Likelihood Ratio (LR), Final Prediction Error (FPE), and Akaike Information Criterion (AIC) methods as the basis get obtain the maximum lag length for estimation. The results for LR, FPE, and AIC as shown in Table 2 below confirmed the appropriate lag structure for fitting the dynamic system models is a maximum lag length of 4.

Table 2: Lag Selection Results

Lag	P-Value	LL	LR	FPE	AIC	HQIC	SBIC
0		244.33		6.9e-11	-9.20	-9.13	-9.02
1	0.000	583.28	677.89	4.0e-16	-21.28	-20.85	-20.15*
2	0.000	621.13	75.71	2.5e-16	-21.77	-20.98*	-19.71
3	0.000	647.94	53.63	2.5e-16	-21.84	-20.69	-18.84
4	0.073	685.36	74.82*	1.8e-16*	-22.32*	-20.81	-18.38

Source: *STATA Output. * means failure to reject the null of a maximum lag length of 4*

4.3.3 Cointegration Test

The Johansen cointegration test was applied to determine the order of cointegration for the VAR model. The tests for cointegration implemented by vecrank are based on Johansen's method. If the log likelihood of the unconstrained model that includes the cointegrating equations is significantly different from the log likelihood of the constrained model that does not include the cointegrating equations, we reject the null hypothesis of no cointegration. The results from both trace and maximum eigenvalue statistics using all 5 series indicate that there are 2 cointegrating relationships with statistical significance at the 5% level of significance as reported below:

Table 3: Johansen Cointegration Test Results

Maximum Rank	**Parms**	**LL**	**Eigenvalue**	**Trace Statistic**	**5% Critical Value**
0	30	560.50	-	91.20	68.52
1	39	581.00	0.5318	50.21	47.21
2	46	593.69	0.3751	24.82*	29.68
3	51	599.93	0.2063	12.35	15.41
4	54	604.90	0.1682	2.41	3.76
5	55	606.10	0.0436		
Maximum Rank	**Parms**	**LL**	**Eigenvalue**	**Max Statistic**	**5% Critical Value**
0	30	560.50	-	57.97	39.37
1	39	581.00	0.5318	28.22	33.46
2	46	593.69	0.3751	23.09*	27.07
3	51	599.93	0.2063	14.15	20.97
4	54	604.90	0.1682	4.88	14.07
5	55	606.10	0.0436	1.48	3.76

Source: STATA Output

* ***means failure to reject the null of only 2 cointegrating equation***

4.3.4 Vector Error Correction Model

The use of VEC estimation approach was informed by the outcome of the Johansen's cointegration test that validated the presence of 2 cointegrating relationships.

4.4 Estimates of VECM

As discussed by Johansen (1995), if there are r cointegrating equations, then at least r^2 restrictions are required to identify the free parameters in β. Johansen proposed a default identification scheme that has become the conventional method of identifying models in the absence of theoretically justified restrictions. Johansen's identification scheme is

$$\beta' = (I_r, \widetilde{\beta}')$$

where I_r is the r × r identity matrix and, $\tilde{\beta}$ is a (K − r) × r matrix of identified parameters. Vector error correction applies Johansen's normalization by default. Thus, a VECM was fitted with 2 cointegrating equations with 5 lags on all 5 series. The Johansen identification scheme placed 4 constraints on the parameters in β: [ce1];cpi = 1, [ce1]lrgdppc = 0, [ce2]lcpi = 0, and [ce2]lrgdppc = 1 and since output and domestic prices are the target or response variables. The results of the first equation (cpi) is interpreted as indicating the existence of an equilibrium relationship between inflation and the impulse variables. Similar interpretation holds true for equation 2, real per capita output (lrgdppc) relative to the impulse variables.

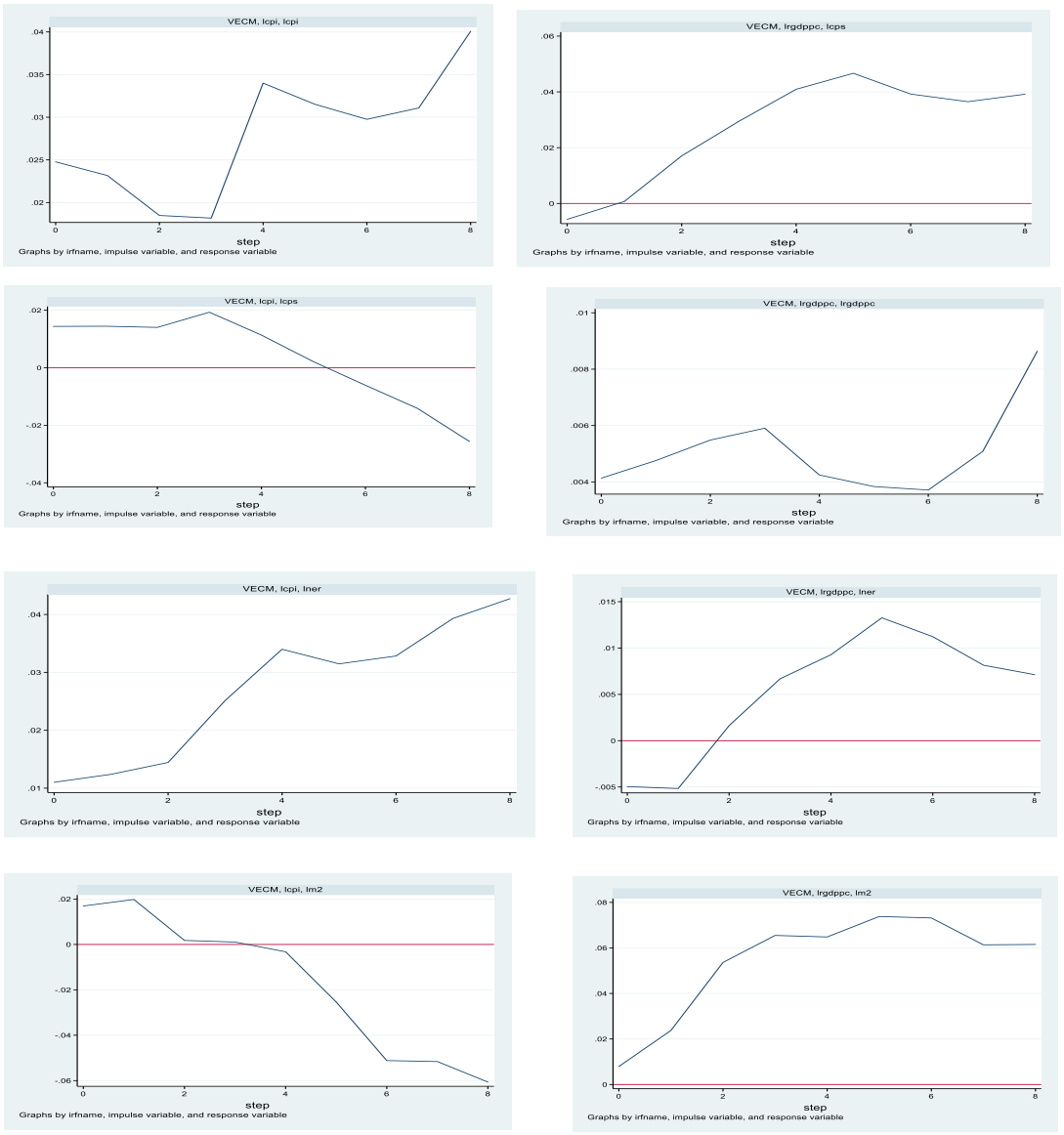
In terms of model stability check, the results show that the eigenvalues lie within the unit circle indicating that the system models were correctly specified. The serial correlation test confirmed the absence of serial dependence or unit root in the residuals. Also, the normality test for the system models found the residuals following normal distribution. Overall, the VEC models fitted well.

4.5 Impulse Response Functions (IRFs) for the VEC Models

The dynamic simulations involving IRFs and forecast error variance decomposition (FEVD) were carried out to better assess the effectiveness of monetary transmission mechanism in Liberia given that VEC models fitted well. The I(1) variables modeled in a cointegrating VECM are not mean reverting, and the unit moduli in the companion matrix imply that the effects of some shocks will not die out over time. This possibility gave rise to terms such as transitory, when the effect of a shock dies out over time and permanent, when the shock does not taper off over time (STATA Reference Manual, Release 15).

The IRFs capturing the effects of an orthogonalized monetary shocks on the response or target variables, real GDP per capita and consumer prices, are reported below in Figure 3. The recommended forecast horizon by STATA, given the small size quarterly frequency of the data, is an 8-quarter period after the occurrence of the shock.

Figure 3: Response to One Cholesky S.D Innovation



In terms of how inflation responded to the monetary variables, the result reveals that a one-time negative shock to money supply (contraction in monetary aggregate) leads to a brief short run rise in prices up to quarter 1 and, thereafter decline from quarter 2 throughout in the long run. However, the initial rise in the first quarter is puzzling, which is likely due to forces of demand and supply interplay that produce different effect on prices. Aggregate demand side effect means a contraction in money supply leads to decrease in demand for goods and services that results into a fall in prices. On the other hand, aggregate supply response to monetary tightening will lead to a rise in interest rates that leads to higher interest payments on borrowing and this will cause money supply to expand, which results to a rise in prices. In the case of Liberia being a cash-based economy with limited role for interest rate, the demand side tends to outweigh the supply side. Overall, it can be inferred that there is a positive permanent relationship between inflation and money supply, which aligns with the monetarist view of inflation in a country. For the exchange rate channel, the impulse response function of inflation to exchange rate shows that the effect of a one-time positive shock to exchange rate (a nominal exchange rate depreciation) leads to a rise in prices throughout the short- to long-run period. This confirms a permanent positive relationship as expected. A depreciation in the Liberian-dollar exchange rate relative to the US dollar leads directly to a rise in inflation since prices of most goods Liberia are quoted in US dollars. In terms of the bank-lending channel, a one-time negative shock to credit to the private sector (monetary tightening) largely results into a fall in prices. In the short run, prices rose initially between quarters 2 and 3 probably driven by structural problems of the economy including high cost of electricity and limited and bad farm-to-market roads. However, prices continue to decline from quarter 3 straight into the long run. Overall, the results point to a permanent positive relationship.

Focusing on how output responded to the impulse variables, the results show that a one-time positive shock to money supply leads to an increase in real per capita GDP rising throughout from the short run to the long run period. This indicates there is a permanent positive relationship which is in line with economic theory. Also, real per capita output responded positively to a one-time positive shock in nominal exchange rate for most of the short run from quarter 1 into the long run, which is consistent with theory. However, Liberia does not optimize the benefits associated with nominal exchange depreciation that makes domestic goods cheaper to induce export because of the country's low productive capacity in finished goods that come on the heels of value addition. Liberia depends mainly on foreign exchange earnings mainly from primary commodity exports of iron ore, rubber, and timber. Real per capita output also demonstrated positive permanent relationship over the long run for a one-

time positive shock in bank lending with output rising immediately throughout the period of the forecast horizon.

4.5.1 Variance Decomposition for the VEC Models

The analysis of forecast error variance decomposition (FEVD) was carried out to have a better sense of the system dynamics using an 8-period horizon. This helps with the process of clearly assessing effectiveness of monetary policy transmission mechanism in Liberia. The results from the FEVD are reported in Table 4.

Table 4: Forecast Error Variance Decomposition (FEVD) for the VEC Models

Step	LCPI	LNER	LM2	LCPS
0	0.0000	0.0000	0.0000	0.0000
1	1.0000	0.2081	0.1332	0.1032
2	0.9759	0.2345	0.1223	0.1011
3	0.9455	0.2941	0.0557	0.0860
4	0.8600	0.4126	0.0297	0.0846
5	0.8541	0.5237	0.0192	0.0681
6	0.8377	0.5655	0.0269	0.0509
7	0.8087	0.5893	0.0593	0.0406
8	0.7781	0.6256	0.0780	0.0385
Step	**LRGDPPC**	**LNER**	**LM2**	**LCPS**
0	0.0000	0.0000	0.0000	0.0000
1	0.9603	0.0421	0.0291	0.0162
2	0.8724	0.0437	0.1127	0.0080
3	0.8524	0.0328	0.2854	0.0453
4	0.8593	0.0365	0.3381	0.1021
5	0.8349	0.0426	0.3319	0.1751
6	0.7775	0.0625	0.3511	0.2290
7	0.6589	0.0661	0.3418	0.2309
8	0.4947	0.0588	0.3130	0.2246

Source: *STATA Output*

Regarding how domestic prices respond to shock from itself (own shock), the result shows that in the short and long run shocks to inflation account for significantly large variations in prices; accounting for about 88.25 percent variations on average. Overall,

there is a strong influence of inflation in predicting future inflation. Exchange rate proved to have strong influence in predicting future inflation in both the short and long run. In the short run, say quarter 3, exchange rate accounts for 29.41 percent fluctuation in inflation and 62.56 percent changes in the long run, say quarter 8. For money supply and bank lending, they had weak influence on inflation in both the short and long run. Their combined effects in the short run was about 15.0 percent, say quarter 3 and about 10.0 percent in the long run, say quarter 8. Therefore, the evidence shows exchange rate as effective over the other 2 in transmitting monetary impulses.

For real per capita output as the other target variable, the result for own shock in both short and long run suggests it is a good predictor of its own future value with fluctuations averaging about 80.0 percent over the forecast period. For an innovation to exchange rate on per capita output, the impact is weak barely averaging 5.0 percent indicating exchange rate as a poor predictor of future real per capita GDP. Money supply and bank lending appeared to do better than exchange rate in explaining future variations in output, but not individually strong enough to influence future outcomes of real per capita output. However, their combined effects in the long run of about 54.0 percent can be considered important in predicting future outcomes of real per capita output.

5.0 CONCLUSION AND RECOMMENDATIONS

In investigating the effectiveness of monetary transmission mechanism in Liberia, the study examined the exchange rate, money supply, and bank lending channels suitable to Liberia and comparable regional member countries including Sierra Leone, the Gambia and other developing countries.

The vector error correction model (VECM) couched within the vector autoregressive (VAR) modelling system was used since data generating process for the quarterly series spanning 2006Q1 to 2019Q4 were found to be integrated of the same order (1). The analyses of the results from the impulse response function and forecast error variance decomposition found the interest rate to be the most effective channel in transmitting monetary policy shocks to domestic prices. This is important to the CBL since its primary goal is price stability. In this regard, the CBL should endeavor to strengthen the exchange rate targeting framework, probably by clearly stating a band around which the exchange rate should fluctuate. Nonetheless, policy consideration should be given to the combined effects of money supply and bank lending channels on real output through better banking supervision by the CBL and enhanced fiscal-monetary

policy coordination that supports macroeconomic stability and ensures inclusive economic growth, job creation, and low inflation. Also, efforts must be made towards achieving financial sector development and deepening; making the economy more cashless away, from the current cash-based state; and improving currency management through optimal growth in monetary aggregate that is consistent with economic growth. This will go a long way in strengthening the transmission channels in Liberia.

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