WEST AFRICAN INSTITUTE FOR FINANCIAL AND ECONOMIC MANAGEMENT (WAIFEM)

WEST AFRICA FINANCIAL AND ECONOMIC REVIEW

Volume 19 ■ December 2019 ■ Number 2

ISSN 0263-0699

West African Institute for Financial and Economic Management

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The Institute is grateful to the **African Capacity Building Foundation (ACBF)** for the financial support toward the publication of this journal.

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Published in Lagos, Nigeria by
West African Institute for Financial and Economic Management (WAIFEM),
Central Bank of Nigeria Learning Center, Navy Town Road, Satellite Town,
PMB 2001, Lagos, Nigeria.

ISSN 0263-0699

Printed by
Kas Arts Service Ltd.
08056124959

FOREIGN AID AND ECONOMIC GROWTH IN ECOWAS COUNTRIES: DO MACROECONOMIC POLICY ENVIROMENT AND INSTITUTIONAL QUALITY MATTER?

Hassan O. Ozekhome*[1]

Abstract

After many years of large development assistance, ECOWAS countries are still mired in poor growth and development performance. The obvious question is: why have these countries not experience impressive growth despite receiving large inflows of foreign aid? Against this backdrop, this paper examines the effect of foreign aid, and in particular whether macroeconomic policy environment and institutional quality influence aid effectiveness, for the period 2002-2015. The study used the Generalized Method of Moments (GMM) Estimator developed for dynamic models of panel data is used. The empirical results show that aid has negative and insignificant effect on growth in ECOWAS countries, but when interacted with macroeconomic policy environment (proxied by inflation) and the institutional quality variable, the negative impact is moderated, with the interactive term appearing positive and significant, implying that macroeconomic policy environment and institutional quality matter to aid effectiveness. The study recommends sound and stable macroeconomic policies, solid institutional framework, and efficient economic management in terms of good governance that will enhance aid effectiveness in the region. These should be supported with open trade and investment-enhancing policies in order to enhance economic growth in sub-region.

Keywords: Foreign aid, Economic growth, Macroeconomic environment, Institutional quality, ECOWAS, Generalized Method of Moments (GMM)

JEL Classification: F35, 047, E61, C30

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1.0 INTRODUCTION

The role of foreign aid in the growth process of developing countries has been a topic of extensive investigation in recent times among economists, researchers and policy makers. The main role of foreign aid is to stimulate economic growth through the augmentation of domestic resources, such as savings, thereby increasing the amount of investment and capital stock in resource-scarce developing countries. On the role of foreign aid on economic growth and development, Morrissey (2001) points out that aid could contribute to economic growth through a number of mechanisms to include; increasing investment in physical and human capital, increasing the capacity to import capital goods or technology, by not discouraging domestic investment or savings rates through indirect effect and by increasing the productivity of capital and promoting endogenous technical change in the case of aid linked technology transfer programmes. Yet, after decades of capital transfers in the form of aid to developing countries, the effectiveness in term of economic growth and increase in social welfare remains a mirage. In the light of this, McGillivray, et al. (2006), posits that aid effectiveness is influenced by external and domestic policy conditions, as well as institutional quality (Ekanayake, and Chatrna 2012). Empirical studies have found positive relationship between foreign aid and economic growth (Burnside & Dollar, 1997; Asteriou, 2009; 2004; Karras, 2006). On the contrary, other studies (Bhaaderi, et al, 2007) confirm the negative relationship between foreign aid and economic growth. Burnside and Dollar (2000), for instance claim good fiscal, monetary, trade and institutional policies as, well as political stability are necessary condition for effectiveness of foreign aid on economic growth.

Understanding the potential implications of foreign aid on growth in the presence of macroeconomic policy environment and institutional quality is critical because good institutions and sound macroeconomic policy environment are major determinant of economic performance. In particular, the existing institutional environment of the recipient country and the macroeconomic environment play big role in determining the success of aid-led development. Abuzeid, (2012) argue that differences between countries in capital accumulation, productivity and output can ultimately be attributed to differences in "social infrastructure," which refers to institutions and government policies that determine the economic environment. This view is supported by Fiodendji and Evlo (2013) that sound institutional framework in the form of predictable, impartial, and consistently applied rule of law, is crucial for the sustained and rapid growth in per-capita incomes of poor countries. In fact, government policies and institutions which constitute the economic environment, is an important determinant of foreign private capital inflow and growth. The degree of private

capital inflows and the ability to reap returns differ considerably across countries, arising partly from variation in government policies and institutions, which constitutes the infrastructure of a country. A country that attracts considerable investments in the form of foreign private capital, technology transfer from abroad, and skills of individuals will be one in which the institutions and laws favours production over diversion; the economy is open to international trade and competition in the global marketplace; and the economic institutions are stable. A good infrastructure provides an environment which encourages private investment, the acquisition of skills, invention and technology transfer.

In the pursuit for economic growth, many developing countries, including ECOWAS countries run import surpluses for a host of reasons including extreme dependence on volatile primary commodity exports, exports instability, unfavourable terms of trade and, internationally transmitted shocks (Iyoha, 2004; Ozekhome, 2017), lack of technical know-how, weak managerial enterprise and innovation. The combination of these growth-constraining factors constitutes critical resource gaps which aid can naturally fill. Available evidence by the World Bank Development Indicators points to the fact that official development assistance (ODA) from members of the OECD's Development Assistance Committee (DAC) rose in real terms from US$108.71 billion in 2013 to US$119.8 billion in 2014 representing a 10. 2 percent increase, which further rose to US$150 billion by 2015, an equivalent of 25.2 percent increase (World Bank, 2016). Africa is the largest recipient of foreign aid. For example, net bilateral ODA from DAC donors to Africa in 2008 totalled US$26 billion, of which US$22.5 billion went to sub-Saharan Africa, including ECOWAS. Excluding volatile debt relief grants, bilateral aid to Africa and Sub-Saharan Africa rose from US$28.5 billion to US$31.52 billion, an equivalent of 10.6% in the period 2008-2010 and further rose by 10% in the period 2011-2015 in real terms (World Bank, 2016).

There is a growing convergence of opinion in the academic community that aid has spectacularly failed to achieve its intended outcomes in Sub-Saharan Africa, including ECOWAS countries, because of the absence of strong absorptive capacities in terms of good macroeconomic policy environment, quality institutional structure and good governance. The indiscriminate nature of foreign aid allocation is believed to have a direct impact on governance through its tendency to perpetuate existing corruption in recipient countries (Abuzeid, 2012). Given that many of the largest recipients of ODA in Sub-Saharan Africa are also some of the world's lowest-ranking countries in many areas of governance, particularly with regards to corruption, foreign aid apparently seems to increase the volume of funds at the disposal of already corrupt government

officials and kleptocratic elites. This position is corroborated by Alesina and Weder's (2002, cited in Abuzeid, 2012) who posit that an increase in aid influx is associated with a statistically significant increase in corruption, and vice versa.

To the best of the author's knowledge, the effects of aid on growth, considering the place of macroeconomic policy environment and institutional settings for aid effectiveness has not received any notable empirical attention in the literature, particularly at regional level. In addition, the few related existing studies on the subject matter (see Hatemi- J and Irandoust, 2005; Malik, 2012; Ekanayake, 2012) ignored the role of macroeconomic policy environment and institutional framework in the aid-growth channel. It is the perceived gap in literature that has made this study important. Given the strong impact of foreign aid-as resource supplement in enhancing economic growth in ECOWAS region, there is need to empirically re-examine their effects on growth. Against this backdrop, the focus of this study is thus to analyze the effects of foreign aid on economic growth in the presence of macroeconomic policy environment and institutional setups, in a regional-based study like ECOWAS, which no other study has examined.

Following this introduction, the paper is organised as follows. Section two presents a stylized facts on aid, economic performance and institutional quality in ECOWAS countries. Section three consists of literature review which considers key theoretical, empirical and policy issues associated with foreign aid-economic growth nexus. Section four contains methodology, model specification and data, while section five contains the empirical results and analysis. Section six contains the conclusion and policy recommendations.

2.0 Stylized Facts on Foreign Aid, Economic Performance and Institutional Quality in ECOWAS.

2.1 Aid Performance

This section presents some stylized facts on aid, economic performance and institutional quality in ECOWAS countries over the period. The distribution of foreign aid to different regions is presented in Table 1.

Table 1. Distribution of Foreign Aid by Region (%) (2002-2015)

	2002-2005	2006-2010	2011-2015
Sub-Saharan Africa (including ECOWAS)	27.8	25.2	21.7
South and Central Asia	15.3	12.4	12.8
Other Asia and Oceania	17.5	17.3	18.5
Middle East and North Africa	14.1	16.4	17.9
Latin America and Caribbean	15.5	15.2	15.7
Developed Economies	3.5	3.7	3.9
Unspecified	7.3	9.8	9.5
	100	100	100

Source: Author's Computation: Underlying Data from World Bank's WDI

From the Table 1 above, it can be observed that Sub-Saharan African countries, which include the ECOWAS sub-region have received the largest of foreign aid, compared to other regions of the world. Despite this, economic performance has been uninspiring, due to poor macroeconomic environment and weak institutional framework. In terms of macroeconomic policy environment indicated by inflation, the sub-region has been characterized by high and variable inflation rates, as most of the individual country's annual inflation rate exceeded the average in the zone. Nigeria and Ghana (the two largest economies in the sub-region), had higher incidence of inflationary pressures during the three sub-periods period under focus, with the inflation rate in Nigeria 2002-2005, 2006-2010 and 2011-2015 standing at 14.4 percent, 10.8 and 9.7 percent, respectively, while that of Ghana in the same periods stood at 16.1 percent, 14.5 percent, and 12.2 percent respectively; compared to a sub-regional average inflation of 12.2 percent, 12.6 percent and 11.9 percent. Cape Verde and Senegal had the lowest inflation rate throughout the three sub-periods, with that of Cape Verde, in particular, in the corresponding sub-periods, being 0.4 percent, 5.3 percent and 4.2 percent, respectively (ECOWAS, Macroeconomic Convergence Report, Various Issues).

Growth performance in the ECOWAS sub-region declined in the past few years. The average growth rate was 4.8% in the 1990-2000; rising slightly to 5.1% in the period 2000-2010, and declining to 3.1% in the period 2011-2015 (WDI, 2016). The poor and unsustainable growth performance is attributed to a host of factors, both internal and

external. The internal factors borders on poor domestic macroeconomic management, leading to high and variable inflation, unemployment, stagnation and rising fiscal deficits, corruption and poor governance. The external factors reflect the increasingly hostile international economic environment, characterized by low and falling primary commodity prices, resulting from negative external shocks, declining terms of trade, and dwindling aid and capital flows into the region (Iyoha, 2004). Table 2 show the real GDP growth in ECOWAS countries in three sub-periods under focus.

Table 2: Growth Rate of Real GDP in ECOWAS

	2002-2005	2006-2010	2011-2015
Benin	3.6	4.8	4.5
Burkina Faso	6.1	4.9	5.1
Cape Verde	5.2	6.8	7.1
Cote d' Ivoire	0.1	2.9	5.2
The Gambia	5.6	6.5	5.6
Ghana	5.3	6.1	4.7
Guinea	2.7	3.3	3.2
Guinea Bissau	0.1	2.8	3.4
Liberia	1.1	8.9	5.5
Mali	5.1	4.9	4.9
Niger	4.3	4.8	4.8
Senegal	4.8	4.2	4.4
Nigeria	6.8	6.5	5.6
Sierra-Leone	8.6	6.2	5.5
Togo	2.1	2.6	2.6

Source: Author's Computation Using Data from ECOWAS Central Banks and World Economic Outlook

A cursory observation of Table 2 shows that most of the countries in the Sub-region have had low and unsustainable growth pattern over three sub-periods, with the exception of Cape Verde, Gambia, Ghana, Sierra- Leone and Nigeria, all member countries of the West African Monetary Zone (WAMZ). Beginning from the latter part of 2014 was a more testing economic period for the sub-region owing to pronounced economic contraction in the ECOWAS region, particularly Nigeria (the largest

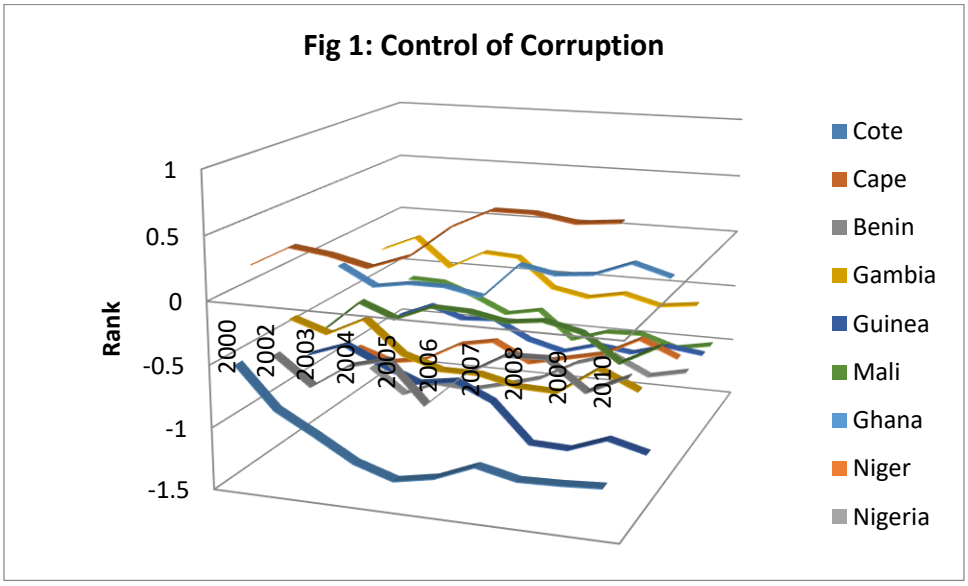
economy in the sub-region), due to internationally generated and transmitted shocks from volatile primary commodity exports in the world market and exports instability; a development which had negative reverberations in ECOWAS countries in terms of economic and fiscal vacillations.

2.2 Institutional Quality

In this section, we show some stylized facts on the quality of institutions in the ECOWAS sub- region using three institutional variables; control of corruption, rule of law and political stability.

Control of Corruption

Corruption is the abuse of public office for self-gratification through fraudulent activities especially siphoning, embezzlement and misappropriation of public funds and is endemic in most ECOWAS countries (World Bank, 2016). Corruption has majorly hampered growth trajectories in the sub-region and negatively affected aid effectiveness. It weakens the ability to attract the much-needed external finance, dislocates the productive system, and diminishes the incentive for creativity, productivity and enterprise (Ozekhome, 2017). Most countries in the ECOWAS sub-region have established anti-graft laws and institutions to curb the menace, like the Economic and Financial Crimes Commission (EFCC) in Nigeria. Control of corruption, therefore entails government commitment and transparency to fighting corruption and the extent to which those found culpable are brought to face the law. It captures the perceptions of the ability of the government to fight corruption to the barest minimum through strong and effective institutional framework and rule of law and procedures. Figure 1 shows the details of corruption control ranking in ECOWAS countries.



Source: Eregha (2014)

Figure 1 above gives further credence to the trend of the ranking. The ranking is between -2.5 to +2.5. It is evident from the figure that all the countries performed poorly in the fight against corruption, except Cape Verde that performed better. The effect of this is that government capacity to function effectively is reduced (Diop et al. 2010, cited in Eregah, 2014), as it reduces the ability to attract and judiciously deploy external finance resources (foreign aid in this context) for development purposes, as expropriation, rent-seeking activities amongst others become prevalent.

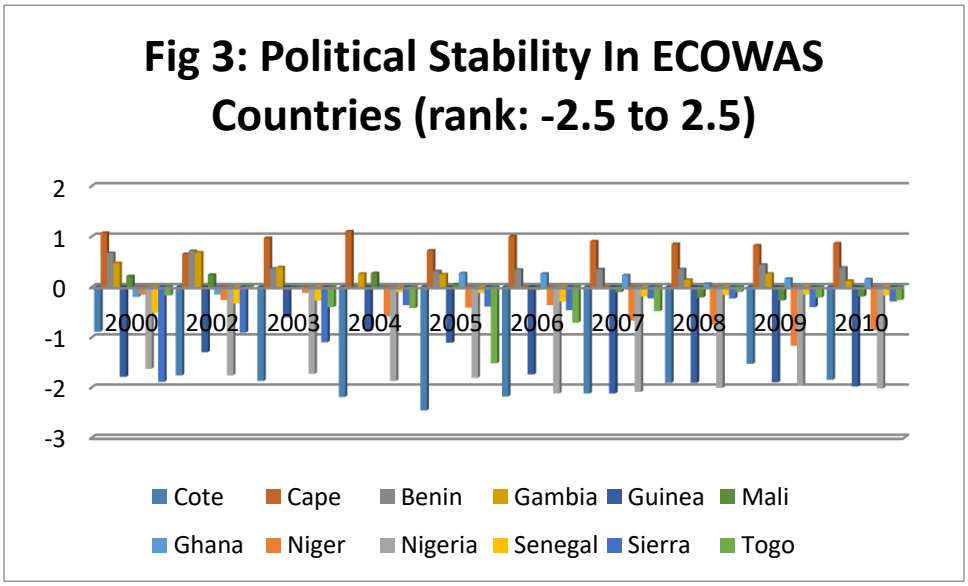
Rule of Law

Another prominent institutional factor that has given rise to weak and negative effect of aid on growth in the ECOWAS sub-region that has undermine growth and development trajectory is the weak rule of law system. The rule of law (RL), as the fulcrum of governance includes several measure of the degree to which citizens have confidence in, and abide by the rules of society, and in particular, the independence, effectiveness and predictability of the judiciary, the quality of contract enforcement, property rights, the police, and the courts, as well as the likelihood of crime and violence. Rule of law is based on a number of indicators measuring the supremacy of the law, equality before the law, civil liberties and human rights, independence of the judiciary and its effectiveness and predictability, and the enforceability of contracts proceedings (World Bank, 2015). In a performance rating by the World Bank, the sub-

region performed poorly in many of the institutional variables. Using a range of (+2.5) to –(2.5) , the sub region , except Cape Verde that consistently maintained an average of -0.92 for regulatory quality, -1.20 for rule of law and -1.05 for government effectiveness. Sound institutional reforms, which embed the rule of law, government effectiveness and regulatory quality are thus required in the sub-region to make foreign aid beneficial to growth, and drive economic growth to sustainable levels.

Political Stability

Political Stability measures the stability of the political system and absence of violence, which measures the likelihood that the government in power will be destabilized or overthrown by unconstitutional means and or violence or threatened by armed conflict such as terrorism. Figure 3 depicts this.



Source: Eregha (2014)

Figure 3 portrayed the political stability ranking in the sub-region. Most the ECOWAS countries are characterized by high level of political instability and ethno-religious crises. In fact, the democratic period has also experience a lot of political violence, extrajudicial killings, election violence and rigging (Eregha, 2014). Political instability has the capability to reduce external finance inflows (foreign aid in this context), crowd out productive private investment by reducing accumulation incentives. With democracy ushered in most of the ECOWAS countries, backed by political and

institutional reforms, democratic institutions are being strengthened and the regulatory framework is being improved to enable external finance inflow affect growth positively.

O, Connell and Soludo (1999) and Iyoha (2004) have argued that the diminishing aid flows to African countries is attributable to poor macroeconomic policy environment, donor fatigue, evidence of low aid effectiveness in many African countries, and evidence of negative systemic effects of aid recipient countries. Other reasons advance for the declining aid flows are absorptive capacity constraints, and that it tends to crowd out domestic institutional developments and create rent-seeking opportunities in African countries (Ozekhome, 2017). Similarly, Abuzeid (2012) posits that aid also creates a moral hazard problem in the recipient country by serving as a permanent soft budget constraint. The persistent influx of easy foreign aid money creates the impression that the recipient government is always likely to be bailed out when things go wrong. He maintained that foreign aid could affect governance and growth through direct and indirect mechanisms. Through the direct mechanism, aid can and does directly strengthen existing corruption patterns in contexts where high levels of corruption are already rampant, if institutions are weak, and indirectly foreign aid could harm governance and growth through its tendency to create multiple distortions in the public sector, foster the emergence of a rentier state effect, and delay pressures for effective reform.

3.0 REVIEW OF LITERATURE

3.1 Conceptual Issues

Foreign aid is often used synonymously with Official Development Assistance (ODA). ODA is defined as the flow of official financing to the developing world that is concessional in character, comprising of grants and loans with at least a 25 percent grant component. It is generally administered with the objective of promoting the economic development and welfare of developing countries, and comprises both bilateral aid that flows directly from donor to recipient governments and multilateral aid that is channelled through an intermediary lending institution like the World Bank. This definition excludes debt relief, technical assistance, and other forms of aid (Abuzeid, 2012). Official development assistance in the form of transfers constitutes an important channel through which wealth is transferred from the rich developed nations to the poor underdeveloped nations (Chatterjee and Turnosky, 2005). Net ODA is defined as the sum of grants and net concessional loan disbursements for development purposes less repayments, and includes free-standing technical

cooperation (TC) grants (Iyoha, 2004). Official development assistance to Africa, including ECOWAS is provided mainly by the rich industrialized countries of Europe, North America, Japan and Australia. These donors are members of the Development Assistance Committee (DAC) of the Organization for Economic Cooperation and Development (OECD). DAC countries are the source of official development assistance to Africa and other developing countries.

In the narrow sense, aid consists of grants and technical assistance. A grant is transfer of resources with no obligation for repayment. The grant may be in hard currency (foreign exchange), services or kind. Technical assistance consists of men, capital and technical equipment. More often than not technical assistance is designed to promote capacity building in the recipient country through the training of manpower and institution building. Nevertheless, in a wider sense, aid is often conceived to include all transfer of resources. Thus, in addition to grants, aid encompasses loans and private foreign investment. The loan, can be long-term, medium-term or short-term and can have strings or conditionalities attached to it, just as grants. The key difference between a grant and a loan is that a grant is a free gift, while the loan has to be repaid (Iyoha, 2004). The justification for foreign aid according to Asher (1996) includes - reconstruction of the economies of war military defence of the free world, and the promotion of economic growth and political stability of the underdeveloped Africa.

3.2 Theoretical Literature

The theoretical underpinning for the proposition that aid can promote economic growth is rooted in th**e** two gap model (i.e- savings gap and foreign exchange gap) articulated by McKinnon, (1964). According to the proposition, the savings gap arises from the fact that domestic savings tend to be low in typical developing countries, and thus falls short of required investment needed to drive economic growth, while the foreign exchange gap arises from the fact that for variety of reasons to include; extreme dependence on single or few range of primary commodity exports, export instability, unfavourable terms of trade, and internationally generated and transmitted shocks, many developing countries run import surpluses or balance of payment deficit (Iyoha, 2004), leading to inadequate foreign exchange earnings needed to facilitate the import of the required capital machineries and other inputs needed for growth. Thus, these gaps can be filled by foreign capital inflow in the form of aid (Ozekhome, 2017).

In addition, there exist two strands of literature on the role of foreign aid on economic growth. The first proponents- the Modernisation Hypothesis asserts that foreign capital

inflow is necessary and sufficient for economic growth in the less developed countries. They argue that there exists a positive relationship between aid and economic growth because it complements domestic resources and also supplements domestic savings. Furthermore, foreign aid assists in closing the foreign exchange gap, provides access to modern technology and managerial skills, and allows easier access to foreign market (Chenery and Strout, 1966; Levy, 1988; Islam, 1992). The second proponents argue that external capital in the form of aid exerts significant negative effects on the economic growth of recipient countries. According to this view, foreign aid is fully consumed and substitutes rather than compliments domestic resources. Furthermore, foreign aid assists to import inappropriate technology, distorts domestic income distribution, and encourages a bigger, inefficient and corrupt government in developing countries (Boone, 1994; 1996; Easterly, 1999). They argue that the host country tend to depend on aid (aid dependency-syndrome) and its poor linkages within the economy to the detriment of meaningful and productive domestic investment. This situation has the tendency to create destabilizing effects on growth, especially when aid is withdrawn or reversed (Bornscier, 1980). They further maintained that as a result of diversion of aid from investment to unproductive consumption uses, corruption tend to increase in host countries, thereby lowering growth.

The literature on the role of foreign private capital inflow however contains overwhelming evidence in support of the growth-enhancing effects of aid, particularly in the presence of sound macroeconomic policy environment, good institutional framework and effective governance. In the same vein, recent developments in growth theory argue that improvements in technology, efficiency, capital accumulation and productivity brought about by foreign private capital (aid in this context) have the capacity to stimulate growth. The theoretical contention is based on the notion that aid increases the rate of technical progress in the host country through its positive spillovers from advanced technology, managerial expertise, entrepreneurship, and innovation (Morrissey, 2001).

3.3 Review of Empirical Studies

Different approaches have been used to analyze growth models to foreign aid, macroeconomic policy and institutional quality. Studies focusing on single country analyses, although few have adopted univariate models (see Chatterjee, & Turnosky, 2005; Dalgaard, Hasen, & Tarp, 2004), multivariate model (see Feeny, & McGillivray (2008 and Sakyi, 2010) and simultaneous equations model (Dollar & Easterly; 1999, Gounder, 2001). For studies that utilize panel data, the static model estimators involving fixed effects and random effects are evident (see Dhakal, Upadhyaya, & Upadhyaya,

1996; Burnside and Dollar, 2000; Gomannee, Girma & Morrissey , 2002; Iyoha, 2004; Ericsson and Irandoust, 2005; Hatemi-J & Irandoust, 2005; Kasuga, 2007; Cieslik and Tarsalewska, 2008; Ndambendia & Njoupouognigni, 2010; Malik, 2010; Eregha, Sede & Ibidapo, 2012; Ekanayake, & Chatrna, 2012; and Olabode, 2013), while the dynamic model estimators involving the GMM-type seem to have gained prominence (e.g Veiderpass and Andersson (2007); hence, the choice of the latter in the current study. Some of the attractions to the GMM-type estimators, including the underlying assumptions are well-documented in the studies of Ndambendia and Njoupouognigni, (2010), Tiwari (2011); Fiodenji & Evlo, (2013; Ozekhome, (2017). In addition, this category of estimators require short T, which is one of the features of data on aid and institutional quality (see Fiodendji & Evlo, 2013). These variables are rarely available for a longer time horizon, and that partly explains why most studies use panel with several cross-sections to compensate for the short time series.

As observed by the previous studies, the effect of foreign private capital inflow (aid in this respect) on economic growth is positive and statistically significant (Roy and Berg, 2006; Xu and Wang, 2007; Bhandari et al., 2007). The effect has been found to be supported by some institutional factors such as level of education, basic physical infrastructure, and appropriateness of institutions (Adams, 2008). However, attractiveness of aid which is based on good policy, economic and political stability of host country is a necessary condition, but not sufficient to stimulate positive relationship between aid and economic growth. Concerning the channels, it seems obvious that domestic investment is likely the most important in which private capital exerts a strong positive effect on economic growth in developing countries. Some other studies find that good fiscal, monetary and trade policies as well as right institutional framework are a necessary condition for effectiveness in the foreign aid-growth nexus (Ekanayake and Chatrna, 2012; Fiodenji and Evlo, 2013). Olabode (2013) re-examines the effects of disaggregated foreign aid on poverty level in 8 West African countries between 1975 and 2010. Employing both the techniques of heterogeneous panel unit root test, cointegration test and empirical estimators with heterogeneous slopes, the findings reveal that total foreign aid impact positively on poverty, while technical aid reduces poverty.

Fiodendji and Evlo (2013) in particular, examine the threshold effects in the foreign aid-economic growth nexus using institutional quality and macroeconomic policy environment. Employing a modified panel threshold model on panel data of 13 ECOWAS countries over the period 1984 to 2010, the findings show that the relationship between aid and economic growth is nonlinear with a unique threshold of 0.206. The

evidence further show that stable macroeconomic environment and good institutional framework are indispensable for aid effectiveness in ECOWAS countries since bad institutional quality may have detrimental effects on economic growth. The study identified the conditions under which aid has a positive impact on economic growth which include: the combination of macroeconomic policy environment and institutional quality above their thresholds respectively. This according to them, is relevant for the achievement of sustainable economic growth. The authors conclude that the findings will be important for policymakers and international financial institutions which increasingly favour conditionality and selectivity in the allocation of aid resources. The major policy implication of the findings according to the authors is not that foreign aid should be reduce, but rather a call for rethinking strategies for international assistance and redesigning existing aid programmes.

From the fairly large volume of literature, there is paucity of empirical studies on the effects of aid on growth, accounting for macroeconomic policy environment and institutional quality, using dynamic panel estimators, hence, warranting further empirical investigations.

4.0 METHODOLOGY

4.1. Theoretical Framework and Model Specification

The empirical model used in this study is motivated by the endogenous growth model. The most interesting aspect of endogenous growth models is that it helps to explain the disparities in growth rate across countries, arising from differential rates of capital accumulation (i.e domestic and external capital in this context), institutional quality and macroeconomic environment.

The general endogenous production function is

$$Y = AK^{\propto_i} L^{1-\propto_i} \quad (1)$$

Where:

A = Total factor productivity- a measure of efficiency of factor inputs

K = Capital stock (which is decomposed to into human and physical capital)

L = Labour.

α and β, represents the elasticity of output with respect to capital and labour, respectively.

The model in equation (1) is an endogenous growth model since the residual component, A, which is a measure of technological progress and human capital accumulation are endogenized; thus, implying that technological knowledge and the

accumulation of human capital are incorporated not as exogenous growth-generating factors but explaining the growth process itself.

Following Jones [1998], the aggregate production function is provided:

$$Y = IK^{\alpha}(AL)^{1-\alpha} \quad (2)$$

Where, Y= Real output (ie as real GDP (a measure of economic growth), I denotes the influence of an economy's infrastructure on the productivity of its inputs, K is capital, decomposed to into human and physical capital, A is a measure of technology, (i.e total factor productivity or a measure of efficiency of factor inputs), L is labour stock; α and 1- α (i.e β), represent the elasticity of output with respect to capital and labour, respectively, where α is a parameter between 0 and 1. In contrast to Solow and neoclassical models of growth, in endogenous growth models, changes in the rate of investment and changes in government policies can impact on the long run rate of growth. This model suggests that the infrastructure of an economy (I), relating to the government policies and institutions which make up the economic environment, is an important determinant of growth. Jones (1998) suggested that the cost of setting up businesses and the ability of investors to reap returns from their investments, varies considerably across countries. Thus, an important assumption in this specification is that institutions and government policies are considered to affect growth through two channels, the total factor productivity and the investment channels. A large part of this variation arises from differences in government policies and institutions – referred to as the infrastructure of a country. He predicts that a country that attracts investments in the form of capital for businesses, technology transfer from abroad and skills of individuals will be one in which: (a) the institutions and laws favour production over diversion; (b) the economy is open to international trade and competition in the global marketplace; and (c) the economic institutions are stable. Jones (1998, cited in Eregha, Sede & Ibidapo, 2012) states that a good infrastructure provides an environment which encourages investment, the acquisition of skills, invention and technology transfer. The empirical model motivated by the above theoretical considerations takes the stylized extended (modified) aid-growth function.

$$y_{it} = f(AID, I, X) \quad (3)$$

Where y_{it} is the dependent variable, which is the growth rate of real GDP (GRGDP)- a measure of economic growth, I , is a measure of infrastructure (encompassing macroeconomic policy and institutional quality), X is a vector of other macroeconomic control variables, which according to literature influences the aid growth nexus. This is because aid can only contribute significantly to growth through increase capital stock, improvements in human capital (i.e investment in human and physical capital) and other policy variables. In particular, good macroeconomic policy and institutional quality enhances aid effectiveness. The inclusion of these

variables is to include, as much as possible other critical variables that impact on the assumed relationship, and thus avoid omitted variable bias.
These variables thus include;
OPN = Openness of the domestic economy
SCHL = enrolment in secondary school as a measure of human capital accumulation

INV= real gross domestic capital formation to GDP (percent)

INST=institutional quality measured by averaging the six indicators of institutional quality to include rule of law, accountability, government effectiveness, control of corruption, regulatory quality and political stability

INF=Inflation rate (a measure of macroeconomic environment). As an indicator of macroeconomic environment, the inflation rate assumes greater importance, and it reflects the overall ability of a government to manage the economy.

The empirical specification of the model to be estimated, without the interaction terms is:

$$y_{i\,t}=, a_0 + a_1OPN_{i,t}+ a_2AID_{,t}+ a_3INV_{i,t}+ a_4SCH_{i,t}+ a_5INFi,t + a_6INST \quad (4)$$

The extended model is further expanded to include three interaction terms to capture the influence of institutional quality and macroeconomic policy environment on the effectiveness of aid on growth. Doing this leads to the following interaction model:

$$y_{i\,t}=, a_0 + a_1OPN_{i,t}+ a_2AIDi,t+ a_3INV_{i,t}+ a_4SCH_{i,t}+ a_5INFi,t + a_6INST + a_7AID*INFi,t + a_8AID *INST_{i,t} + a_9INST*INF_{i,t} + \varepsilon_t \quad (5)$$

Where AID*INST, AID*INF, INST*INF = interaction of aid and institution, aid and macroeconomic policy environment, and institutional quality and macroeconomic policy environment, respectively, *i* represent country (The 15 ECOWAS, and t represents the period (2002-2015). All other variables are as previously defined.

The a priori expectations are (a_1, a_2 a_3, a_4, a_6, a_7, a_8, a_9) > 0; a_5 < 0.
a_0 – a_9 are parameters to be estimated and ε_t is the unobserved error term.

From macroeconomic theory, aid, openness, foreign direct investment, real domestic capital formation, human capital and interaction term consisting of aid interacted with institutional quality variable and macroeconomic policy are expected to have positive impact on economic growth, while the coefficient of inflation is expected to

have a negative relationship with economic growth. The expected signs are based on capital accumulation and external finance theory. The higher degree of trade openness of a country, the higher will be the economic growth rate since trade openness facilitates greater integration into the global economy and stimulates growth through the channels of better resource allocation, greater competition, innovation, transfer of technology and access to foreign capital. Foreign aid stimulates growth by increasing the stock of capital, easing domestic resource and foreign exchange constraints to development, and facilitating the transfer of advanced technology, managerial and technical know-how from industrialized countries to host countries, thereby increasing productivity through positive spillovers, which in turn stimulates growth.

The higher the level of domestic investment, the more rapid will be the rate of economic growth since investment increases the capital stock and stimulate aggregate demand. An improvement in human capital brought about by human capital accumulation enhances economic growth through increase in the productivity of the work force. Thus, the higher the quality of human capital, the higher the rate of economic growth. Strong institutional framework that guarantees regulatory quality, government effectiveness, combats corruption and rent-seeking behaviour of economic agent is expected to impact positively on growth and enhance the effectiveness of aid. The interaction of aid with macroeconomic policy variable and aid with institutional quality variable is thus theoretically expected to have a positive relationship with economic growth. This is because; sound macroeconomic policy environment and institutional framework enhance aid effectiveness on growth.

4.2 Definition of Variables and Sources of Data

The definitions of the variables in the model, as well as the sources of data are provided in Table 3.

Table 3. Definition of Variables and Data Sources

Variable	Description	Source
Growth rate of real GDP	Annual real GDP growth	World Economic Outlook (IMF), WAMZ Macroeconomic Convergence Report
Trade Openness	Sum of Imports and exports as percentage of GDP	World Development Indicators (World Bank)
AID	Ratio of foreign aid (Official Development Assistance) to GDP percent	World Development Indicators (World Bank)
Investment	Ratio of gross capital formation to GDP percent	World Economic Outlook (IMF
Human capital	Secondary school enrolment ratio	World Development Indicators (World Bank)
Institutional quality	Institutional quality is measured as the average of six institutional indicators http://info.worldbank.org/governance/wgi/index #home	World Development Indicators (World Bank)
Inflation	Annual growth rate of consumer price index	WAMZ Macroeconomic Convergence

Source: Author's compilation

4.3 Justification for the Inclusion of the Control variables

Several control variables are critical to the effectiveness of aid on growth. First, institutional quality and government policies (proxied by macroeconomic policy influence aid effectiveness in line with the endogenous growth theory that strong policy variables and institutional quality are critical determinants of growth, as well as influencing the effect of external private capital (aid in this context). Thus, the inclusion of macroeconomic policy, institutional quality variable and trade openness is in line with the extant of theory.

Second, domestic investment influences the absorptive capacity of foreign private capital. As stock of capital increases, the rate of growth increases as well, as accumulation of human and physical capital are critical to sustained economic growth in the long run, since they facilitate the efficient absorption of new capital development, improves the speed of adaptation of entrepreneurs and generates

innovation necessary for sustained economic growth. In particular, increase level of domestic investment, will generate more rapid economic growth since investment increases the capital stock and stimulate aggregate demand. Human capital accumulation, in accordance with the endogenous growth model, permits diffusion of knowledge (knowledge spillovers), technology efficiency and productivity growth, which have the capacity to stimulate growth. Through 'learning by doing', the model further demonstrates the high growth-generating capacity of human capital accumulation. In general, the model demonstrates that human capital accumulation encompassing knowledge and skills which induce labour efficiency is critical to rapid and sustained growth path. This position is supported by Lucas (1988) who argued that increased investment and improvements in innovations and technical progress arising from human capital development can lead to increase productivity and competitiveness, which trigger a further growth. The inclusion of the variables is thus in line with theory and extant literature.

4.4 Estimation Technique

The choice of a GMM-type is based on a number of reasons. First, the GMM-type estimators including the system GMM estimator are used for dynamic models as they help resolve any inherent endogeneity in the model. Second, the GMM-type estimators are also useful when dealing with a situation where N>T, I presumed to be the case here. Third, the estimators are used if T is short (where T<25) after accounting for the first and second conditions.

One of the problems of most studies of the aid-growth relationship based on cross-country regressions is that they lump together countries of heterogeneous characteristics and size. There is also the problem of reverse causality. For example, aid may rise in response to poor growth (and saving) performance, producing a high correlation between low growth and high aid flows. This may generate potential bias in estimation. In order to avoid the problems of potential bias and heteroskedasticity arising from endogeneity (simulataneity) associated with cross-country studies, and problems of mis-specification and omission of variable bias, this study adopts the system-GMM. The technique addresses the triple-problem of endogeneity of the regressors, the measurement error and omitted variables. In the literature, one of the methods of estimating a dynamic panel data model is the first-differenced equation estimated by the Generalized Method of Moments (GMM) approach. This approach overcomes the problem of unobserved period and country specific effects (economic peculiarities) and joint endogeneity of most of the explanatory variables with the endogenous variable, and, thus, control for the biases resulting from simultaneous or

reverse causation. The system-GMM estimator developed by Arellano and Bover (1995), Blundell and Bond (1998) tends to have better finite sample properties, provide more precise, less biased, consistent estimates and asymptotically efficient estimates than the first-differenced GMM estimator since it exploits the available time-series information more efficiently; Blundell and Bond (1998), and Bond et al. (2001).

The good performance of the System GMM estimator relative to the difference-GMM estimator in terms of finite sample bias and root mean square error has made it preferable, particularly when series are persistent and there is asymptotic reduction in the finite sample bias due to the exploitation of additional moment conditions (Alonso-Borrego and Arellano, 1999). The system GMM estimator is computed by combining moment conditions for the equations in first-differences using suitably lagged variables as instruments, with additional moment conditions for the equations in levels where the instruments are suitably lagged values, provided these first-differences are uncorrelated with the within-sample effects. System GMM estimator thus eliminates any potential bias that may arise from ignoring dynamic endogeneity and also provides theoretically based and powerful instruments that accounts for simultaneity while eliminating any unobservable heterogeneity (Blundell and Bond (1998). Unlike the difference estimation, the system estimators make use of lagged differences of the endogenous variables as standard instruments for the level equation. In view of the obvious strengths of the Blundell and Bond's (1998) extended version of the GMM estimator (known as the System- GMM estimator) in overcoming complications that may arise from efforts to estimate the usual linear dynamic panel data models; it is therefore considered appropriate and applied in this study. To check for the robustness of the estimated parameters, the Fully Modified Ordinary Least Squares (FMOLS), which corrects for autocorrelation, potential endogeneity of regressors and reverse cauasality is also employed to estimate the model. The FMOLS is also able to account for considerable heterogeneity across individual panel to produce asymptotic unbiased estimators and nuisance parameters, free normal distributions (Pedroni, 2000).

5.0 EMPIRICAL RESULTS

5.1 Descriptive Statistics

Table 4 presents the summary statistics for the variables used in this study. Average real GDP growth for the ECOWAS countries during the period is 4.9 percent. The median value is 5.1 percent. The maximum and minimum growth rate is 8.2 percent and 0.8 percent respectively. Invariably, growth performance tend to have converged

around the mean value in the focus period, portraying a pronounced differential real GDP growth among the ECOWAS member countries from high growth rate, which exceeded the observed average in the zone in some of the countries to very low growth rate which were far below the sub-region's average in others. By implication, Real GDP growth rate seems to have exhibited differential patterns in the respective countries. This wide dispersion and differential growth rate among the countries is further confirmed by the relatively high standard deviation value of 4.8. The corresponding average values for trade openness, Aid, investment, human capital development, inflation and institutional quality variable are 61.1, 17.2 , 34.4 and 41.6, 11.4 and 1.42. The standard deviation of inflation of 5.3, combined with a Jarque Bera value of 572.3 which is higher than all others over the sample period is a clear indication of non-symmetry (i.e inflation variability) in the sampled countries during the period of the study. The skewness statistic of growth rate of real GDP is -0.38, which, combined with the value of the Jarque-Bera statistic of 12.26 suggests that the hypothesis of normality in the distribution cannot be accepted, thus implying a non-symmetric distribution. Therefore, the data series may have endogeneity issues, unless an appropriate technique, which is capable of removing potential bias and endogeneity is used in the estimation of the model. This therefore necessitates the adoption of a dynamic GMM estimator which is capable of controlling the joint endogeneity effects of most of the explanatory variables with economic growth, and, thus to control for the biases resulting from simultaneous or reverse causation.

Table 4: Descriptive Statistics

	Mean	*Median*	*Max.*	*Min.*	*Std. Dev.*	*Skewness*	*Kurtosis*	*J-B*
GRGDP	4.90	5.10	8.20	0.75	4.8	-0.38	2.64	12.26
OPN	61.07.	60.24	74.50	49.60	5.25	-0.02`	2.75	6.81
AID	17.22	20.03	37.62	0.01	3.65	-0.25	2.80	6.22
INV	34.44	35.10	50.30	18.7	7.62	-0.08	2.20	4.83
SCHL	41.55	42.40	57.32	19.20	7.20	-0.75	3.78	14.30
INF	11.40	12.25	32.10	0.30	4.90	1.75	8.45	573.2
INST	1.42	-1.50	2.50	-1.25	3.30	-0.75	2.14	9.44

5.2 Analysis of Generalized Method of Moments (GMM) Results

The Arellano and Bond (1991) GMM estimator can be carried out to determine the impact of foreign aid on economic growth in ECOWAS. The growth model is estimated first without accounting for macroeconomic policy environment and institutional quality and then, accounting for their respective interaction with aid (i.e without the inclusion of the interaction of aid with institutional quality and aid with macroeconomic policy and with their inclusion The alternative results from the FMOLS which is used to test for robustness, by using alternative proxies for the institutional quality variable is also presented.

Lagged growth rate of real GDP has the correct sign and is significant at the 10 percent level in all the estimations. This implies that previous economic growth constitute a basis for attaining higher economic growth rate in countries. This is particular important as it tends to help in the re-direction of macroeconomic policies towards achieving better growth rate in succeeding years. Basing the elasticity estimate on the interaction model, a 10 percent increase in previous economic growth will stimulate future economic growth in the succeeding year by 0.8 percent. The coefficient of trade openness is consistent with theoretical projection in all the model estimations and significant at the 1 percent level. Thus, increased trade openness stimulates economic growth in ECOWAS countries through more integration into the global economy, efficient and optimal resource allocation and competition. The finding supports the results of Adamu, Igodaro and Iyoha (2012) and Ozekhome (2017). In line with the estimates, a 10 percent increase in trade openness will stimulate economic growth by 2.1 percent in ECOWAS countries.

The coefficient of foreign aid is negative and fails the significance test in the model without the pair of interaction. Invariably, in the absence of good institutions and macroeconomic environment, aid effectiveness on growth is negative and weak. The interaction of aid with macroeconomic policy and institutional quality with macroeconomic policy are both positive, but pass the significance test only at the 10 percent level, while that of the interaction of aid with institutional quality is statistically significant at the 5 percent level. This implies that strong institutional framework that encompasses government effectiveness, regulatory quality, rule of law, political stability, enforceability of contract proceedings, prevention of expropriation and rent-seeking behaviours matters more to aid effectiveness than macroeconomic policy, in terms of moderating the negative impact of aid on growth in ECOWAS countries, and making aid beneficial to growth. Apparently, the latter enhances the former, as it provides strong institutional settings for good economic policy management. Thus,

sound macroeconomic policy environment and good institutional framework are critical to aid effectiveness on growth in the sub-region, but building strong institutional framework is more compelling and result-oriented. The finding corroborates the results of Abuzeid (2012) and Fiodendji and Evlo (2013).

Thus, aid effectiveness in ECOWAS countries can be enhanced through sound and stable macroeconomic policies, good institutional framework, excellent economic management and good governance. This idea is also consistent with the insight that countries with lower level of distortions, good macroeconomic policies and institutional framework, will on the average grow faster than countries with poor macroeconomic and institutional environment. Aid effectiveness is thus responsive to sound macroeconomic policy environment, good institutions and efficient economic management. The elasticity coefficient of the interaction of aid with macroeconomic policy, aid with institutional quality and institutional quality with macroeconomic policy show a growth intensification of 0.6 percent, 0.2 percent and 0.1 percent, respectively. Invariably, sound economic policy management, good governance and quality institutional framework enhance growth effectiveness of aid.

The coefficient of domestic investment (real gross domestic capital formation) has the expected positive sign and is significant at the 1 percent level in all the estimations. This implies that increase investment in capital is highly growth-inducing. Invariably, increased capital accumulation has the capacity to generate faster economic growth in the sub-region. The elasticity coefficient of gross capital formation (domestic investment) shows that a 10 percent increase in domestic capital accumulation will on the average trigger economic growth in ECOWAS region by 2.3 percent.

The coefficient of human capital is appropriately signed in line with theoretical expectation and passes the significance test at the 5 percent level in all the estimations. Thus, increase human capital development will promote rapid economic growth in ECOWAS countries, through the acquisition of better knowledge that induces the speed of technological adaptation, via its positive spillovers, labour productivity, efficient absorption of new capital developments, improved managerial enterprise and generation of innovation necessary for growth (Baliamount-Lutz, 2004; Ozekhome, 2017). The elasticity coefficient indicates that a 10 percent increase in human capital accumulation (development) will on the average induce economic growth in ECOWAS by 2.2 percent.

The coefficient of institutions is positively signed but not significant at conventional levels in all the estimations. This implies that though institutions positively affect growth, the sub-region is characterized by weak institutional framework. The result buttresses the findings of Park (2012) and Ozekhome (2016) and again confirms the earlier findings that in the absence of interaction, the impact of institutions on growth is weak in the sub-region, but when interacted with aid, growth is enhanced.

Inflation (an indicator of macroeconomic environment) is negatively signed in line with theoretical expectation, and is statistically significant at the 5 percent in all the estimations. Thus, high inflation (a symptom of macroeconomic instability) undermines economic growth in the sub-region. The elasticity coefficient indicates that a 10 percent rise in the rate of inflation will dampen economic growth in ECOWAS by percent 1.8 percent.

Considering key diagnostic tests for the robustness and validity of results obtained, the Hansen-J over-identification test, which serves to verify the validity of instruments fails to reject the null hypothesis that there is no endogeneity problem in the two GMM-type estimations. This implies that the over-identifying restrictions are equal to zero and valid. Thus, we cannot reject the specification of the model, since it is well specified and the instruments seem to be appropriate and valid. The result provides good certification for the choice of the exogeneity of the levels and differenced instruments, as required in a system-GMM. The post-estimation evidence also leads to the rejection of the null hypothesis of no serial correlation at order one in the first-difference errors, but a failure to reject same at order two (with AR (1) = -2.88 (0.003)*** and AR (2) = -0.65 (0.51) and AR (1) = -3.01 (0.003) *** and AR (2) = -0.61 (0.54), respectively for the model without interaction and with interaction. There is thus no evidence to invalidate the model considering that, according to Arellano and Bond (1991), the GMM estimates are robust in the presence of first-order serial correlation, but not in the second-order serial correlation in the error terms. The long-run variance in the alternative FMOLS estimation used for robustness check also indicates that the model is robust and sound. This therefore implies both models are good for structural and policy analysis.

Table 5. Results from the Arellano and Bover (1995) (GMM) Estimator
The Effect of Aid on Growth in ECOWAS

Regressors	Without Interaction	With (Interaction)	FMOLS
C	0.892	0.125*	-
S.E		0.015	0.107
Lagged GRGDP	0.8024*	0.076*	-0.773*
S.E		0.002	0.104
OPN	0.314***	0.213***	0.356***
S.E		0.070	0.051
AID	-0.113	-0.016	-0.093
S.E		0.104	0.102
INST	0.019	0.046	0.031
S.E		0.105	0.103
INF	-0.109**	-0.177**	-0.126**
S.E		0.020	0.003
AID*INF		0.061	0.032
S.E		0.033	0.029
AID*INST		0.024**	0.003**
S.E		0.024	0.018
INST*INF		0.011*	0.016*
S.E		0.0041	0.038
INV	0.202***	0.225***	0.049***
S.E		0.202	0.196
SCHL	0.1320***	0.223**	0.170**
S.E		0.602	0.014
J statistic	3.60	4.025	
AR(1) **AR(2)**	-2.880[0.004] -0.652[0.51]	-3.01[0.003] -0.610[0.54]	
Long-run Variance			0.032

Reported coefficients and corresponding standard errors (S.E.) in the interaction model estimation are average marginal effects and have been calculated following the approach suggested by Bartus (2005).
***** Statistical significance at the 1% level: ** Statistical significance at the 5 % level; * Statistical significance at the 10% level**
Note: Sargan, Hansen tests, AR (1) indicates rejection of the null hypothesis of no serial correlation at order one (1) and non-rejection of same at order two (2) AR (2).
Source: Author' computation

6.0 CONCLUSION

This study investigates the impact of foreign aid on economic growth, and whether macroeconomic policy environment and institutional settings matter to the to aid effectiveness in the ECOWAS region, using system-GMM on dynamic panel data for the period 2002-2015. In doing this, a growth model that does not account for macroeconomic policy environment and institutional quality (i. e without their interaction with aid) is first estimated, and then, estimating another, where they are accounted for, using pairs of interaction of variables. The empirical results reveal that foreign aid has a negative but weak impact on growth in the model where macroeconomic policy environment and institutional quality are not accounted for. But when macroeconomic policy environment (poxied by inflation) and institutional quality variable are accounted for (i.e interaction of aid with macroeconomic policy environment and interaction of aid with institutional quality), the negative effect of aid is moderated, with the coefficient of the interactive terms appearing positive and significant, with that of the interaction of aid and institutional quality more pronounced. This implies that although macroeconomic policy environment and institutional quality both matter for aid effectiveness, greater emphasis should be placed on creating strong institutional framework in terms of rule of law, political stability, control of corruption, government effectiveness, regulatory framework and curtailment of rent-seeking and expropriational tendencies.

The interaction of institutional quality with macroeconomic policy environment also yields positive and significant effect on economic growth. The intuition and implication of this finding is that sound policy and good economic management and institutional setup are critical to enhancing aid effectiveness. As the evidence show, without good institutions and favourable macroeconomic policies, given the poor macroeconomic policy environment and institutional framework in the sub-region, aid is likely to have a detrimental impact on growth. Ostensibly, selectivity on the basis of institutional setups that promote good governance and macroeconomic policy management could

become potential policy conditonalities for official development assistance by donors. Other variables that influence economic growth in the region are openness to trade, real gross domestic capital formation and human capital development.

Against the backdrop of making aid and other private capital inflows beneficial to growth in the sub-region, in terms of effectiveness, it is important that sound and stable macroeconomic policy environment and good institutional structures be put in place in the sub-region. In addition, economic openness to trade, increase investments in physical and human capital accumulation are critical to sustained economic growth in the sub-region. Nevertheless, cautious optimism should be exercised in terms of over-dependence on foreign aid, a condition termed 'aid dependency syndrome', in which after large injections of aid for many years, a country or region becomes too dependent on aid and no longer prepares to be self-reliant. Given sudden policy reversal culminating in abrupt aid withdrawal by donors, such country or region might be heavily affected, in addition to sometimes 'too stringent' and unfavourable economic conditionalites that may be attached to receiving aid form bilateral donors.

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DETERMINANTS OF FDI INFLOWS TO NIGERIA: DOES CRIME RATE MATTER?

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Abstract

The study investigates the effect of crime on inflow of FDI to Nigeria. The effects of other macroeconomic factors on FDI inflows are also investigated. To achieve these objectives, the dynamic OLS (DOLS) technique is employed to analysis annual time series data spanning 1981 to 2016. The study finds that crime rate in Nigeria discourages FDI inflows. Further evidences from the study are that globalization, financial development and acceptable levels of inflation enhance the flow of FDI into the country. Based on the evidence, the study recommends, as measures to attract more FDI into country, intensification of government's efforts at combating crime in the country.

Keywords: Crime, FDI, Multinational Corporations, Political Regime
JEL Codes: F21, F23, K14.

1.0 Introduction

The role of FDI in economic growth has been copiously investigated (Asogwa & Osondu, 2014; Iamsiraroj & Ulubasoglu, 2015; Carbonell & Werner, 2018). Owing to low level of savings consequent on low income levels, the level of investment in Nigeria has been quite low. The savings-investment gap necessitates the need for inflow of foreign investment to expand the level of capital formation in the country. Foreign direct investment (FDI) in Nigeria constitutes significant portion of investment in key sectors of the economy such as oil and gas, manufacturing, and telecommunications (NCC, 2017). These sectors contribute largely to the nation's gross domestic product. The country's government is also making efforts to attract more FDI into other sectors of the economy to boost the level of economic activities therein.

The amount of FDI that flows into the economy is affected by myriads of factors and these have been investigated by various researchers (Demirhan & Masca, 2008; Mottaleb & Kalirajan, 2010; Wafure & Nurudeen, 2010; Offiong & Atsu, 2014; Ndem, Okoronkwo & Nwamuo, 2014; Akinlo, 2017; Arawomo & Apanisile, 2018). Most of the

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literature involving the determinants of FDI inflows have argued from economics perspective (such as effects of inflation, trade openness, infrastructure, exchange rate, interest rate, government spending, inflation, domestic investment, market size, economic growth, etc), ignoring the behavioural issues in FDI inflows. This creates an obvious gap in the literature. This study is motivated by the need to investigate the determinant of FDI inflows following the behavioural approach as suggested by Hosseini (2005). In doing this, the effect of crime (which is a behavioural factor) on FDI inflows to Nigeria is investigated.

Crime refers to "any activity publicly proscribed by the written laws of the society" (McGuire 2004, p.3). These activities are proscribed by law because of the dangers they pose to (and their harmful effects on) lives, property, investment, etc. Criminal activities include burglary, theft, murder, homicide, armed robbery, kidnapping, advanced fee fraud (online and offline), bribery and corruption, violence perpetrated by terrorists, and other violent and non-violent crimes. The causes of crime are numerous and they include economic, political, cultural and psychological factors. These have been investigated by researchers (Buonanno, 2003; İmrohoroğlu, Merlo & Rupert, 2006; Meera & Jayakumar, 2006; Khan, Ahmed, Nawaz & Zaman, 2015; Igbinedion & Ebomoyi, 2017).

According to Ramos and Ashby (2017, p. 1), the Halo Effect theory posits that "foreign investors draw overly broad impressions about a country based on high level of violent crimes in specific locations impacting on foreign direct investment (FDI) across the country". This suggests that crime rate could be a determinant of FDI in a country. High crime rate may serve as deterrent to FDI inflows to an economy. Considering the rising crime rate in Nigeria in recent times, and the recent ranking of the country as one of the top 20 countries with the highest crime rates in the world (NUMBEO, 2019), testing the validity of the Halo Effect theory for Nigeria will not be out of place. The outcome of the study will serve as a useful guide for the formulation of policies that are germane to enhancing the attractiveness of the country to foreign investors.

Figure 1 shows the trends in crime rate in the country in the period from 1981 to 2017.

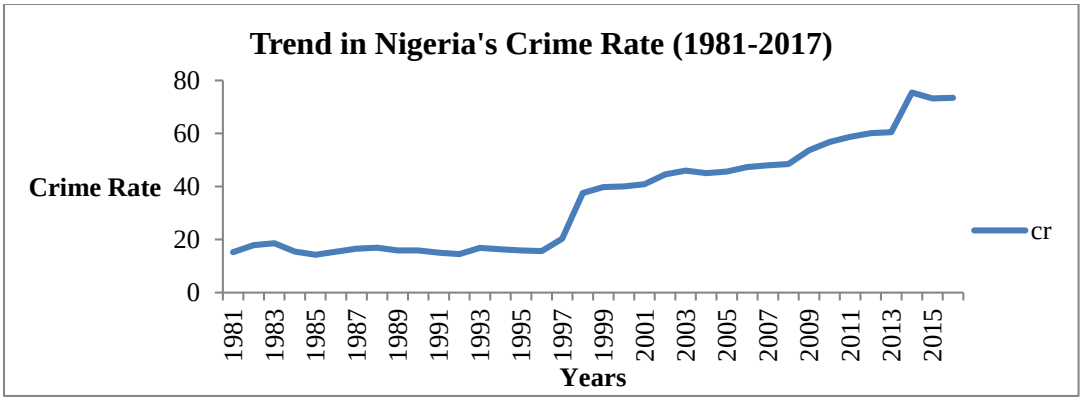

Figure 1. Nigeria's Annual Crime Rate.
Source: National Bureau of Statistics (2018)

Figure 1 shows that annual crime rate in the country generally trended upwards following the return of the country to the new democratic rule in 1999. From 1980 to 1997, crime rate was less than 20.5%. In fact, the highest crime rate in the period was recorded in 1997 as 20.3%. However, following the return of the country to democratic rule, crime rate in the country has been quite high. During the period from 2000-2008, annual crime rate was over 40%; during the 2009-2011 period, it was over 50%; during 2012-2013 period it was over 60%; during the period from 2014-2017 it was over 70%. With these figures, the efficiency of the anti-graft agencies such as the Independent Corrupt Practices and Other Related Offences Commission and Economic and Financial Crimes Commission which were set up in the period, and other government agencies set up to combat crime is in doubt. The rise in crime rate in the country may not be unconnected to the recent spate of kidnappings in the country, which may be linked to the high rates of unemployment, underemployment, and poverty (among other factors) prevalent in the country.

Figure 2 shows the trends in net FDI as a percentage of GDP in Nigeria.

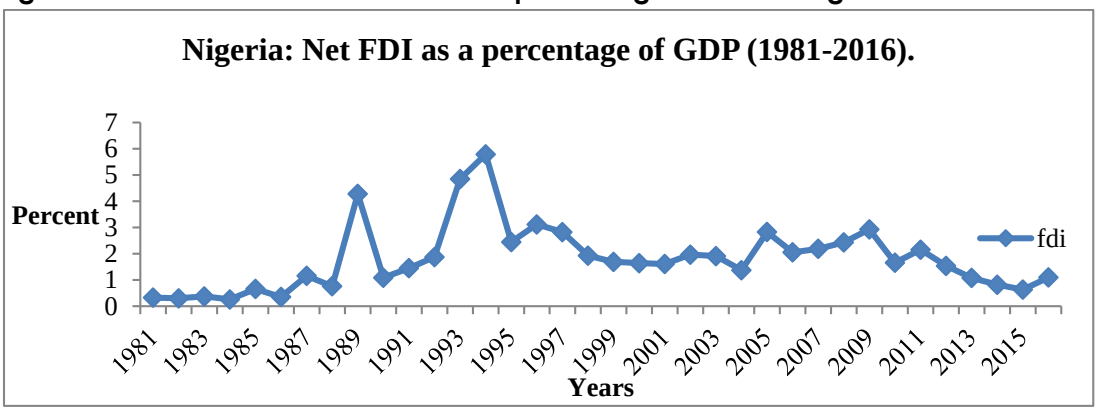

Figure 3. Trends in net FDI as a percentage of GDP in Nigeria (1981-2016)
Source: Data from WDI (2018)

Figure 2 shows that net FDI inflows in Nigeria has been quite unstable, and low. Its highest value between 1981 and 2016 was 5.74% recorded in 1994. Generally, between 1981 and 2016, crime rate and net FDI as a percentage of GDP trended in opposite directions. Increase in crime rate was associated with decrease in net FDI inflows in most part of the period. This tends to suggest that higher crime rates may have served to discourage flow of FDI into the country within the period under review. This shall be empirically investigated in this study.

For ease of presentation, the remainder of this paper is structured as follow. Section 2 presents a review of the relevant literature. Section 3 presents the methodology of the study. Here the theoretical framework for the study, the model specification and estimation technique are discussed. The results of analysis and discussion are presented in section 4. Section 5 contains the conclusion and the recommendations of the paper.

2.0 Literature Review

2.1 Theoretical Literature

There exist numerous theories explaining the determinants of FDI. Each of the theories identifies at least one factor explaining FDI inflows to an economy. Thus, Economists are of the view that there is no generally accepted theory of determinants of FDI, and that any model explaining the amount of FDI that flows into an economy must be derived from a combination of several theories (Agarwal, 1980; Feath, 2009; Denisia, 2010).

Denisia (2010) classified the theories of FDI into four, namely: The production cycle theory of Vernon; theory of exchange rates and imperfect capital markets; the internalisation theory; and the eclectic paradigm of Dunning. The production cycle theory was developed by Vernon in 1966. It was used to explain foreign investments made by United States (U. S) corporations in Western Europe after the Second World War. The theory identified four stages of production cycle namely: innovation, growth, maturity and decline. The first stage involves creation of new innovative products by U. S. corporations to serve the domestic markets and also to export surplus to Western Europe where there was increased demand for products manufactured in the U. S. This continues as the U. S. firms go through the growth and maturity stages since they had technological advantage over international competitors. Overtime, Western Europe firms began to copy and imitate the technologies of U. S. firms and to produce items similar to those imported from the U. S. To maintain their market shares in local markets of Europe, U. S. firms reacted by setting up plants in Western Europe. Thus the summary of this theory is that the desire by multinationals (which are key channels through which FDI is channeled into an economy) to maintain market shares of their products in domestic market is a determinant of foreign direct investment in a host economy. A drawback of this theory is that it ignored the fact that American multinational corporations also made investment in countries for production of goods in which they did not have any technological advantage during the period.

Proponents of the theory of exchange rate and imperfect capital markets argue that multinational corporations (MNCs) move into and set up production facilities in countries with weak or undervalued currencies, so as to sell their products to countries whose currencies are strong or overvalued (Moosa, 2012). Thus, the theory predicts positive effect of exchange rate devaluation or depreciation on FDI inflow.

The internalisation theory is based on domestic transactions cost. It predicts that a firm will decide to set up production plant(s) in foreign markets where costs of transactions (exporting and licensing a product to another country) are quite high in home markets. Thus, the firm internalises the transaction cost, and set up production plants/facilities in another country (Blonigen, 1997). Hymer (1976) argues that firms undertake foreign investment if the relative cost of operating abroad is less than the transaction cost.

The Eclectic paradigm, initially known as the Eclectic theory developed by Dunning (1958, 2001) is an extension of the internalisation theory. It is also referred to as the OLI (ownership, location and internalisation) model or framework for determination of international production. The ownership or specific advantage refers to the competitive advantage of the firm wishing to engage in foreign direct investment. The greater the firm's competitive advantage, the more likely it is to engage in foreign production. On the location advantage, firms are attracted to, and tend to engage in foreign production in locations where there is abundance of immobile natural or created resources which they require to use jointly with their competitive or ownership advantage. The internalisation advantage derives from the internalisation theory. As firm is more likely to engage in foreign production if the advantage of internalising its domestic transaction cost and engaging in foreign production exceeds the cost of licensing its technology or product(s) in another country.

Several other theories exists which attribute firms' decision for FDI or international production to market size, trade openness, and other economic factor (Demiran & Masca, 2008; Faeth, 2009). However, Hosseini (2005) attempted to explain the decision by multinational firms to engage in FDI in other countries. According to Hosseini (2005, p. 535) "culture (with indicators such as ethnicity, religion, etc.) is important for studying the behavior of multinational enterprises, in their investment and other activities". Where the cultures of the home country of the MNCs differ significantly from that of the targeted foreign market, this creates uncertainties which adversely affect the decision for international production.

The Halo effect theory of FDI determination attributes firms' decision to engage in foreign direct investment in a country to investors' broad impression of the country based on the level of crime in specific locations across the country. Thus, this theory identifies crime rate as a determinant of FDI inflow into a country.

2.2 Empirical Literature

Several studies have been conducted to examine the effect of crime on FDI inflows. In this section, we review some of the empirical studies.

Ashby and Ramos (2013) investigated the effect of violent crime on FDI from 116 countries into different sectors of the 32 states of Mexico from 2004 to 2010. In the study, number of reported murders was used to proxy regional organised crime, and Granger causal analysis was employed for the analysis. The study found that organised crime deters FDI inflows to financial services, commerce and agriculture sectors. However, increased crime was found to be associated with increased FDI inflows in the oil and gas sectors. Inflow of FDI to manufacturing sector was found to be unaffected by violent crime. Similar study by Blanco, Ruiz, Sawyer and Wooster (2015) examined the effect of crime on FDI inflows in different sectors (primary, secondary and tertiary) in Latin American and Caribbean countries during the period from 1996 to 2010. Three different crime-related variables namely homicide, crime victimization and an index of organized crime were used for the study. The study found that higher crime victimization and organised crime were associated with lower FDI inflows to the tertiary sector. It found no robust evidence of significant effect of crime on FDI in the primary and secondary sectors. The study recommended intensification of efforts by the government to combat crime in the regions.

Daniele and Marani (2011) investigated the effect of organised crime on FDI inflows in Italian provinces using panel data analysis. In the study, organised crime is measured as the number of cases of reported crimes perpetrated by the mafia crime organisation. The study found an inverse relationship between organised crime and FDI. The result, according to the researchers, suggests that organised crime served as deterrent to foreign investors as it renders the investment environment unfavourable for FDI. A previous study by Daniele (2010) also concluded that high level of crime in Southern Italy negatively affects economic outcomes, thereby creating notable distortions in local markets and a business climate unfavourable to foreign and domestic investment.

Helmy (2012) examined the effect of corruption, homicide and macroeconomic factors on FDI flows to the Middle East and North Africa (MENA) region during the 2003-2009, using different panel settings (fixed effects model estimated with the least squares estimator, and a dynamic specification estimated using the system generalised method of moments (GMM). The study found positive and significant effect of corruption on FDI. It also found that homicides and tax adversely affected FDI inflows into the region. Further evidences from the study are that macroeconomic

factors such as per capita income, trade openness, freedom and security of investment positively and significantly affected FDI inflows to the region. Thus there is need to combat crime (in the form of homicide and corruption) to enhance the attractiveness of the region to FDI.

The impact of crime on firm entry across municipal regions in South Africa during the period from 2003 to 2011 was examined in the study by Mahofa, Sundaram and Edwards (2016). Alternative estimations involving pooled OLS and fixed effect controlled OLS were performed to achieve the study objective. The results indicated that crime (contact crime, property crime, and household crime) negatively affected entry of new firms into South Africa's municipal regions.

Brown and Hibbert (2017) examined the effect of violent crime proxied by homicidal rates on FDI inflows in a sample of 67 countries in the period from 1997 to 2012, using OLS fixed effect and generalized method of moments (GMM) specifications. The study found that violent crime discouraged inflows of FDI into the economies. The researchers recommended that efforts should be made to address crimes so as to stem their effect on growth-enhancing FDI.

Afriyanto (2017) investigated the effect of crime on FDI in a sample of 31 provinces of Indonesia during the period from 2005 to 2015. The study found that crime negatively affected inflow of FDI into the provinces. The study therefore recommended that in addition to pursuing other policies to attract FDI, the government of Indonesia should also pay attention to incidence of crime in each of the provinces.

Ramos and Ashby (2017) investigated the effect of violent crime (homicides) on FDI in the states of Mexico in the period from 2001 to 2015. Fixed effect and system GMM models were employed for the analysis. The study found an inverse relationship between homicides and inward FDI, suggesting that high rate of violent crime negatively affects inflow of FDI to the states. Cabral, Mollick and Saucedo (2018) also studied the effect of violent crime on FDI inflows in the 32 subnational states of Mexico using quarterly data that span the period from 2005 to 2015. The study found that homicide and theft negatively and significantly affects FDI inflows to the country. The effects of other crimes on FDI inflows were found to be statistically not significant. In view of the observation that homicide and theft served as deterrence to inflow of FDI in subnational states, there is therefore need for the government to take steps to curb homicide and theft in the country, so as to enhance the attractiveness of various subnational states to foreign investment.

In Nigeria, the Nigerian Communications Commission, NCC (2018) attempted to examine the effect of cyber-crime on FDI inflows during the period from 2013 to 2016 using trend analysis to investigate the effect of cybercrime on FDI inflows to Nigeria during the period from 2013 to 2016. The study found that cyber-attacks either deter foreign investors from continuing their business or setting up new ones in the country. The study only focuses on the relationship between cyber-crime and FDI inflows in Nigeria, ignoring the other categories of crime. Moreover the study space is quite narrow and the methodology applied is less sophisticated. This study improves on the NCC's study by considering the effect of crime in a broader sense of the number of reported criminal cases (not just cyber-attacks) on FDI inflows over a wider scope of 1981 to 2016 using a more advanced econometric technique.

3.0 Methodology

3.1. Theoretical Framework and Model

The study follows the behavioural approach to modeling FDI decision developed by Hosseini (2005). This approach highlights the superiority of behavioural economics theory of FDI to other theories and identifies behavioural factors that are germane to attracting FDI to an economy. In adopting this approach, we build on the Halo Effect theory which attributes a country's attractiveness to FDI to foreigner's broad impressions about the country based on crime rate (which is a behavioural factor) therein (Ramos & Ashby, 2017). Thus FDI inflow to an economy may be regarded as a function of crime rate.

The theoretical framework on determinants of FDI developed in Demirhan & Masca, (2008) and Anyanwu (2011), identify market size (per capital income), inflation, financial development, infrastructure, trade openness, government consumption expenditure, etc. as determinants of FDI. Combining this with the position of the Halo Effect theory, we derive our model to be estimated for the study as follow:

From the Halo Effect theory,

$$\text{fdi} = f(crime) \tag{1}$$

From the theories on macroeconomic determinants of FDI,

$$\text{fdi} = f(pcy, inf, infsq, gi, findep, exrt, polreg) \tag{2}$$

Agarwal (1980, p.740) noted that "there is not one, but a number of competing theories with varying degrees of power to explain FDI". Corroborating this, Feath (2009, p.1) argues that "FDI should be explained more broadly by a combination of factors

from a variety of theoretical models". Our model to explain the determinants of FDI inflows to Nigeria is therefore derived by combining equations (1) and (2) above as:

$$\text{fdi} = f(cri, pcy, inf, infsq, gi, findep, exrt, polreg) \quad (3)$$

Where fdi = foreign direct investment as a percentage of GDP, cr = crime rate, measured as annual number of reported cases of crime per year (including homicides, kidnapping, etc.) per 100, 000 of the population, pcy = per capita real GDP (proxy for market size), inf = inflation rate, measured as annual percentage change in the consumer price index, infsq (squared inflation) is incorporated to determine existence or otherwise, of threshold effect of inflation, gi = globalistion index, which is a composite index for economic, political and social-cultural integration or globalisation computed by KOF Swiss Economic Institute, findep = index of financial depth, defined by the World Bank (2018) as "private credit by deposit money banks and other financial institutions to GDP", and calculated by the Bank using the following deflation method: {(0.5)*[Ft/P_et + Ft-1/P_et-1]}/[GDPt/P_at] where F is credit to the private sector, P_e is end-of period CPI, and P_a is average annual CPI. Exrt = nominal (N/$) exchange rate, Polreg = political regime (or regime type, using polity iv index whose value range from -10 to +10, with -10 representing highly autocratic regime/dictatorship, and +10 representing highly democratic regime).

The static (long-run) model is presented in its econometric form as:

$$fdi_t = \beta_0 + \beta_1 cr_t + \beta_2 \ln(pcy_t) + \beta_3 inf_t + \beta_4 infsq_t + \beta_5 gi_t + \beta_6 findep_t + \beta_7 \ln(exrt)_t + \beta_8 polreg_t + \varepsilon_t \quad (4)$$

Equation 3 is the static specification of the econometric model.
The *a priori* expectations are: $\beta_1 < 0$, $\beta_2 > 0$, $\beta_3 > 0$, $\beta_4 < 0$, $\beta_5 > 0$, $\beta_6 > 0$, $\beta_7 > 0$, $\beta_8 </> 0$.
The autoregressive distributed lag (ARDL) modeling approach to cointegration and error correction analysis developed by Pesaran, Shin and Smith (2001) was adopted to analyse the relationship between the dependent variable and explanatory variables. The choice of this approach was informed by its flexibility in application in that it can be applied in cases of mixed order of integration of data, and the fact that it yields consistent and efficient long-run coefficient estimates valid t-statistics even in the presence of regressor endogeneity inherent among cointegrated regressors. The ARDL model is specified as:

$$\Delta \mathrm{fdi}_t = \beta_0 + \sum_{j=1}^{p}(\theta_{1j}\Delta \mathrm{fdi}_{t-j}) + \sum_{j=0}^{p}(\theta_{2j}\Delta \mathrm{cr}_{t-j}) + \sum_{j=0}^{p}(\theta_{3j}\Delta \ln(\mathrm{pcy}_{t-j}) + \sum_{j=0}^{P}(\theta_{4j}\Delta inf_{t-j}) + \sum_{j=0}^{P}(\theta_{5j}\Delta infsq_{t-j}) + \sum_{j=0}^{P}(\theta_{6j}\Delta gi_{t-j}) + \sum_{j=0}^{P}(\theta_{7j}\Delta findep_{t-j}) + \sum_{j=0}^{p}(\theta_{8j}\Delta exrt_{t-j}) + \sum_{j=0}^{p}(\theta_{9j}\Delta polreg_{t-j}) + \beta_1 \mathrm{cr}_{t-1} + \beta_2 \ln(\mathrm{pcy}_{t-1}) + \beta_3 \mathrm{inf}_{t-1} + \beta_4 \mathrm{infsq}_{t-1} + \beta_5 gi_{t-1} + \beta_6 \mathrm{findep}_{t-1} + \beta_7 \ln(exrt_{t-1}) + \beta_8 \mathrm{polreg}_{t-1} + \mu_t \quad (5)$$

The parameters β_1 to β_8 are the corresponding long run parameters, while the parameters θ_{1i} …θ_{8i} are the respective short run coefficients of the underlying ARDL model. Δ is the difference operator, μ is the error term, j is the optimal lag order of the ARDL to be empirically determined. The implementation of the ARDL bounds test begins with the OLS estimation of equation 4, and testing the joint significance of the lagged levels of the explanatory variables using the F-test.

The null hypothesis of no cointegration ($\beta_1 = \beta_2 = \beta_3 = \ldots\beta_8 = 0$) is tested against the alternative hypothesis of cointegration (($\beta_1 \neq \beta_2 \neq \beta_3 \neq \ldots\beta_8 \neq 0$).

Two sets of asymptotic critical values at different levels of statistical significance for the computed F-statistics are provided by Pesaran *et al.* (2001). The first (which are the lower bound critical values) assumes that all variables of the model are I(0), while the second (the upper bound critical values) assumes all the variables are I(1). If the computed F-statistic is greater that the upper bound critical value at a given level of significance, the null hypothesis of "no cointegration" is rejected; if it is less than the lower bound critical value, the null hypothesis of no cointegration cannot be rejected. No conclusion is drawn if it is between the lower bound and the upper bound critical values. If the null hypothesis of no cointegration is rejected, the short run (error correction) model is derived from the ARDL as:

$$\Delta \mathrm{fdi}_t = \beta_0 + \sum_{j=1}^{p}(\theta_{1j}\Delta \mathrm{fdi}_{t-j}) + \sum_{j=0}^{p}(\theta_{2j}\Delta \mathrm{cr}_{t-j}) + \sum_{j=0}^{p}(\theta_{3j}\Delta \ln(\mathrm{pcy}_{t-j}) + \sum_{j=0}^{P}(\theta_{4j}\Delta inf_{t-j}) + \sum_{j=0}^{P}(\theta_{5j}\Delta infsq_{t-j}) + \sum_{j=0}^{P}(\theta_{6j}\Delta gi_{t-j}) + \sum_{j=0}^{p}(\theta_{7j}\Delta findep_{t-j}) + \sum_{j=0}^{p}(\theta_{8j}\Delta exrt_{t-j}) + \sum_{j=0}^{p}(\theta_{8j}\Delta exrt_{t-j}) + \varphi \mathrm{ECT}_{t-1} + \varepsilon_t \quad (6)$$

Where φ is the error correction coefficient, measuring the speed of adjustment to equilibrium in the event of short run deviation therefrom. ECT is the error correction term derived as the residual of the long-run model (equation 3). The error correction coefficient is expected to be negatively signed and statistically significant to lay the role of error correction (restoration of equilibrium) in the model.

Estimation of the model was preceded by the unit root and cointegration tests. The variables were tested for unit root using the Augmented Dickey Fuller (ADF), the Phillips-Perron (PP) and the Kwiatkowski-Phillips-Schmidt-Shin (KPSS) unit root tests

3.2. Theoretical Justification for Included Explanatory Variables

Crime

Based on the Halo effect theory and evidence from previous empirical studies, we expect the coefficient of crime rate to be negative. This implies that increase in crime rate will serve to deter multinational corporations from moving into the country.

Market Size

Going by the market size hypothesis of determinant of FDI, tthe coefficient of market size (proxied by real GDP per capita) is expected to be positively signed. This is because foreign investors tend to move their investments to where there is large market for their products (Chakrabrati, 2001). However, the empirical evidence on the effect of per capita income has been inconclusive. While several studies have found positive relationship between market size and FDI inflows (Nasir, 2016; Petrović-Ranđelović, Vesna Janković-Milić & Kostadinović, 2017), others found inverse relationship between them (Edwards, 1990; Jaspersen, Aylward & Knox, 2000). Market seeking FDI may respond positively to market expansion, whereas resource seeking FDI may not respond in same manner.

Inflation

High inflation could deter inward FDI as it reduces the value of returns on investment. We hypothesise in this study that threshold inflation exists for effect of inflation on FDI inflow. Inflation below a threshold, may be favourable to FDI inflows, whereas high inflation (above the threshold) could deter inward FDI as it reduces the value of returns on investment. Thus, the coefficient of inflation is expected *a priori* to be positively signed, while that of inflation-squared is expected to be negatively signed.

Globalisation

Theories of international trade and capital flows (which constitute economic globalisation) posit that greater openness of an economy to trade opens it up for multinational corporations' entrance and participation. In this study, we use an index of globalisation which incorporates economic, political and socio-cultural aspects of globalisation. We hypothesis that the more globalised the country is, the more attractive it is to FDI. Hence, the coefficient of globalisation index is expected be positively signed.

Financial Depth

The level of development of the financial system is also a determinant of the amount of FDI that flows into the economy. This is in consideration of the tremendous role the financial system plays particularly in the provision of financial services to the multinational corporations. Poorly developed financial system will not attract as much FDI as highly developed financial system. Hence the deeper or more developed the financial system of a country, the more FDI the country will attract.

Exchange rate

The theory predicts positive relationship between currency depreciation (increase in the exchange rate) and FDI. The mechanism by which exchange rate positively affects FDI inflow can be explained partly by the theoretical prediction of export-growth and import-inhibition effects of currency depreciation or devaluation. Multinational firms may decide to engage in international production in another country with weak currency where it is advantageous to produce and the investment climate is favourable so as to produce therein and export to country or countries with stronger currency or currencies.

Political Regime Type

The theoretical and empirical discussion on the relationship between political regime type and FDI inflow has been inconclusive. The relationship is not clear-cut. Each

regime type (autocracy or democracy) may attract different type of FDI depending on the policy the government is implementing. Where the policies implemented are attractive to FDI, it is expected that more FDI will flow into the country irrespective of whether they are implemented by autocratic or democratic government. Jensen (cited in Konki and Notermans, 2017) argues that transparency which is characteristic of democracy is favourable to investment. O'Donnell's theory argued that foreign companies are attracted to authoritarian regime as it offers the opportunity of monopolistic position and financial incentives in the host countries with the possibility of higher returns on investment than in democracies (Konki and Notermans, 2017). Thus, the coefficient of political regime variable could be expected either positively or negatively signed. It is therefore indeterminate.

3.3. Data

Data used for the estimation are annual time series data spanning the period from 1981 to 2016. They were sourced from the World Bank's World Development Indicators of 2018, the World Banks's Global Financial Development Database, 2018, the Nigeria's National Bureau of Statistics Statistical Bulletin (2018) and the KOF Swiss Economic Institute Globalisation Index, 2018.

4.0 Results and Discussions

4.1 Unit Root and Cointegration Tests

The results of the unit root test for the variables are presented in Table 1.

Table 1. Unit Root Test Results.

Augmented Dickey Fuller (ADF) Unit Root Test							
Level				First Difference			I(d)
Variables	ADF test stat.	Critical Value (5%)	Inference	ADF test stat.	Critical Value (5%)	Inference	
Fdi	-3.24	-3.54	NS	-8.13	-3.55	S	1
Crime	-1.99	-3.54	NS	-5.59	-3.55	S	1
ln(pcy)	-1.47	-3.55	NS	-3.56	-3.55	S	1
Inf	-3.84	-3.55	S	-	-	-	0
GI	-2.40	-3.54	NS	-5.80	-3.55	S	1
Findep	-2.37	-3.55	NS	-3.90	-3.55	S	1
Log(exrt)	-1.24	-3.54	NS	-5.36	-3.55	S	1
Polreg	-3.89	-3.55	S	-	-	-	0

Phillips-Perron (PP) Unit Root Test							
Level				First Difference			I(d)
Variables	PP test stat.	Critical Value (5%)	Inference	PP test stat.	Critical Value (5%)	Inference	
Fdi	-3.17	-3.54	NS	-21.58	-3.55	S	1
Cr	-1.91	-3.54	NS	-5.70	-3.55	S	1
ln(pcy)	-3.08	-3.54	NS	-3.56	-3.55	S	1
Inf	-2.73	-3.54	NS	-9.62	-3.55	S	1
GI	-2.53	-3.54	NS	-5.81	-3.55	S	1
Findep	-1.64	-3.54	NS	-4.09	-3.55	S	1
Log(exrt)	-1.27	-3.54	NS	-5.63	3.55	S	1
Polreg	-3.02	-3.54	NS	-5.41	-3.55	S	1
Findep	-1.64	-3.54	NS	-4.09	-3.55	S	1
Kwiatkowski-Phillips-Schmidt-Shin (KPSS) Unit Root Test							
Level				First Difference			I(d)
Variables	KPSS test stat.	Critical Value (5%)	Inference	KPSS test stat.	Critical Value (5%)	Inference	
Fdi	0.17	0.46	S	-	-	-	0
Cr	0.16	0.15	NS	0.09	0.15	S	1
ln(pcy)	0.20	0.15	NS	0.12	0.15	S	1
Inf	0.11	0.15	S	-	-	-	0
GI	0.10	0.15	S	-	-	-	0
Findep	0.17	0.15	NS	0.07	0.15	S	1
Log(exrt)	0.20	0.15	NS	0.08	0.15	S	1
Polreg	0.43	0.46	S	-	-	-	0

NS = Non-stationary; S = Stationary; I(d) = Order of integration

Whereas the result of PP test for unit root indicates that the variables are stationary at first differences, the ADF and the KPSS test results indicate that the variables are of mixed order of integration. The orders of integration of the variables of a model to be estimated determine the approach to testing for cointegration relationships among the variables and also in many cases, the estimation technique to be adopted for estimation of the model. In this study, the ARDL bounds testing approach to cointegration and error correction analysis was employed because of its applicability, irrespective of the order of integration of the variables, so long as none of them is I(2)

(that is none is integrated of order 2). The result of the cointegration test is presented in Table 2.

Table 2. ARDL Bounds Test

Sample: 1982-2016		
Included Observation: 35		
Null Hypothesis: No long-run relationships exists		
Test Statistic	Value	K
F-statistic	18.20	8
Critical Value Bounds		
Significance	Lower (I0) Bound	Upper (I1) Bound
10%	1.95	3.06
5%	2.22	3.39
2.5%	2.48	3.70
1%	2.79	4.10

The Bounds test for cointegration clearly rejects the null hypothesis that "No long-run relationships exist" among the variables, as the F-statistic value of 18.20 is greater than the upper bounds critical value even at the 1% significance level. Thus it can be inferred that the variables are cointegrated.

4.2 Model Estimation

The result of estimation of the short-run and long-run models based on the estimated ARDL (1,1,1,1,1,1,1,1) model (shown in Table A1 in the Appendix) is presented in Table 3.

Table 3. Model Estimation Result

Dependent Variable: fdi			
Selected Model: ARDL (1,1,1,1,1,1,1,1,1)			
Sample: 1981-2016			
Included Observations: 35			
Variable	Coefficient	T-stat	Prob.
d(Crime)	-0.02	-0.79	0.44
D(ln(pcy))	-11.51	-3.84	0.00
d(inf)	0.06	1.90	0.07
d(infsq)	-0.00	-1.94	0.07
d(gi)	0.20	2.75	0.01

d(findep)	0.03	0.43	0.67
d(ln(exrt))	-0.09	1.33	0.20
d(polreg)	0.05	1.08	0.29
CointEq(-1)	-1.39	-9.62	0.00
Long-Run Coefficients			
Variable	Coefficient	T-stat	Prob.
Cr	-0.04	-2.54	0.02
ln(pcy)	-2.13	-2.50	0.02
Inf	0.14	3.51	0.00
Infsq	-0.002	-2.81	0.01
Gi	0.24	3.88	0.00
Findep	0.06	1.86	0.08
ln(exrt)	0.31	1.33	0.20
Polreg	-0.09	-3.12	0.01
C	4.06	0.81	0.43
R2 = 0.93; Adj. R2 = 0.86; F = 12.90 (p = 0.00); D. W. = 2.08			

The estimation result shows that crime rate is negatively related to FDI (as percentage of GDP) both in the short-run and the long-run. The short-run effect is not statistically significant, but the long-run effect is significant at the 2.5% level. Thus crime adversely affects inflow of FDI – it acts as a deterrent to foreign investment inflows to Nigeria. This conforms to *a priori* expectation, and is in sync with findings from previous studies such as those of Blanco et al. (2015), Daniele and Marani (2011), Brown and Hilbert (2017), Mahofa *et al*. (2016), Aiyanto, 2017 and Brown *et al*. (2017).

The coefficient of per capita income which is an indicator of the level of economic development and market size is negatively signed and highly statistically significant in the short run and in the long run. While it passes the significance test at the 1% level in the short run, it does so at the 2.5% in the long run. This goes contrary to our *a priori* expectations. However, it suggests that FDI flowing into the country is mainly the resource-seeking type, not the market-seeking type. Thus, increase in market size measured as real per capita income does not enhance the attractiveness of Nigeria's economy to FDI; rather it has been associated with decrease in the amount of FDI flowing into the country. This finding corroborates the empirical evidence from Jaspersen, *et al*. (2000) which also found an inverse relationship between market size (real GDP per capita) and FDI.

The effects of inflation and squared inflation are respectively positive and negative in the short-run and in the long-run. These conform to *a priori* expectation. The effects are significant at the 10% level in the short-run, and at 1% level in the long-run. This suggests existence of threshold level of inflation. Below the threshold, inflation could be favourable to growth. However, above the threshold, inflation could act as a deterrent to FDI inflow. This observation is in sync with Obiamaka, Onwumere and Okpa (2011) and Tsaurai (2018).

The depth of the financial system is found to be a significant determinant of FDI inflows in Nigeria. The effect of financial depth on FDI inflows in Nigeria is positive, and significant at the 2.5% significance level. This suggests that financial system development enhances the attractiveness of the country to inward FDI. The result is consistent with the empirical evidence from Desbordes and Wei (2014), Varnamkhasti and Mehregan (2014), Kiiza and Seguya (2015), Shah (2017) and Dellis (2018).

The short-run and the long-run effects of globalisation on FDI inflows in Nigeria are observed to be positive and significant at the 1% level. These conform to a priori expectations. The findings suggests that highly globalized economies tend to be attractive to FDI inflow. The more integrated the country (Nigeria) is with the rest of the world, the more FDI it attracts. This is in line with evidence from previous studies such as those of Kandiero and Chitiga (2006), Dima (2016) and Brun and Gnangnon (2017), and it suggests that (cautious) removal of barriers to free flow of cross-border trade will engender increase in inflow of FDI to Nigeria's economy.

The short-run and the long-run effects of exchange rate on FDI inflow in Nigeria are respectively positive and negative, but none is statistically significant. These suggest that the exchange rate of the Naira plays no significant role in the determination of the amount of FDI that flows into the country.

The short-run, effect of political regime on FDI inflow is positive, as expected, but not statistically significant. However, its long-run effect is negative and significant at the 1% level. This suggests that autocratic government tends to favour FDI inflows. This validates the O'Connell's theory of FDI. It suggests that foreign investors engaging in FDI in Nigeria's economy may have preferred to channel their investments in more autocratic government. It also suggests that FDI inflow is not a matter of polity but a matter of policy as observed by Konki & Notermans (2017). This is in view of the fact, that democratic government could also be autocratic in dispensation. Policies favouring FDI inflows may have been implemented by governments that were more autocratic in their operations. Caution should however be exercised in recommending

policy based on the observed negative coefficient of political regime variable as it does not necessarily imply that the government has to be more autocratic to attract FDI.

The coefficient of the lagged error correction term (CointEq) is, as expected, negatively signed and statistically significant at the 1%. This further confirms the existence of long run relationship between the explanatory variables and the dependent variable. The coefficient value of -1.39 implies that the error correction process (that is the convergence toward equilibrium in the relationship in the event of short-run deviation therefrom) is oscillatory instead of being monotonic or asymptotic (Narayan and Smith, 2005).

The coefficient of determination of the model is quite impressive, as it indicates that the model has a high goodness of fit or explanatory power. The model explains about 93% of the systematic variation in the dependent variable. The reliability of the explanatory power is indicated by the F-statistic of 12.90 which easily passes the significance test at the 1% level, indicating the joint significance of the explanatory variables. The Durbin-Watson (D. W.) of 2.08 indicates absence of problem of autocorrelation in the model. The test for normality of the residual shows that the residuals are normally distributed as indicated by the probability of the Jarque-Bera statistic (p = 0.54) which fails to reject the hypothesis of normality. This is shown in the Appendix of this paper. The Ramsey RESET test result also shown in the Appendix reveals that the functional form of the ARDL model is correctly specified. The model could therefore be reliably deployed for policy formulation.

5.0 Concluding Remarks and Recommendations

Crime serves as a deterrent to participation by multinational corporations in Nigeria. There is therefore the need to intensify efforts to holistically combat crime in the country in order to attract more FDI to complement domestic capital so as to enhance the growth of the nation' economy. The government of Nigeria should strengthen the nation's anti-crime agencies and the legal and criminal justice systems to holistically combat crime in the country. Greater but cautious integration of the country's trade, finance, politics and culture with the rest of the world will enhance the attractiveness of the country to FDI. There is need for the monetary authority to strive to achieve levels of inflation not detrimental to FDI inflows, and develop the financial system as these will also enhance the attractiveness of the nation's economy to FDI.

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APPENDIX

TABLE A1. ARDL MODEL

Dependent Variable: FDI
Method: ARDL
Date: 05/11/19 Time: 22:16
Sample (adjusted): 1982 2016
Included observations: 35 after adjustments
Maximum dependent lags: 1 (Automatic selection)
Model selection method: Akaike info criterion (AIC)
Dynamic regressors (1 lag, automatic): CR LOG(RGDPPC) INF INFSQ GI FINDEP LOG(EXRT) POLREG
Fixed regressors: C
Number of models evalulated: 256
Selected Model: ARDL(1, 1, 1, 1, 1, 1, 1, 1, 1)

Variable	Coefficient	Std. Error	t-Statistic	Prob.*
FDI(-1)	-0.391129	0.144552	-2.705811	0.0150
CR	-0.019908	0.025104	-0.793022	0.4387
CR(-1)	-0.039702	0.029444	-1.348416	0.1952
LOG(RGDPPC)	-11.51024	2.999274	-3.837675	0.0013
LOG(RGDPPC(-1))	8.540642	2.880252	2.965241	0.0087
INF	0.059948	0.031500	1.903141	0.0741
INF(-1)	0.139388	0.028012	4.976048	0.0001
INFSQ	-0.000913	0.000472	-1.936072	0.0697
INFSQ(-1)	-0.001395	0.000384	-3.636048	0.0020
GI	0.196144	0.071673	2.736652	0.0141
GI(-1)	0.141383	0.087713	1.611881	0.1254
FINDEP	0.026397	0.061061	0.432310	0.6710
FINDEP(-1)	0.055274	0.053171	1.039537	0.3131
LOG(EXRT)	-0.093158	0.398542	-0.233748	0.8180
LOG(EXRT(-1))	0.527905	0.421834	1.251451	0.2277
POLREG	0.045484	0.042267	1.076119	0.2969
POLREG(-1)	-0.172107	0.051535	-3.339602	0.0039
C	5.645007	6.989244	0.807671	0.4304
R-squared	0.929348	Mean dependent var		1.861062

Adjusted R-squared	0.858696	S.D. dependent var	1.253811
S.E. of regression	0.471313	Akaike info criterion	1.639849
Sum squared resid	3.776316	Schwarz criterion	2.439743
Log likelihood	-10.69736	Hannan-Quinn criter.	1.915972
F-statistic	13.15386	Durbin-Watson stat	2.080300
Prob(F-statistic)	0.000001		

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

TABLE A2. ARDL (BOUNDS) TEST

ARDL Bounds Test
Date: 05/11/19 Time: 22:22
Sample: 1982 2016
Included observations: 35
Null Hypothesis: No long-run relationships exist

Test Statistic	Value	K
F-statistic	18.20425	8

Critical Value Bounds

Significance	I0 Bound	I1 Bound
10%	1.95	3.06
5%	2.22	3.39
2.5%	2.48	3.7
1%	2.79	4.1

Test Equation:
Dependent Variable: D(FDI)
Method: Least Squares
Date: 05/11/19 Time: 22:22
Sample: 1982 2016
Included observations: 35

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(CR)	-0.019908	0.025104	-0.793022	0.4387
DLOG(RGDPPC)	-11.51024	2.999274	-3.837675	0.0013
D(INF)	-0.139388	0.028012	-4.976048	0.0001
D(INFSQ)	-0.000913	0.000472	-1.936072	0.0697
D(GI)	0.196144	0.071673	2.736652	0.0141
D(FINDEP)	0.026397	0.061061	0.432310	0.6710
DLOG(EXRT)	-0.093158	0.398542	-0.233748	0.8180
D(POLREG)	0.045484	0.042267	1.076119	0.2969
C	5.645007	6.989244	0.807671	0.4304
CR(-1)	-0.059610	0.025048	-2.379876	0.0293
LOG(RGDPPC(-1))	-2.969597	1.179059	-2.518616	0.0221
INF	0.199336	0.046823	4.257234	0.0005
INFSQ(-1)	-0.002309	0.000707	-3.265371	0.0046
GI(-1)	0.337527	0.091070	3.706234	0.0018
FINDEP(-1)	0.081671	0.043299	1.886201	0.0765
LOG(EXRT(-1))	0.434746	0.329939	1.317657	0.2051
POLREG(-1)	-0.126623	0.038749	-3.267787	0.0045
FDI(-1)	-1.391129	0.144552	-9.623760	0.0000

R-squared	0.928055	Mean dependent var	0.021965
Adjusted R-squared	0.856109	S.D. dependent var	1.242490
S.E. of regression	0.471313	Akaike info criterion	1.639849
Sum squared resid	3.776316	Schwarz criterion	2.439743
Log likelihood	-10.69736	Hannan-Quinn criter.	1.915972
F-statistic	12.89941	Durbin-Watson stat	2.080300
Prob(F-statistic)	0.000001		

TABLE A3. ARDL Cointegrating And Long Run Form

Dependent Variable: FDI
Selected Model: ARDL(1, 1, 1, 1, 1, 1, 1, 1, 1)
Date: 05/11/19 Time: 22:23
Sample: 1981 2016
Included observations: 35

Cointegrating Form

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(CR)	-0.019908	0.025104	-0.793022	0.4387
DLOG(RGDPPC)	-11.510238	2.999274	-3.837675	0.0013
D(INF)	0.059948	0.031500	1.903141	0.0741
D(INFSQ)	-0.000913	0.000472	-1.936072	0.0697
D(GI)	0.196144	0.071673	2.736652	0.0141
D(FINDEP)	0.026397	0.061061	0.432310	0.6710
DLOG(EXRT)	-0.093158	0.398542	-0.233748	0.8180
D(POLREG)	0.045484	0.042267	1.076119	0.2969
CointEq(-1)	-1.391129	0.144552	-9.623760	0.0000

Cointeq = FDI - (-0.0429*CR -2.1347*LOG(RGDPPC) + 0.1433*INF
-0.0017*INFSQ + 0.2426*GI + 0.0587*FINDEP + 0.3125*LOG(EXRT)
-0.0910*POLREG + 4.0579)

Long Run Coefficients

Variable	Coefficient	Std. Error	t-Statistic	Prob.
CR	-0.042850	0.016858	-2.541895	0.0211
LOG(RGDPPC)	-2.134666	0.853649	-2.500637	0.0229
INF	0.143291	0.040795	3.512434	0.0027
INFSQ	-0.001659	0.000591	-2.806115	0.0121
GI	0.242628	0.062480	3.883273	0.0012
FINDEP	0.058708	0.031647	1.855081	0.0810
LOG(EXRT)	0.312513	0.234950	1.330129	0.2010
POLREG	-0.091022	0.029200	-3.117149	0.0063
C	4.057860	5.036410	0.805705	0.4315

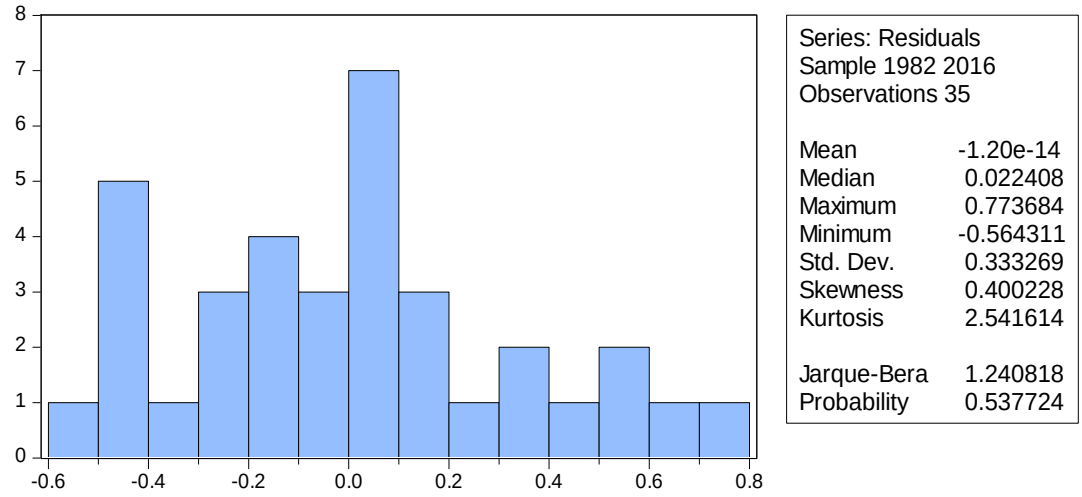

FIGURE A1. RESIDUAL NORMALITY TEST

TABLE A4. ACCURACY OF FUNCTIONAL SPECIFICATION

Ramsey RESET Test
Equation: UNTITLED
Specification: FDI FDI(-1) CR CR(-1) LOG(RGDPPC) LOG(RGDPPC(-1)) INF INF(-1) INFSQ INFSQ(-1) GI GI(-1) FINDEP FINDEP(-1) LOG(EXRT) LOG(EXRT(-1)) POLREG POLREG(-1) C
Omitted Variables: Squares of fitted values

	Value	df	Probability
t-statistic	1.377467	16	0.1873
F-statistic	1.897414	(1, 16)	0.1873

F-test summary:

	Sum of Sq.	df	Mean Squares
Test SSR	0.400350	1	0.400350
Restricted SSR	3.776316	17	0.222136
Unrestricted SSR	3.375965	16	0.210998

MONETARY POLICY EFFECTIVENESS IN AFRICA: DOES TRADE OPENNESS MATTER?

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Abstract: *This paper investigates the effect of trade openness on the impact of monetary policy on output growth and inflation in Africa using a panel data regression-based approach with annual data from the period 1990-2015 for a panel of 37 African countries. We find a strong significant relationship between trade openness and monetary policy effectiveness in Africa. The effects of monetary policy on output growth is positive and negative for inflation at higher levels of trade openness. This suggests that trade openness can enhance the effectiveness of monetary policy for macroeconomic stabilization on the continent. Therefore, monetary authorities in Africa should place emphasis on the degree of trade openness when designing their choice of optimal monetary policy.*

Keywords: Openness; Monetary Policy; Panel Data Analysis; Africa.
JEL Classification: C33; E52; F41; O55

1.0 Introduction

As a useful tool for macroeconomic stabilization, monetary policy is important for the purpose of influencing the direction of economic activities. Through various monetary transmission channels (i.e. interest rate, exchange rate, and credit channels), monetary authorities can use monetary policy to either expand or contract activities in the real economy depending on the desired macroeconomic objective. For instance, a monetary expansion often raises both the output and price levels respectively, while monetary tightening has the opposite effects. However, the debate on the effects of monetary policy often requires a better understanding of the underlying factors that influences its effectiveness. So far, several factors such as industry structure, labour market rigidities, trade openness, domestic financial market development and globalization have been highlighted as plausible determinants of the effectiveness of monetary policy (see Bernanke and Gertler, 1995; Walsh, 2005; Karras, 1999, 2001; Berument and Dogan, 2003; Berument et al., 2007; Carranza et al., 2010; Cwik et al., 2011; Georgiadis and Mehl, 2016; Ma and Lin, 2016; Ma, 2018). In this

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paper, we consider the role of trade openness on the effect of monetary policy on output growth and inflation in African countries.

In open economy monetary economics, a country's domestic currency (i.e. the nominal exchange rate) is a defining variable in the monetary transmission process, such that its adjustments do affect the design and conduct of monetary policy. For instance, international trade activities often have an exchange rate pass-through effect in an economy. Here, the impact of trade openness on the effects of monetary policy depends on the manner in which the fluctuations in the exchange rate influences input prices, inflationary expectations and wage formation. For example, an exchange rate depreciation following a domestic monetary expansion often leads to higher input prices, higher prices for imported consumer goods and higher wage demands. In relatively more open economies, these supply-side mechanisms reduce the impact of monetary policy on output and increase the impact of monetary policy on consumer prices (see Bryant et al. 1988; and Karras (1999, 2001). In other words, monetary expansion is supposed to have a weaker effect on output level and a strong inflationary effect in more open economies. The intuition is straightforward: for more open economies, expectation of a domestic currency depreciation triggers higher wage demand which steepens the aggregate supply such that monetary expansion will be more reflected in prices and less on output (Karras, 1999).[3]

Another perspective to the debate focuses on the trade openness-inflation relationship resulting from the absence of pre-commitment in monetary policy. Building on Romer (1993), the argument is that unanticipated monetary expansion induces real exchange rate depreciation which, in turn, generates an inefficiently high inflation. For more open economies faced with a steeper Phillips curve (i.e., a larger output-inflation trade-off), the incentive to engage in expansionary monetary policy diminishes with a higher degree of openness. Consequently, inflation is expected to be lower in more open economies (see also, Lane, 1997). Put differently, the short-term benefit of an unanticipated monetary expansion is negatively correlated with the degree of openness such that less expansion will, on average, lower inflation in more open economies. In all, the theoretical expectation is that the effect of monetary policy on output diminishes with trade openness; while in the case of inflation, the

[3] This is the supply-side effect of monetary expansion in a more open economy. The opposite will be true for the less open economy. On the other hand, the demand-side effect would depend on the nature of expenditure-switching between domestic and foreign goods. However, the assumption is that the demand effect will be similar for both a more open and relatively closed economies.

relationship can be positive or negative to indicate that prices increase or decrease respectively with an increasing level of openness.

Using annual data for a panel of 37 African countries from the period 1990 to 2015, this paper investigates the role of trade openness on the effects of monetary policy on output and inflation. The aim is to examine whether these theoretical effects can be empirically validated for African countries. A number of reasons motivate our focus on Africa. First, there is a dearth of empirical evidence on the impact of trade openness on the effects of monetary policy in Africa. Attempts at investigating the underlying factors that could influence monetary policy effectiveness on the continent have so far concentrated on the role of excess liquidity (Saxegaard, 2006), and financial sector development (Effiong et al., 2017). Hence, there is need to investigate whether openness to trade influences the effects of monetary policy on output and prices in Africa. Second, regional integration has been intensified on the continent over the last three decades with the formation of regional economic communities through the initiatives of Regional Trade Agreements (RTAs). Recent efforts include the Tripartite Free Trade Area (TFTA) and the Continental Free Trade Area (CFTA) which are designed to deepen intra-regional trade and investment for both employment creation and growth (AEO, 2016).[4] These initiatives are expected to enhance regional economic co-operation and financial market integration among Africa countries, the realization of which, would lead to the birth of an African Monetary Union. The success of such macroeconomic interdependence among African economies will no doubt have implications for the design and conduct of monetary policy on the continent.

The balance of this paper is organised as follows. Section 2 provides a brief survey of the literature while Section 3 discusses the empirical methodology and data. Section 4 presents the empirical results with a number of robustness checks. Section 5 concludes with the policy implications.

[4] The TFTA is the largest free trade zone in Africa, and it comprise of member countries of the Common Market for Eastern and Southern Africa (COMESA), East African Community (EAC) and the Southern African Development Community (SADC). Meanwhile, the objective of CFTA is that it will evolve into an African Economic Community that would reduce the overlaps between Africa's regional communities.

2.0 Literature Review

There is an extant literature on the monetary policy transmission mechanism with specific focus on the empirical effects of monetary policy on aggregate demand (see Walsh, 2017). Much of the literature on the subject have focussed on the advanced and emerging economies with the empirical evidence showing that monetary policy shocks do exert strong and systematic effects on both output and prices, thereby confirming the effectiveness of monetary policy in influencing aggregate demand. For developing countries, the effectiveness of monetary policy has been limited. For instance, in a survey on the effectiveness of monetary policy transmission in low-income countries, Mishra and Montiel (2013) found no evidence for a strong monetary transmission. Thus, the important challenge has been that of identifying the means through which the effectiveness of monetary policy could be enhanced in these countries. In that respect, research into the determinants of monetary policy effectiveness have highlighted several factors which include industry structure, labour market rigidities, trade openness, domestic financial market development and globalization (see Bernanke and Gertler, 1995; Walsh, 2005; Karras, 1999, 2001; Berument and Dogan, 2003; Berument et al., 2007; Carranza et al., 2010; Cwik et al., 2011; Georgiadis and Mehl, 2016; Ma and Lin, 2016; Ma, 2018).

Concentrating on the relationship between trade openness and the effects of monetary policy on output and prices, Karras (1999) used annual data from 1953-1990 for a panel of 38 countries and finds evidence in support of the theory: the more open an economy, the smaller (larger) the output (inflation) effects of monetary policy shocks. Karras (2001) reports similar evidence for the relationship between openness and the effects of monetary policy on output for eight countries (Australia, Canada, Germany, Italy, Japan, South Africa, the U.K. and the U.S.A.) using quarterly data from the period 1960 to 1994. Berument and Dogan (2003) find evidence on the importance of openness for monetary policy effectiveness in Turkey. Their results show that a change in money supply will lead to a smaller output, whereas the impact on inflation is a parallel to Romer's hypothesis that demonstrates a negative relationship with the level of openness.

Berument et al. (2007) analysed the effect of openness on the effectiveness of monetary policy on output growth and inflation for a group of 29 countries using quarterly data from 1957:2 to 2003:4 on the basis of country-by-country estimations. They find variations in the effect of openness on monetary policy effectiveness on output and inflation across countries. Thus, they argued that difference in countries' characteristics such as exchange rate regimes, the degree of central bank

independence, exposure to international financial crises, terms-of-trade shocks, different monetary policy stance, and the degree of capital controls could affect the monetary policy transmission process, and thereafter influence the relationship between openness and monetary policy effectiveness. Isik and Acar (2006) find empirical support for the theoretical relationship that a higher degree of openness will dampen the output effects of changes in money supply. Further evidence shows that monetary policy has limited effect in developing countries than in developed economies.

Cwik et al. (2011) evaluates the role of trade integration - or openness - for monetary policy transmission in a medium-scale New Keynesian Dynamic Stochastic General Equilibrium (DSGE) model with strategic complementarities in price setting. Their counterfactual simulations show that openness affects monetary transmission significantly, and that the effect of a monetary policy shock on inflation and output tend to increase with openness. Coric et al. (2016) investigates the impact of economic openness and the responsiveness of output to a domestic monetary policy shock for a sample of 48 developing and developed countries. Using the structural vector autoregression (SVAR) model, the effects of a monetary policy shock on output for each country is estimated, and subsequently used in a cross-section regression to investigate the sources of cross-country variation in the output response to a monetary policy shock. Their findings indicate that monetary policy shock has on average a larger effect on output with a higher openness to trade. Other important factors include the exchange rate regime and banking sector development.

Related to this strand of the literature are other studies that have considered alternative factors that may influence the effects of monetary policy on output growth and inflation. For instance, Ma and Lin (2016) investigates the relationship between financial development and the effectiveness of monetary policy using panel data from 41 economies. They find that the effects of monetary policy on output and inflation are significantly and negatively correlated with financial development, which indicates that the effectiveness of monetary policy declines as the financial system becomes more developed. Similarly, Ma (2018) investigates how financial development and financial structure affect the growth effect of monetary policy using panel data from 49 countries over the period 1980–2014. Evidence from the empirical analysis show that financial development has a significantly negative impact on the growth effect of monetary policy. Moreover, the growth effect of monetary policy tends to be more pronounced as the financial structure of a country becomes more market-based. Georgiadis and Mehl (2016) investigates the net impact of financial

globalization on monetary policy effectiveness with evidence suggesting that financial globalisation has modified the transmission of monetary policy by strengthening the importance of the exchange rate channel. For example, their estimates show that the output effect of tightening monetary policy has increased by 25 percent due to financial globalisation.

Most of the above studies have concentrated on advanced economies with little research for developing countries in general, and Africa in particular. For Africa, Saxegaard (2006) examined the relationship within the context of Sub-Saharan Africa (SSA) and with particular focus on excess liquidity and its consequent effect on monetary policy effectiveness. The evidence suggests that excess liquidity weakens the monetary policy transmission mechanism and thus the ability of monetary authorities to influence demand conditions in the economy. Likewise, Effiong et al., (2017) examined the role financial development on monetary policy effectiveness for Africa. Their evidence suggest that financial development has a weak effect on the effectiveness of monetary policy which can be attributed to the underdeveloped nature of the financial sector on the continent. Meanwhile, studies on the role of trade openness within the context of African countries are non-existent, therefore, this study seeks to fill the research gap in the literature.

3.0 Econometric Methodology and Data

Following the empirical approach of previous studies (see e.g. Karras, 1999, 2001; Ma and Lin, 2016), we examine the relationship between a country's degree of trade openness on the effectiveness of monetary policy in Africa. To that end, the effects of trade openness on monetary policy must be specified within a tractable econometric framework. Consequently, we use two standard panel data models for macroeconomic analysis to demonstrate the effects of trade openness on the impact of monetary policy on output and inflation as follows:[5]

$$\Delta y_{j,t} = \beta_0 + \sum_{i=1}^{Q} \beta_i^{y} \Delta y_{j,t-i} + \sum_{i=0}^{R} \beta_i^{oil} \Delta OIL_{j,t-i} + \sum_{i=0}^{S} \beta_{i,j,t}^{m} \Delta m_{j,t-i} + u_{j,t}^{y} \quad (1)$$

[5] The literature on monetary policy and the monetary transmission mechanism uses the VAR methodology to derive impulse response functions (IRFs) of real macroeconomic variables such as output and prices following an unanticipated monetary policy shock. Its methodological shortcomings include: identification of the intermediate target of monetary, and exogenous monetary policy shocks through various identification schemes such as Choleski decompositions or non-recursive (simultaneous) identification.

$$\Delta p_{j,t} = \gamma_0 + \sum_{i=1}^{Q} \gamma_i^p \, \Delta p_{j,t-i} + \sum_{i=0}^{R} \gamma_i^{oil} \, \Delta OIL_{j,t-i} + \sum_{i=0}^{S} \gamma_{i,j,t}^m \, \Delta m_{j,t-i} + u_{j,t}^p \quad (2)$$

where j and t indexes cover countries and time respectively. Δy is the output growth rate, Δp is the inflation rate, Δm is the money growth rate, and ΔOIL is the growth rate of real oil prices which is included as a proxy for possible supply shocks. As in Karras (1999), Eq. (1) and (2) represents the reduced-form expressions for output growth and inflation with β's and γ's as coefficients; and $u_{j,t}^y$ and $u_{j,t}^p$ as the output and inflation shocks respectively, which are modelled as $u_{j,t}^y = u_j^y + w_{j,t}^y$ and $u_{j,t}^p = u_j^p + w_{j,t}^p$, where u_j^y and u_j^p denote country fixed effects.

To capture the impact of trade openness on the effects of money growth on output and inflation, an interaction term for trade openness is incorporated in the following manner (see Karras, 1999; Berument and Dogan, 2003; Ma and Lin, 2016):

$$\beta_{j,t-1}^m = \vartheta_i^m + \vartheta_i^o open_{j,t-1} \quad (3)$$

$$\gamma_{j,t-1}^m = \phi_i^m + \phi_i^o open_{j,t-1} \quad (4)$$

where $open_{j,t}$ is a measure of trade openness in country j at time t, while ϑs and ϕs are the parameters. Incorporating Eq.(3) into Eq.(1), gives the output equation which measures the effect of trade openness on the money growth and output growth relationship; while the inflation equation is obtained by incorporating Eq.(4) into Eq.(2), to measure the effect of trade openness on the money growth and inflation relationship. The resulting equations are as follows:

$$\Delta y_{j,t} = \beta_0 + \sum_{i=1}^{Q} \beta_i^y \, \Delta y_{j,t-i} + \sum_{i=0}^{R} \beta_i^{oil} \, \Delta OIL_{j,t-i} + \sum_{i=0}^{S} (\vartheta_{i,j,t}^m \, \Delta m_{j,t-i} + \vartheta_i^{om} open_{j,t-1} \Delta m_{j,t-1}) + u_{j,t}^y \quad (5)$$

$$\Delta p_{j,t} = \gamma_0 + \sum_{i=1}^{Q} \gamma_i^p \, \Delta p_{j,t-i} + \sum_{i=0}^{R} \gamma_i^{oil} \, \Delta OIL_{j,t-i} + \sum_{i=0}^{S} (\phi_{i,j,t}^m \, \Delta m_{j,t-i} + \phi_i^{om} open_{j,t-1} \Delta m_{j,t-1}) + u_{j,t}^p \quad (6)$$

where $open_{j,t-1}\Delta m_{j,t-1}$ is the interaction between trade openness and money growth on output growth and inflation respectively, while all other variables remain as earlier defined.

The overall strength of monetary policy on output growth and inflation in Eq. (5) and (6) is easily identified from the sum of the money growth coefficients, $\sum_{i=0}^{S} \vartheta_i^m$ and $\sum_{i=0}^{S} \phi_i^m$ respectively. For example, monetary policy shocks (say an increase in Δm_{t-i}) that leads to larger values in these coefficients would imply a larger overall effect of

monetary policy on output growth and inflation, whereas the reverse for smaller values would suggest a dampening effect of monetary policy. Moreover, our main focus centres on the coefficients of the interaction term between trade openness and money growth ($\sum_{i=0}^{S}\vartheta_i^{om}$, $\sum_{i=0}^{S}\phi_i^{om}$), which measures the impact of trade openness on money growth to output and inflation respectively. Specifically, if the coefficient sign is positive (negative), then this would imply that more openness to trade will strengthen (weaken) the effects of monetary policy on output growth and inflation. Meanwhile, the magnitude of the impact will depend on the coefficient size. For theoretical consistency, we expect a negative relationship between trade openness and the effects of monetary policy on output; and a positive relationship between trade openness and monetary policy effects on inflation as in Karras (1999) or a negative relationship to fit with Romer's expectation about the policy choice of monetary authorities.

Annual data of 37 African countries over the period 1990 to 2015 is used for the empirical analysis, where countries and time span are selected subject to data availability. The datasets are retrieved mainly from the World Bank's *World Development Indicators* and the IMF's *International Financial Statistics* except for oil prices which is sourced from the U.S. Energy Information Administration website. Our main variables for the analysis include, broad money supply (M2), consumer price index (CPI), real gross domestic product (GDP), real oil prices (OIL), and measures of trade openness (*open*). The first three variables are expressed in growth rates (i.e., annual percentage change) as follows respectively:

$$\Delta m_{j,t} = (M2_{j,t} - M2_{j,t-1})/M2_{j,t-1}$$
$$\Delta p_{j,t} = (CPI_{j,t} - CPI_{j,t-1})/CPI_{j,t-1}$$
$$\Delta y_{j,t} = (GDP_{j,t} - GDP_{j,t-1})/GDP_{j,t-1}$$

We use as a measure of trade openness the sum of import and export as a fraction of GDP:
$OPEN_{j,t} = (IM_{j,t} + EX_{j,t})/GDP_{j,t}$. Alternatively and for robustness checks, imports as a fraction of GDP ($IM_{j,t}/GDP_{j,t}$) is also used. Lastly, we deflate U.S. dollar oil prices by the U.S. implicit price deflator to obtain the real oil prices.

Table 1 shows the list of the 37 African economies and their country averages over the sample period for each measure of inflation, output growth, money growth and the trade openness indices. As evident from Table 1, substantial variation exists across

countries. For instance, average annual output growth rate ranged from a minimum of 0.49% in Central African Republic to a maximum of 21.071% in Equatorial Guinea; while the average annual rate of inflation ranged from 2.694% in Senegal to 40.278% in Sudan. Also, the annual money growth ranged from 6.607% in the Central African Republic to 46.648% in Guinea Bissau.

Table 1: Sample Means (1990-2015)

Country	Δy	Δp	Δm	$open_1$	$open_2$
1. Algeria	2.885	9.464	16.085	60.097	26.245
2. Benin	4.520	4.414	13.105	57.179	33.832
3. Botswana	4.664	8.905	16.144	96.811	45.662
4. Burkina Faso	5.361	3.178	12.147	41.399	27.514
5. Burundi	1.225	11.448	15.639	36.295	28.319
6. Cabo Verde	7.059	3.642	13.838	90.147	61.003
7. Cameroon	2.604	3.668	7.079	42.158	21.462
8. Central African Rep.	0.490	5.627	6.607	41.385	24.906
9. Chad	5.969	4.241	12.351	67.955	40.635
10. Congo Rep.	3.188	5.155	13.275	126.902	55.335
11. Cote d'Ivoire	2.554	3.903	9.275	78.372	35.559
12. Egypt	4.224	9.178	14.043	49.708	27.710
13. Equatorial Guinea	21.071	5.845	27.306	232.051	147.607
14. Gabon	2.455	2.928	9.069	87.611	31.984
15. Gambia	3.366	5.895	15.948	63.467	38.049
16. Ghana	5.490	20.527	34.369	78.559	46.520
17. Guinea-Bissau	2.285	16.029	46.648	50.427	32.998
18. Kenya	3.612	12.688	16.876	56.426	32.998
19. Madagascar	2.372	12.415	16.706	62.037	37.195
20. Malawi	4.293	21.616	29.776	61.172	36.935
21. Mali	4.439	3.038	11.525	54.765	32.435
22. Mauritius	4.671	6.041	12.623	120.909	63.367
23. Morocco	3.979	2.710	10.192	63.781	35.557
24. Mozambique	7.467	18.782	29.832	71.369	49.641
25. Niger	3.601	2.975	9.816	47.929	30.162
26. Nigeria	5.561	18.886	27.389	56.375	23.165
27. Rwanda	5.519	7.434	16.254	36.409	26.832
28. Senegal	3.535	2.694	9.717	66.457	39.674

29. Seychelles	3.818	5.063	12.019	141.851	81.978
30. Sierra Leone	2.822	21.420	27.908	53.455	33.629
31. South Africa	2.446	7.364	12.656	52.886	25.843
32. Sudan	4.996	40.278	40.445	27.967	15.543
33. Swaziland	3.887	8.092	12.599	131.74	71.779
34. Tanzania	5.319	13.598	22.753	47.462	30.013
35. Togo	2.773	4.357	9.551	86.673	50.413
36. Tunisia	4.106	4.222	9.793	92.644	48.656
37. Uganda	6.652	10.33	24.841	38.979	25.333
Panel	4.469	9.407	17.465	72.187	40.969

Note: Δp is the CPI inflation rate (%),Δy is the real growth rate of GDP (%),Δm is the growth rate of M2 (%),$open_1$ is the sum of import and export as a fraction of GDP, and $open_2$ is the ratio of import to GDP.

In addition, trade openness has also varied substantially across African countries. The sum of imports and exports as a fraction of GDP (i.e. $open_1$) ranged from a minimum of 27.067% in Sudan to a maximum of 232.051% in Equatorial Guinea. Similar pattern is observed for import as a fraction of GDP (i.e. $open_2$). Moreover, the panel average of 72.187% and 40.969% for both measures of trade openness respectively, indicate that African countries have become more open to international trade with a high import component within the sample period. Therefore, these variations in trade openness should lead to considerable differences in the monetary policy effects on output and inflation across these countries. Also, whether trade openness exert a significant influence on the monetary policy effects on output growth and inflation in line with theoretical prediction remains an empirical question within the context of African countries which this paper intends to validate in the next section.

4.0 Empirical Results

4.1 Main Results

Table 2 reports the estimate between the degree of openness and the effects of monetary policy on output growth and inflation. This comprise of the estimates for output growth and inflation regressions respectively with the definition of openness as the ratio of sum of import and export to GDP. For the estimation, only the first lag of output growth and inflation as well as the first lag and contemporaneous level of oil price growth are included in both output growth and inflation regressions respectively. Moreover, we allow for a richer lag structure of up to three lags for the interactive

effect between money growth and openness to trade. Lastly, panel fixed effects technique is used to estimate all regression equations. This is because of its consistency under plausible assumptions in the presence of lagged terms of the dependent variable (see Judge et al., 1985).

As shown from Table 2, output growth and inflation exhibit some persistence as indicated by the statistically significantly positive AR(1) term and is precisely estimated in all regressions; higher oil prices are shown to impact output positively at both contemporaneous level and first lag, whereas it affects inflation negatively across the inflation regressions with variation in statistical significance. As for the impact of money growth, though the signs and statistical significance of the estimated coefficients of Δm_{t-i} do change across both output growth and inflation regressions, the cumulative effect of the sum of money growth coefficients (i.e. $\sum_{i=0} \vartheta_i^m$, $\sum_{i=0} \phi_i^m$) indicate the overall strength of monetary expansion, and monetary policy in general. For output growth, the sum of Δm_{t-i} (i.e. $\sum_{i=0} \vartheta_i^m$) are negative and statistically indifferent from zero except when up to two lags of money growth is included in the output growth regressions. These suggest that monetary expansion leads to a reduction in the output level. In the short-run, monetary expansion often leads to a temporary increase in output level. But, a backward reversal is possible in the long run following adjustments of the monetary authority. Hence, output level may fall, on average, in the long run. Meanwhile, the absence of statistical significance across the regressions is consistent with the money neutrality proposition in the long run. On the other hand, the estimated coefficients for the sum of the interactive terms of money growth and trade openness (i.e. $\sum_{i=0} \vartheta_i^{om}$), is positive - although quantitatively small - and statistically significant. This means that there is positive relationship between trade openness and the effect of monetary policy on output growth such that a given change in money supply increases the output level in a more open economy. In other words, openness to trade enhances the effectiveness of monetary policy on output level. While the evidence is in contrast with the theoretical prediction of a negative relationship, recent studies show that trade openness contributes to economic growth on the continent (see e.g., Brueckner and Lederman, 2015).

Table 2: Openness and monetary policy effectiveness in Africa (main results)

Dependent variable: real output growth Δy_t					Dependent variable: inflation rate Δp_t				
Variables	(1)	(2)	(3)	(4)	Variables	(5)	(6)	(7)	(8)
Δy_{t-1}	0.190**	0.153***	0.0857***	0.0701**	Δp_{t-1}	0.549***	0.495***	0.457***	0.431***
	(2.463)	(2.893)	(3.461)	(2.688)		(13.788)	(15.877)	(14.880)	(11.784)
Δoil_t	0.0191***	0.0151	0.0137	0.0123	Δoil_t	-0.0214	-0.021	-0.0188	-0.0174
	(2.854)	(1.482)	(1.463)	(1.372)		(-1.715)	(-1.685)	(-1.499)	(-1.386)
Δoil_{t-1}	0.0210*	0.0144*	0.0123**	0.0097	Δoil_{t-1}	-0.0177	-0.0222*	-0.0250*	0.0229*
	(1.958)	(2.180)	(2.297)	(1.668)		(-1.552)	(-1.880)	(-1.981)	(-1.878)
Δm_t	-0.0031	0.0536*	0.0913***	0.101***	Δm_t	0.237***	0.2504***	0.2332***	0.192***
	(-0.098)	(2.100)	(3.468)	(3.476)		(4.168)	(5.199)	(5.794)	(4.798)
Δm_{t-1}		-0.0997***	-0.1194**	-0.121**	Δm_{t-1}		0.113***	0.0931*	0.0962
		(-2.969)	(-2.597)	(-2.655)			(4.369)	(1.762)	(1.685)
Δm_{t-2}			-0.0729***	-0.0627***	Δm_{t-2}			0.0431***	0.0231
			(-5.287)	(-3.387)				(2.949)	(0.703)
Δm_{t-3}				0.008	Δm_{t-3}				0.0349***
				(0.394)					(3.407)
$\Delta m_t open_t$	0.0006***	-0.0002	-0.0004***	-0.0005***	$\Delta m_t open_t$	-0.0007**	-0.0006**	-0.0005**	-0.0003
	(3.113)	(-1.178)	(-3.419)	(-3.466)		(-2.065)	(-2.157)	(-2.172)	(-1.183)
$\Delta m_{t-1} open_{t-1}$		0.0018***	0.0017***	0.0018***	$\Delta m_{t-1} open_{t-1}$		-0.0006*	0.0005	-0.0006
		(5.952)	(4.822)	(4.987)			(-1.829)	(-1.391)	(-1.509)
$\Delta m_{t-2} open_{t-2}$			0.0013***	0.0016***	$\Delta m_{t-2} open_{t-2}$			-0.0002	-0.0001
			(11.206)	(9.651)				(-0.738)	(-0.438)
$\Delta m_{t-3} open_{t-3}$				0.0002**	$\Delta m_{t-3} open_{t-3}$				-0.0003***
				(2.531)					(-2.847)
Constant	2.733***	2.407***	2.620***	1.561**	Constant	0.922	-0.150	0.0372	0.650
	(8.460)	(6.999)	(5.256)	(2.380)		(1.269)	(-0.181)	(0.036)	(0.503)
$\sum_{i=0} \vartheta_i^m$	-0.0031	-0.0461	-0.101*	-0.0749	$\sum_{i=0} \phi_i^m$	0.237***	0.3634***	0.3694***	0.3462***
	(-0.098)	(-1.124)	(-1.916)	(-1.672)		(4.168)	(5.401)	(4.415)	(3.261)

$\sum_{i=0} \vartheta_i^{om}$	0.0006***	0.0016***	0.0026***	0.0031***	$\sum_{i=0} \vartheta_i^{om}$	-0.0007***	-0.0012**	-0.0012**	-0.0013**
	(3.113)	(5.499)	(6.147)	(6.870)		(-2.065)	(2.615)	(-2.333)	(-2.174)
N	925	925	888	851		925	925	888	851
Adj. R^2	0.068	0.164	0.212	0.276		0.472	0.496	0.473	0.401

Note: $\sum_{i=0}^{S} \vartheta_i^m$ and $\sum_{i=0}^{S} \phi_i^m$ are the sum of the money growth coefficients (Δm_{t-i}) in the output and inflation equation respectively; $\sum_{i=0}^{S} \vartheta_i^{om}$ and $\sum_{i=0}^{S} \phi_i^{om}$ are the sum of the coefficients of the interaction terms ($\Delta m_t open_t$) in the output and inflation equation respectively with their Wald test F-statistics in the parenthesis, For other coefficients, t-statistics are reported in parentheses. ***,**,* indicates 1%, 5% and 10% significance level.

As for the case of inflation, the sum of the estimated coefficients of money growth (i.e. $\sum_{i=0} \phi_i^m$) are positive and statistically significant across the various lag structure in the regressions (see Karras, 1999; Berument et al., 2007; Ma and Lin, 2016). The size of these coefficients are quantitatively higher than those of the output growth regressions, and is consistent with economic theory prediction that monetary expansion is associated with higher inflation. However, the sum of the coefficients for the interactive term of money growth and trade openness (i.e. $\sum_{i=0} \phi_i^{om}$) is negative and statistically significant. This means that inflation decreases in a more open economy with monetary expansion, which fits with Romer's expectations on the openness-inflation nexus. In other words, there is a negative relationship between the degree of openness and the effect of monetary policy on inflation. Therefore, openness to trade dampens the effect of monetary policy on inflation. Our finding is consistent with Berument and Dogan (2001), and the recent evidence from Lin et al. (2017) that trade openness restraints inflation in Sub-Saharan Africa.

Some explanations for our empirical results are worth highlighting. First, higher imports increases the output level while decreasing prices due to substitution effects (Berument & Dogan, 2003).[6] Africa's export to the world market is mainly dominated by primary products such as oil, metals etc., and in turn, their import of intermediate goods (including raw materials) tend to contribute towards output expansion in both the tradable and non-tradable sectors. With regional integration, increased trade volume can accelerate output and productivity. Second, openness is likely to reduce inflation through its positive effect on output in accordance with the 'new growth theory' (Jin, 2000; Ashra, 2002). This link could operate through: (i) increased efficiency which is likely to reduce costs through changes in composition of inputs procured domestically and internationally; (ii) better allocation of resources; (iii) increased capacity utilization; and (iv) an increase in foreign investment. Accordingly,

[6] Note that the openness measure increases due to higher imports.

Cukierman et al. (1992) shows that free trade facilitates convergence in prices of traded goods across small open economies. Therefore, a lower degree of price distortion is expected in outward-looking countries. Moreover, inflation - a kind of tax on domestic currency - is expected to be low in more open economies because of the relative ease in converting domestic and foreign currencies (Zakaria, 2010). Lastly, the existence of imperfect competition and nominal price rigidity in the non-tradable sector can lead to an inverse relationship between openness and inflation (Lane & Gian, 2006).

4.2 Robustness Checks

As a first step towards validating the above findings, we vary the data frequency to address possible long-term business cycle effects in the data. Thus, a three-year non-overlapping country average for each variable is used to re-estimate the output growth and inflation regressions with the same lag structure as in the above analysis. Hence, the sample is split into eight data points of the three-year non-overlapping periods which are 1990-1992, 1993-1995, 1996-1999, 2000-2002, 2003-2005, 2006-2009, 2010-2012, and 2013-2015. The result of the regressions is presented in Table A1 in the Appendix.

Across both output growth and inflations regressions in Table A1, the sum of the money growth coefficients has a negative and positive effect on output growth and inflation respectively. Statistical significance is observed for these coefficients in the output growth regression with the various lag structure used, and the exception for the inflation regressions is when the third-lag of money growth is included in the estimation. However, this evidence does not invalidate the above main findings that monetary expansion reduces output while increasing inflation. In fact, it reaffirms the importance of monetary policy as a useful tool for macroeconomic stabilization particularly in the short run. As for the sum of the interactive term between money growth and openness, the findings of a positive and negative relationship between openness and the effect of monetary policy on output and inflation respectively remains unchanged. As an economy becomes more open, monetary expansion increases output level and reduces inflation. Therefore, accounting for possible long-term business cycle effects in the data does not change the reported findings in Table 2 despite the variation in statistical significance.

For further sensitivity checks, an alternative measure of openness namely, the ratio of import to GDP ($open_2$) is used. Table A2 presents the estimates for both output growth and inflation regressions. Looking through the results, the use of import as a fraction of

GDP to measure openness does not change the main results but instead it reaffirms our findings. The sign for the sum of money growth coefficients is negative for output growth and is statistically significant except at its contemporaneous level in Column (1). Meanwhile, the effect is positive and statistically significant across the inflation regressions. Thus, monetary expansion reduces output and increases inflation. On the other hand, the sum of the interactive term between money growth and openness is positive for output growth and negative for inflation with all estimates across both output growth and inflation regressions being statistically significant at the various lag structure. Therefore, our findings that output level increases while inflation decreases following monetary expansion in a more open economy is robust with an alternative measure of openness.

5.0 Conclusion

This paper investigates whether the effects of monetary policy on output growth and inflation in Africa is influenced by the degree of openness to international trade. Theory predicts that a monetary expansion dampens output level in a more open economy, while the effect on inflation is ambiguous as it could be positive in line with Karras (1999), or negative in support of Romer's prediction. Annual data for a panel of 37 Africa countries over the period 1990 to 2015 is used to estimate the empirical accuracy of these theoretical predictions.

Our empirical results show that openness to international trade is an important determinant of monetary policy effectiveness in Africa. Specifically, openness enhances the effect of monetary policy on output. Put differently, the effect of a monetary expansion accelerates output growth as the level of openness increases. This is contrary to the theoretical prediction of a negative relationship. On the other hand, openness dampens the effect of monetary policy on inflation. These suggest a negative relationship between openness and the effect of a given change in money supply on inflation, such that an increase in openness leads to a decline in inflation. Hence, the result supports Romer's prediction on the openness and inflation relationship. Our empirical results are robust to varying data frequency so as to account for business cycle effects, and with an alternative measure of trade openness.

In the light of these empirical results, a direct policy implication is that monetary authorities in African countries should keep watch on the degree of trade openness when designing their choice of optimal monetary policy. This is paramount since trade openness is positively related with output level, while negatively related to inflation.

Therefore, monetary authorities should act parallel to Romer's prediction on openness and monetary policy. Otherwise, the effects of monetary expansion will be absorbed by inflation. Furthermore, current efforts at regional integration should be deepened and sustained, since it encourages capital and labour mobility, enhanced trade volume, and promotes technological innovation, which ultimately contributes to output growth and productivity. Also, possible concerns among African countries on the potential loss of monetary policy independence should be weighed with the stabilization benefit of output and prices in the proposed African Monetary Union.

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APPENDIX

Table A1: Robustness to long-term panel average (three-year averages)

Dependent variable: real output growth Δy_t					Dependent variable: inflation rate Δp_t				
Variables	(1)	(2)	(3)	(4)	Variables	(5)	(6)	(7)	(8)
Δy_{t-1}	0.0444	-0.119	-0.0484	-0.0043	Δp_{t-1}	0.216***	0.182**	0.193***	-0.012
	(1.239)	(-0.798)	(-0.819)	(-0.032)		(2.827)	(2.047)	(2.896)	(-0.115)
Δoil_t	0.0366**	0.0341*	0.0211	0.0324*	Δoil_t	-0.121***	-0.120***	-0.0087	-0.0004
	(2.247)	(1.953)	(1.297)	(1.945)		(-3.976)	(-3.886)	(0.361)	(-0.018)
Δoil_{t-1}	0.0056	0.0222	0.0139	0.0357**	Δoil_{t-1}	-0.112*	-0.111*	0.0295	0.0282
	(0.369)	(1.219)	(0.943)	(2.141)		(-1.984)	(-1.887)	(0.735)	(0.739)
Δm_t	-0.206**	-0.188***	-0.177***	-0.066	Δm_t	0.518***	0.476***	0.0741	-0.0467
	(-2.539)	(-3.205)	(-4.584)	(-1.417)		(4.272)	(3.848)	(1.308)	(-0.848)
Δm_{t-1}		-0.0135	0.0154	-0.0574	Δm_{t-1}		0.0893**	0.0503	0.0614
		(-0.397)	(0.406)	(-1.401)			(2.402)	(0.653)	(0.880)
Δm_{t-2}			0.0223*	-0.0375	Δm_{t-2}			0.0551	-0.0328
			(1.915)	(-0.825)				(1.020)	(-0.403)
Δm_{t-3}				0.0237	Δm_{t-3}				-0.0265
				(1.145)					(-0.549)
$\Delta m_t open_t$	0.00347***	0.0033***	0.0032***	0.0014***	$\Delta m_t open_t$	-0.0014**	-0.0011	0.00005	0.0007
	(5.652)	(6.156)	(8.682)	(3.066)		(-2.091)	(-1.633)	(0.086)	(1.101)
$\Delta m_{t-1} open_{t-1}$		0.0022**	0.0012**	0.0014**	$\Delta m_{t-1} open_{t-1}$		-0.0007***	-0.0003	-0.0002
		(2.298)	(2.677)	(2.705)			(-2.999)	(-0.356)	(-0.515)
$\Delta m_{t-2} open_{t-2}$			-0.0011***	0.0003	$\Delta m_{t-2} open_{t-2}$			0.00005	-0.00002
			(-7.395)	(0.728)				(0.087)	(-0.031)
$\Delta m_{t-3} open_{t-3}$				-0.0003	$\Delta m_{t-3} open_{t-3}$				0.00004
				(-0.929)					(0.129)

Constant	3.258***	2.372***	2.955***	2.815**	Constant	1.088	0.945	1.792**	6.012***
	(4.452)	(3.017)	(3.880)	(2.705)		(0.587)	(0.516)	(2.683)	(3.067)
$\sum_{i=0}^{} \vartheta_i^m$	-0.206**	-0.2015*	-0.1395*	-0.1375*	$\sum_{i=0}^{} \phi_i^m$	0.518***	0.565***	0.1794***	-0.0446
	(-2.539)	(-2.596)	(-2.727)	(-1.811)		(4.272)	(4.264)	(3.331)	(-0.291)
$\sum_{i=0}^{} \vartheta_i^{om}$	0.00347***	4.57×10^{-3}***	0.0033***	0.0027***	$\sum_{i=0}^{} \vartheta_i^{om}$	-0.0014**	-0.0018**	-1.69×10^{-4}	-5.07×10^{-4}
	(5.652)	(4.329)	(6.655)	(5.548)		(-2.091)	(-2.353)	(-0.495)	(0.643)
N	259	259	222	185		259	259	222	185
Adj. R^2	0.453	0.532	0.692	0.473		0.410	0.414	0.237	0.016

Note: $\sum_{i=0}^{S} \vartheta_i^m$ and $\sum_{i=0}^{S} \phi_i^m$ are the sum of the money growth coefficients (Δm_{t-i}) in the output and inflation equation respectively; $\sum_{i=0}^{S} \vartheta_i^{om}$ and $\sum_{i=0}^{S} \phi_i^{om}$ are the sum of the coefficients of the interaction terms ($\Delta m_t open_t$) in the output and inflation equation respectively with their Wald test F-statistics in the parenthesis, For other coefficients, t-statistics are reported in parentheses. ***,**,* indicates 1%, 5% and 10% significance level.

Table A2: Robustness with alternative measure – Import/GDP ($open_2$)

Dependent variable: real output growth Δy_t					Dependent variable: inflation rate Δp_t				
Variables	(1)	(2)	(3)	(4)	Variables	(5)	(6)	(7)	(8)
Δy_{t-1}	0.184**	0.121***	0.0280	0.0047	Δp_{t-1}	0.553***	0.500***	0.467***	0.440***
	(2.422)	(3.005)	(1.070)	(1.131)		(13.338)	(14.894)	(13.887)	(11.728)
Δoil_t	0.0198***	0.0139	0.0141	0.0133	Δoil_t	-0.0225*	-0.0226*	-0.0201	-0.0183
	(3.000)	(1.329)	(1.480)	(1.522)		(-1.767)	(-1.789)	(-1.586)	(-1.453)
Δoil_{t-1}	0.0228*	0.0173**	0.0152***	0.0127**	Δoil_{t-1}	-0.0184	-0.0240*	-0.0270**	-0.0249*
	(1.987)	(2.468)	(2.791)	(2.032)		(-1.613)	(-2.024)	(-2.112)	(-2.001)
Δm_t	-0.0109	0.0634***	0.0817***	0.0945***	Δm_t	0.221***	0.233***	0.222***	0.184***
	(-0.407)	(3.086)	(3.967)	(4.202)		(4.498)	(5.561)	(6.111)	(5.139)
Δm_{t-1}		-0.128***	-0.120***	-0.117***	Δm_{t-1}		0.09943***	0.0756	0.0777
		(-5.352)	(-3.109)	(-3.367)			(3.828)	(1.629)	(1.550)
Δm_{t-2}			-0.0689***	-0.0582***	Δm_{t-2}			0.0330***	0.0084
			(-5.131)	(-3.301)				(2.775)	(0.302)
Δm_{t-3}				0.0076	Δm_{t-3}				0.0384***
				(0.479)					(3.200)
$\Delta m_t open_t$	0.0012***	-0.0004***	-0.00006***	-0.0008***	$\Delta m_t open_t$	-0.0007**	-0.0006**	-0.0006**	-0.0002
	(7.258)	(-3.686)	(-5.938)	(-6.681)		(-2.228)	(-2.066)	(-2.093)	(-0.933)
$\Delta m_{t-1} open_{t-1}$		0.0033***	0.0029***	0.0030***	$\Delta m_{t-1} open_{t-1}$		-0.0006	0.0005	-0.0006
		(16.638)	(8.856)	(9.105)			(-1.489)	(-1.267)	(-1.375)
$\Delta m_{t-2} open_{t-2}$			0.0018***	0.0024***	$\Delta m_{t-2} open_{t-2}$			-3.9×10^{-6}	0.0001
			(14.564)	(17.539)				(-0.019)	(0.466)
$\Delta m_{t-3} open_{t-3}$				1.86×10^{-4}**	$\Delta m_{t-3} open_{t-3}$				-4.31×10^{-4}***
				(2.072)					(-2.949)
Constant	2.791***	2.827***	3.179***	2.248***	Constant	0.891	-0.239	-0.0441	0.509
	(9.913)	(8.643)	(5.094)	(3.709)		(1.170)	(-0.261)	(-0.040)	(0.362)

$\sum_{i=0}^{} \vartheta_i^m$	-0.0109	-0.0644*	-0.1073**	-0.0727	$\sum_{i=0}^{} \phi_i^m$	0.221***	0.3326***	0.3303***	0.3089***
	(-0.407)	(-2.014)	(-2.432)	(-1.906)		(4.498)	(5.486)	(4.415)	(3.186)
$\sum_{i=0}^{} \vartheta_i^{om}$	0.0012***	0.0029***	0.0041***	0.0048***	$\sum_{i=0}^{} \vartheta_i^{om}$	-0.0007**	-0.0011***	-0.0011**	-0.0012**
	(7.258)	(13.499)	(12.566)	(14.029)		(-2.228)	(-2.719)	(-2.356)	(-2.175)
N	925	925	888	851		925	925	888	851
Adj. R^2	0.079	0.237	0.279	0.351		0.471	0.492	0.468	0.396

Note: $\sum_{i=0}^{S} \vartheta_i^m$ and $\sum_{i=0}^{S} \phi_i^m$ are the sum of the money growth coefficients (Δm_{t-i}) in the output and inflation equation respectively; $\sum_{i=0}^{S} \vartheta_i^{om}$ and $\sum_{i=0}^{S} \phi_i^{om}$ are the sum of the coefficients of the interaction terms ($\Delta m_t open_t$) in the output and inflation equation respectively with their Wald test F-statistics in the parenthesis, For other coefficients, t-statistics are reported in parentheses. ***,**,* indicates 1%, 5% and 10% significance level.

CREDIT MARKET DEVELOPMENT AND ECONOMIC GROWTH IN LIBERIA: AN EMPIRICAL INVESTIGATION

Michael D. Titoe Jr.*[1], Mussah A. Kamara[1]

Abstract

The importance of credit market development to economic growth and development in Liberia has gained traction over time and has been widely discussed in Liberia. This paper empirically contributes to the discussion by analyzing, within an endogenous growth framework, the relationship between credit market development and economic growth in Liberia. An autoregressive distributed lag model is employed to estimate the relationship, and the findings reveal that in the long run, credit market development, proxied by domestic credit to private sector as a percentage of gross domestic product, enhances economic growth which is proxied by the growth of gross domestic product per capita. The findings also show a unidirectional relationship, with credit market development Granger causing economic growth in Liberia and the reverse causality being nonexistent.

JEL Classification: E58, G21, O16
Keywords: Credit Market, Economic Growth, Auto-regressive Distributed Lag, Cointegration

1.0 Introduction

Credit market plays a major role in economic growth and development of many economies. Some scholars and researchers have propounded that the development of credit market can help enhance economic growth and development through providing credit which helps facilitate entrepreneurship (Schumpeter, 1934; Guiso et al., 2004), reduce inequality and alleviate poverty (Beck et al., 2007), promote education (Levine and Rubinstein, 2013), among other positive impacts. Other researchers have found that a growing economy drives the development of the credit market (Adamopoulos, 2010; Mishra et al., 2009), while some others have shown that there exists a two-way causal relationship between credit market development and economic growth (Greenwood and Jovanovic, 1991; Pradhan, 2009).

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In Liberia, the credit market has not been fully developed and functional. It is largely dominated by the banking sector, with a significant informal sector. Some participants in the market have had complaints on why they think the market has not been functioning properly. On one hand, some borrowers (particularly small and medium-sized enterprises) complain of high interest rate and the relatively short period for the repayment of loans as factors which make loans unhelpful in realizing significant economic gains, and at times, even make them worse off than they were before taking the loans. On the other hand, most lenders complain of the issue of non-performing loans resulting from borrowers defaulting on loan repayments as a major factor which affects their operations. With these mixed and contending views, there is a need to investigate the impact of the credit market on economic growth in Liberia. Against this background, this paper analyzed the credit-growth nexus in Liberia in order to shed light on what has been the actual impact of the credit market in the Liberian economy, and thereafter provide recommendations to help inform policy-making on the development of the country's credit market. Esso (2010) conducts a cross-country analysis on the finance-growth nexus in the Economic Community of West African States (ECOWAS) and tries to address this issue by using 1974-2005 data to do a bivariate analysis on the relationship between credit to private sector and gross domestic product per capita in Liberia. The author, however, does not control for other variables which might affect the relationship between credit to private sector and growth. This study overcomes such limitation and contributes to the literature on the credit-growth nexus by utilizing a relatively longer time series on Liberia, and other control variables, including a polity variable, which controls for the political regime and authority characteristics of the country.

The rest of the paper is organized as follows. Chapter two presents a review of the literature, both theoretical and empirical. Chapter three presents the methodology, detailing the theoretical framework and the empirical model. Chapter 4 presents the empirical findings and analysis. Chapter five concludes the paper and presents policy recommendations.

2.0 Literature Review

The literature on credit market development and economic growth provides theoretical and empirical evidence supporting the view that credit market development (and in general, financial development) affects economic growth and development.

2.1 Theoretical Literature Review

There are many arguments in the theoretical literature on the importance of credit to economic growth and development. Some earlier contributors to the literature argued in favor of the positive role credit market plays in an economy. For example, Schumpeter (1934) argues that development can be occasioned in an economy when entrepreneurs, who are innovative, receive credit to invest. Keynes (1937) emphasizes the need for credit to finance investment which can spur growth and development. In recent times, Guiso et al. (2004) contend that finance fosters entrepreneurship, increases market competition by encouraging the entrance of new firms, and promotes growth.

The credit market being a component of the financial system, significantly contributes to the overall performance of the system. When the financial system performs well, it improves the probability of successful innovation and consequently spurs economic growth (King and Levine, 1993). The financial system also plays an important role in improving the welfare of people living in poverty. Findings from the work of Beck et al. (2007) show that credit to private sector alleviates poverty by promoting economic growth and reducing income inequality which by extension enhances economic development. The financial system also promotes education by providing access to finance particularly through the credit market. Levine and Rubinstein (2013) show that banking sector reforms that ease credit conditions (for example, lower interest rates) increase college enrollment and hence economic opportunities.

Some authors support the view that there exists a bi-directional relationship between financial development and growth. For example, Greenwood and Jovanovic (1990) argue that while economic growth enhances financial development, a developed financial system also promotes economic growth by allowing more efficient investments to be undertaken. Blackburn and Hung (1998), also support this view that there is a two-way causal relationship between growth and financial development.
The quality of financial services significantly impacts economic growth and development. Levine (2002) supports this argument and confirms the crucial role banks and markets play in mobilizing and directing savings to the most productive investment projects. He highlights the importance of the legal system in financial sector development in terms of protecting the rights of market participants.

As discussed earlier, from a theoretical perspective, credit market has a very germane role to play in the growth and development of an economy. When the credit market functions properly, it enhances growth and development; but when it malfunctions,

the economy might be adversely affected. In the literature, a common theme found in the arguments of some of the proponents of the credit-led growth view is the fact that credit is needed to facilitate investment which spurs growth and development. However, the accessibility and affordability of credit are to a great extent dependent on the nature of the credit market.

2.2 Empirical Literature Review

On the empirical front, there have been some studies that focused on the nexus between credit market development and economic growth and development. These studies have used many methodologies and have provided mixed results. For example, Akpansung and Babalola (2011), using data for the period 1970-2008, investigate the relationship between banking sector credit and economic growth in Nigeria. They employ a two-stage least squares approach and find that private sector credit, a proxy for credit market development, positively impacts economic growth in Nigeria. Esso (2010) conducts a cross-country analysis to investigate the relationship between financial development and economic growth in the fifteen ECOWAS countries. Using a sample ranging from 1974 to 2005 for Liberia, he finds that there exists a long-run relationship between financial development (proxied by credit to private sector as a percentage of gross domestic product) and economic growth (represented by gross domestic product per capita), with there being a one-way causality running from the former to the latter. Koivu (2002), using a fixed-effect panel model to analyze the relationship between banking sector development and economic growth in 25 transition countries for the period 1993-2002, finds that economic growth does not seem to be accelerated by an increase in the amount of credit to private sector in those countries. The author argues that banking crises and soft budget constraints in transition countries have made growth in credit not sustainable and at times may have even reduced growth.

Adu et al. (2013) use the autoregressive distributed lag approach and principal component analysis to analyze the financial development-growth nexus in Ghana. They find that both credit to private sector and total domestic credit enhance growth. Nkoro and Uko (2013), using vector error correction model (VECM) to analyze data on Nigeria, find that credit to private sector does not enhance growth. They attribute this to the problems of high non-performing loans and a deficient legal system which does not protect contracts in the private sector.

Vazakidis and Adamopoulos (2009) investigate the nexus between credit market development and economic growth in India for the period 1965-2007. They employ

VECM and find that in the short run, an increase in economic growth causes an increase in bank lending, a proxy they use for credit market development. Adamopoulos (2010) also analyzes the nexus between credit market development and economic growth in Spain for the period ranging from 1976 to 2007 using VECM. He finds that in the short run, economic growth induces an increase in bank lending. Mishra et al. (2009) use a vector autoregression (VAR) framework and find that economic growth positively affects credit market development in India.

Pradhan (2009) uses a multivariate VAR model to analyze the relationship between financial development and economic growth in India. He finds that there exists two-way causality between economic growth and bank credit. Cappiello et al. (2010) find that changes in the supply of credit, with regards to volumes and credit standards applied on loans provided to enterprises, significantly impact real economic activity in the euro area.

Kar and Pentecost (2000) analyze the nexus between financial development and growth in Turkey and find that the choice of proxy for financial development determines the direction of causality between financial development and economic growth. When private sector credit is considered as a proxy, growth seems to drive financial development.

3.0 METHODOLOGY

3.1 Theoretical Framework

Following the works of Pagano (1993) and Bailliu (2000), this study adopts an endogenous growth model to analyze the nexus that exists between credit market development and economic growth in Liberia. For a closed-economy, the model is specified as:

$$Y_t = AK_t \quad (1)$$

where Y_t, A and K_t are national output, total factor productivity, and capital stock, respectively.

In each period, capital stock is assumed to depreciate at a rate of δ. Hence, gross investment is given by:

$$I_t = K_{t+1} - (1-\delta)K_t \quad (2)$$

Through financial intermediation in the credit market, savings are transformed into investment by financial intermediaries who take from each dollar saved a fraction, 1-

θ, as service fee (or say, transcation cost), and make available θ for investment. It then follows that equilibrium is attained in the market when net savings and gross investment are equal such that:

$$\theta S_t = I_t \quad (3)$$

Making use of equations (1), (2) and (3) and dropping the time subscripts, growth rate of output at steady state, g, with financial intermediation is given by:

$$g = A\left(\frac{I}{Y}\right) - \delta = A\theta s - \delta \quad (4)$$

where s is the gross savings rate. Equation (4) shows that economic growth can be affected by credit market development based on how efficiently financial intermediation directs savings and capital to investment. For example, it is expected that the more intermediation banks do, the more efficient they become at doing so, and thus, transaction cost is reduced. A reduced transaction cost would mean that the fraction of savings available for investment is increased, thereby resulting to an increase in g in equation (4).

An improvement in capital allocation leads to a rise in overall productivity, A, and this drives higher growth. This happens because as financial institutions do more intermediation, they become better able to assess various investment projects and choose those with better returns.

Assume that the economy receives international capital inflows (for example, through foreign direct investment). In this case, higher net inflows of capital in addition to domestic savings would provide increased funds to facilitate investment. Thus, equilibrium in the market becomes:

$$\theta^*(S_t + CI_t) = I_t^* \quad (5)$$

where CI_t is capital inflows (in this case, from foreign direct investment), and * shows the presence of international factors. By substituting equation (5) into (4), the steady-state growth rate is given by:

$$g^* = A^*\frac{I^*}{Y} - \delta = A^*\theta^*\frac{(S+CI)}{Y} - \delta = A^*\theta^* s^* - \delta \quad (6)$$

According to Bailliu (2000), a comparison of equations (4) and (6) shows that capital inflows can lead to growth if they increase financial intermediation; if they occasion

investments which produce positive spillovers; and primarily, if they cause investment rate to increase such that g^* is greater than g when s^* is greater than s, other things being equal. However, for s^* to be greater than s, net capital inflows should be used to finance investments which do not crowd out domestically financed investments.

3.2 Empirical Model

Following the work of Jalil and Feridun (2011) who built on the work of Christopoulos and Tsionas (2004) to transit from the theoretical model to an empirical specification, the following equation is specified:

$$LGDPPC_t = \beta_0 + \beta_1 CREDIT_t + \beta_2 INFL_t + \beta_3 TROP_t + \beta_4 FDI_t + \beta_5 POLITY_t + u_t \quad (7)$$

where $GDPPC$ is the log of gross domestic product (GDP) per capita; $CREDIT$ represents credit market development; $INFL$ represents the rate of inflation; $TROP$ represents trade openness; FDI represents foreign direct investment; $POLITY$ represents polity score; and u_t is the error term.

To estimate the equation specified in equation (7), this study employs the Auto-regressive Distributed Lag (ARDL) estimation approach, following Pesaran et al. (2001). The ARDL approach is appropriate in situation where the variables are integrated of different orders, namely zero (0) and one (1); and it can be specified as follows:

$$\begin{aligned}\Delta LGDPPC_t = \alpha_0 &+ \sum_{i=0}^{p} \alpha_{1i} \Delta LGDPPC_{t-i} + \sum_{i=0}^{p} \alpha_{2i} \Delta CREDIT_{t-i} + \sum_{i=0}^{p} \alpha_{3i} \Delta INFL_{t-i} \\ &+ \sum_{i=0}^{p} \alpha_{4i} \Delta TROP_{t-i} + \sum_{i=0}^{p} \alpha_{5i} \Delta FDI_{t-i} + \sum_{i=0}^{p} \alpha_{6i} \Delta POLITY_{t-i} + \alpha_7 LGDPPC_{t-1} \\ &+ \alpha_8 CREDIT_{t-1} + \alpha_9 INFL_{t-1} + \alpha_{10} TROP_{t-1} + \alpha_{11} FDI_{t-1} + \alpha_{12} POLITY_{t-1} \\ &+ u_t \end{aligned} \quad (8)$$

where $\alpha_1, \alpha_2, \alpha_3, \alpha_4, \alpha_5,$ and α_6 are parameters representing short-run dynamics of the model, and $\alpha_7, \alpha_8, \alpha_9, \alpha_{10}, \alpha_{11},$ and α_{12} are parameters representing the long-run relationship.

3.3 Data and Variable Description

This study utilizes annual time series data for the period 1974-2015 and they are sourced from the World Bank's World Development Indicators (2017), the Central Bank of Liberia's database and the Polity IV Project (Center for Systemic Peace, 2017). Table 1 describes the variables used in this study.

Table 1: Variable Description

Variable	Description
Dependent	
LGDPPC	The logarithm of gross domestic product per capita used as a proxy for economic growth/development
Independent	
CREDIT	Domestic credit to private sector (% of GDP) used as an indicator of credit market development.
INFL	Annual rate of inflation (GDP deflator)
TROP	Trade openness proxied by the sum of exports (% of GDP) and imports (% of GDP)
FDI	Foreign direct investment inflows (% of GDP)
POLITY	This variable gives yearly information on the political regime and authority characteristics of countries. It is compiled under the Polity IV Project conducted by the Center for Systemic Peace. It shows the difference between democracy and autocracy, and it ranges from +10 (strong democracy) to -10 (strong autocracy).

4.0 ESTIMATION AND ANALYSIS OF RESULTS

4.1 Unit Root Test

Before estimating the ARDL model, it is necessary that the variables are tested to know their order of integration as the model is appropriate in the case where variables are integrated of order zero (0) and order one (1), but not order two (2) and higher. To do this, the Augmented Dickey Fuller Test is conducted on the variables. The results of the test reveal that some variables are integrated of order one (that is, become stationary after first difference) and others are integrated of order zero (that is, stationary at

levels), thus confirming the suitability of the ARDL model for this study. The test results are presented in table 2 below.

Table 2: Augmented Dickey-Fuller Test

		Critical Value			
Variable	**Test Statistic**	**1% level**	**5% level**	**10% level**	**Order of Integration**
LGDPPC	-2.115283	-3.610453	-2.938987	-2.607932	I(1)
ΔLGDPPC	-3.823343	-3.605593	-2.936942	-2.936942	I(0)
CREDIT	-1.158096	-4.226815	-3.536601	-3.200320	I(1)
ΔCREDIT	-15.50034	-4.205004	-3.526609	-3.194611	I(0)
INFL	-5.115110	-3.600987	-2.935001	-2.605836	I(0)
TROP	-1.934094	-3.600987	-2.935001	-2.605836	I(1)
ΔTROP	-5.908973	-3.605593	-2.936942	-2.606857	I(0)
FDI	-5.367240	-3.600987	-2.935001	-2.605836	I(0)
POLITY	-0.400153	-3.600987	-2.935001	-2.605836	I(1)
ΔPOLITY	-5.580998	-3.605593	-2.936942	-2.606857	I(0)

4.2 Bounds Test

Since the variables in the model are found to be integrated of different orders, to verify the presence of cointegration among them, a bounds testing approach is employed following Pesaran et al. (2001). The null hypothesis under this approach is that there is no levels relationship. To test this hypothesis, the F-statistic from the bounds test is compared with the values corresponding to the lower bound, I(0) and the upper bound, I(1) of the test. If the F-statistic is less than the lower bound value, there is no rejection of the null hypothesis. If the F-statistic is higher than the upper bound value, there is a rejection of the null hypothesis. If the F-statistic falls between the lower and upper bounds, the test is inconclusive. Since the bounds test results presented in table 3 show that the F-statistic is greater than the upper bound value, there is a rejection of the null hypothesis. Thus, the conclusion is that there exists a level (long-run) relationship among the variables in the model.

Table 3: Bounds Test

F-Bounds Test		Null Hypothesis: No levels relationship		
Test Statistic	Value	Signif.	I(0)	I(1)
			Asymptotic: n=1000	
F-statistic	10.37569	10%	2.08	3
k	5	5%	2.39	3.38
		2.5%	2.7	3.73
		1%	3.06	4.15
Actual Sample Size	38		Finite Sample: n=40	
		10%	2.306	3.353
		5%	2.734	3.92
		1%	3.657	5.256
			Finite Sample: n=35	
		10%	2.331	3.417
		5%	2.804	4.013
		1%	3.9	5.419

4.3 ARDL Estimation Result

In order to analyze how credit market development affects growth in Liberia, while controlling for other variables such as inflation, trade openness, foreign direct investment and polity, an ARDL model is estimated using EViews 10. In order to choose the appropriate model, a maximum of 4 lags and the Akaike Information Criteria (AIC) are used. The automatically selected ARDL model based on AIC is of the lag order (4, 3, 4, 3 ,4, 4). The top 20 models selected by AIC are presented in the Appendix.

4.3.1 Short Run (Error Correction) Form

The short-run estimates of the ARDL model are presented in table 4. In the short run, the coefficient on CREDIT is negative and not significant, implying that domestic credit to private sector does not exert a significant negative impact on growth. However, with lags, CREDIT negatively affects growth. Inflation is found to promote growth in the short run, but the variable is found to negatively affect growth with lags. These findings imply that an increase in inflation in previous years would reduce growth in the current year. Trade openness, foreign direct investment and polity are all found to negatively affect growth. However, with lags, these variables are found to increase growth.

The coefficient of the error correction model (ECM) is negative and statistically significant, and it lies in the ideal -1 to 0 range, implying that there indeed exists cointegration (long-run relationship) among the variables. The coefficient of the ECM is -0.775, indicating that any deviation from equilibrium in the current year is corrected by 77.5 percent in the next year. This shows a fast speed of adjustment to equilibrium.

Table 4: Short Run (Error Correction) Form

ARDL Error Correction Regression
Dependent Variable: D(LGDPPC)
Selected Model: ARDL(4, 3, 4, 3, 4, 4)
Sample: 1974 2015
Included observations: 38

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(LGDPPC(-1))	0.290075	0.076367	3.798458	0.0035***
D(LGDPPC(-2))	0.210107	0.080305	2.616373	0.0258**
D(LGDPPC(-3))	0.404046	0.080922	4.993016	0.0005***
D(CREDIT)	-0.004566	0.005099	-0.895443	0.3916
D(CREDIT(-1))	-0.080843	0.013550	-5.966378	0.0001***
D(CREDIT(-2))	-0.050180	0.009337	-5.374490	0.0003***
D(INFL)	0.007287	0.001230	5.923894	0.0001***
D(INFL(-1))	-0.017666	0.002365	-7.469814	0.0000***
D(INFL(-2))	-0.008815	0.001501	-5.871104	0.0002***
D(INFL(-3))	-0.006479	0.001051	-6.164408	0.0001***
D(TROP)	-0.000478	7.21E-05	-6.631287	0.0001***
D(TROP(-1))	-2.23E-05	0.000110	-0.201622	0.8443

D(TROP(-2))	0.000369	0.000108	3.418854	0.0066***
D(FDI)	-0.003010	0.000286	-10.51016	0.0000***
D(FDI(-1))	0.004578	0.000527	8.684615	0.0000***
D(FDI(-2))	0.002539	0.000394	6.449103	0.0001***
D(FDI(-3))	0.001504	0.000301	4.989111	0.0005***
D(POLITY)	-0.056728	0.006912	-8.207282	0.0000***
D(POLITY(-1))	0.119565	0.010706	11.16829	0.0000***
D(POLITY(-2))	0.058022	0.014951	3.880816	0.0031***
D(POLITY(-3))	0.069219	0.013050	5.304340	0.0003***
CointEq(-1)	-0.774815	0.071875	-10.77997	0.0000***

R-squared	0.986888	Mean dependent var	0.003806
Adjusted R-squared	0.969678	S.D. dependent var	0.205297
S.E. of regression	0.035749	Akaike info criterion	-3.531717
Sum squared resid	0.020447	Schwarz criterion	-2.583641
Log likelihood	89.10263	Hannan-Quinn criter.	-3.194399
Durbin-Watson stat	2.277556		

Note: *, **, *** indicate that parameter estimates are statistically significant at 10%, 5% and 1%, respectively.

4.3.2 Long Run (Levels) Equation Form

The levels relationship giving the long-run estimates of the ARDL model are presented in table 5.

Table 5: Long Run Equation Form

Variable	Coefficient	Std. Error	t-Statistic	Prob.
CREDIT	0.148381	0.009422	15.74775	0.0000***
INFL	0.042186	0.005430	7.769524	0.0000***
TROP	-0.001468	0.000170	-8.621214	0.0000***
FDI	-0.011011	0.002849	-3.865442	0.0031***
POLITY	-0.174046	0.012074	-14.41501	0.0000***

C	4.936001	0.108929	45.31389	0.0000***

Note: *, **, *** indicate that parameter estimates are statistically significant at 10%, 5% and 1%, respectively.

In the long run, credit market development is found to enhance economic growth. A 10-percent increase in domestic credit to private sector (% of GDP) drives economic growth by 1.5 percent. This result is consistent with the credit-led growth view and confirms findings by Esso (2010) who reveal that there is a long-run relationship between credit to private sector and growth in Liberia. The result also corroborates findings by Akpansung and Babalola (2011) and Adu et al. (2013) who reveal that credit market development drives economic growth in Nigeria and Ghana, respectively.

Inflation is also found to drive growth in the long run, albeit minimally. A 1-percent increase in inflation leads to a 0.04-percent GDP growth. This result is in line with findings by Mallik and Chowdhury (2001) who reveal that inflation positively affects growth in the long run in four South Asian countries (Bangladesh, India, Pakistan and Sri Lanka).

Trade openness has a very minimal, negative impact on economic growth in Liberia. A 1-percent increase in trade openness reduces growth by 0.001 percent. This finding is consistent with findings of other studies. This could be as a result of Liberia exporting mainly primary commodities with little or no value addition and importing mainly consumer goods. Hausmann, Hwang, and Rodrik (2007) find that countries with low-quality products are more likely to be adversely affected by trade openness. Vlastou (2010) also finds that trade openness negatively affects growth in African countries.

Foreign direct investment is also found to decrease growth in the long run. A 1-percent increase in FDI inflows (% of GDP) reduces growth by 0.01 percent. This finding corroborates the view that FDI has sector-specific growth effects, with FDI to primary sector having negative impact on growth. This is the case in Liberia as most of the FDI inflows to the country go to the primary sector. Alfaro (2003) finds that FDI flowing to the manufacturing sector enhances growth while FDI to the primary sector has a negative effect on growth.

Polity is found to have an adverse effect on economic growth in Liberia. A 1-unit increase in the polity score occasions a 0.17 percent decline in economic growth in

the long run, revealing that democracy in Liberia is not growth-enhancing. This result corroborates findings from the work of Tavares and Wacziarg (2001) who show that democracy negatively affects growth. Barro (1996) and Barro (1999) also argue that democracy has negative effects on growth through encouraging rich-to-poor redistributions of income and enhancing the power of interest groups in systems which have legislative representations.

4.4 Post-estimation Diagnostics

Several post-estimation diagnostic tests verify the robustness and stability of the estimated ARDL model. The results contained in table 6 below reveal that there are no heteroskedasticity and serial correlation, and that the residuals are normally distributed since the null hypotheses of all three tests are not rejected.

Table 6: Post-estimation Tests

Test	Null Hypothesis	Test Statistic and P-value
Breusch-Pagan-Godfrey Test for Heteroskedasticity	Homoskedasticity (or no heteroskedasticity)	F-statistic = 0.912724 Prob. F(27,10) = 0.6002
Breusch-Godfrey Serial Correlation LM Test	No serial correlation	F-statistic = 2.824819 Prob. F(8,2) = 0.2877
Normality Test	Residuals are normally distributed	Jarque-Bera = 0.260087 Prob. = 0.878057

4.4.1 Stability Diagnostics

To verify the stability of the estimated ARDL model, three tests are conducted. The Cumulative Sum of Recursive Residuals (CUSUM Test) and the Cumulative Sum of Squares of Recursive Residuals (CUSUM of Squares Test) show that the model is dynamically stable and that there is no problem of structural break. The plots of these stability tests using the 5-percent confidence interval are found in the Appendix.

The results of the Ramsey RESET Test of functional form presented in table 7 below show that the estimated model is correctly specified since the null hypothesis of the test is not rejected.

Table 7: Ramsey RESET Test

Null Hypothesis	Test Statistic and P-value
The functional form is correctly specified	F-statistic = 1.110473 Prob. = 0.4069

4.5 Pairwise Granger Causality Test

Since it is established that the variables used in this study are cointegrated, it is safe to conclude that there is either unidirectional Granger causality or bidirectional Granger causality. Following the work of Granger (1969), this study tests Granger causality between credit market development and economic growth. The following VAR model is estimated to establish the direction of causality:

$$Y_t = a_0 + a_1 Y_{t-1} + \ldots + a_p Y_{t-p} + b_1 X_{t-1} + \ldots + b_p X_{t-p} + U_t \quad (7)$$

$$X_t = c_0 + c_1 X_{t-1} + \ldots + c_p X_{t-p} + d_1 Y_{t-1} + \ldots + d_p Y_{t-p} + V_t \quad (8)$$

The following hypotheses are then tested:
$H_0: b_1 = b_2 = \ldots = b_p = 0$, against $H_A: Not\ H_0$
The null hypothesis is that X does not Granger-cause Y

$H_0: d_1 = d_2 = \ldots = d_p = 0$, against $H_A: Not\ H_0$
The null hypothesis is that Y does not Granger-cause X

In each case, a rejection of the null hypothesis implies that there is Granger causality.

The results of the Pairwise Granger Causality Tests displayed in table 8 indicate that there is a unidirectional or one-way causal relationship running from credit market development to economic growth, as the null hypothesis that D(CREDIT) does not Granger cause D(LGDPPC) is rejected at the 10-percent level of significance. The null hypothesis that D(LGDPPC) does not Granger cause D(CREDIT) is not rejected.

The variables are first differenced because they are both integrated of order one, I(1).

Table 8: Pairwise Granger Causality Tests

Sample: 1974 2015 Lags: 3			
Null Hypothesis	**Obs.**	**F-Statistic**	**Prob.**
D(CREDIT) does not Granger Cause D(LGDPPC**)**	38	2.67417	0.0645
D(LGDPPC) does not Granger Cause D(CREDIT**)**		0.32809	0.8050

5.0 Conclusion and Policy Recommendations

This study analyzes, within an endogenous growth framework, the impact of credit market development on economic growth in Liberia, while controlling for other factors such as inflation, trade openness, foreign direct investment inflows and polity. An ARDL model is utilized to estimate the relationship and the findings show that, in the short run, domestic credit to private sector (% of GDP), the proxy for credit market development, has no significant impact on growth but adversely affects growth with lags. However, in the long run, domestic credit to private sector (% of GDP) enhances growth. This implies that even though the credit market in Liberia is not fully developed and is still challenged, it has the potential to drive growth and development in the long run if it is developed and the challenges which affect it are addressed. The results show that a 10-percent increase in domestic credit to private sector (% of GDP) drives growth by 1.5 percent in the long run. This, however, requires proper policy formulation and implementation by the Government of Liberia (GoL), mainly through the Central Bank of Liberia.

To ensure an increase in domestic credit to private sector which would enhance growth, there is a need for GoL to put in place policies to provide protection for both borrowers and lenders in the credit market. The necessary legal and regulatory frameworks should be instituted and enforced to ensure that borrowers who acquire loans from financial institutions (lenders) make repayments as and when due. This would help to address the problem of non-performing loans. Also, GoL should ensure that borrowers are not charged excessive interest rates on loans they acquire, because high interest rates could make loans unattractive or could make borrowers default on loan repayments. Either of these factors could negatively impact the volume of credit given out, and by extension, inhibit economic growth.

The ongoing reforms of the financial sector by the Central Bank[2] is a positive step in the right direction. However, there is a need for greater support from other players, including the three (3) branches of Government to ensure full implementation of these reforms.

[2] The reforms, which are meant to enhance the efficiency in the financial sector, include strengthening the regulation and supervision of financial institutions; deepening the financial system to cover other financial institutions and agent banking; and improving the national payment system to include mobile money and digital financial services.

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APPENDIX

Figure 1: Cumulative Sum of Recursive Residuals (CUSUM Test)

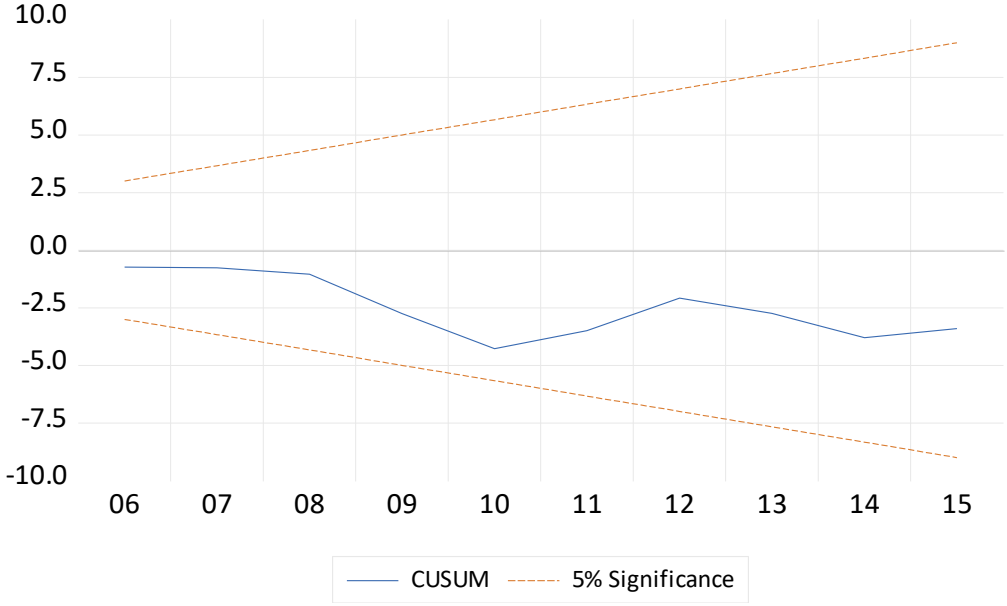


Figure 2: Cumulative Sum of Squares of Recursive Residuals (CUSUM of Squares Test)

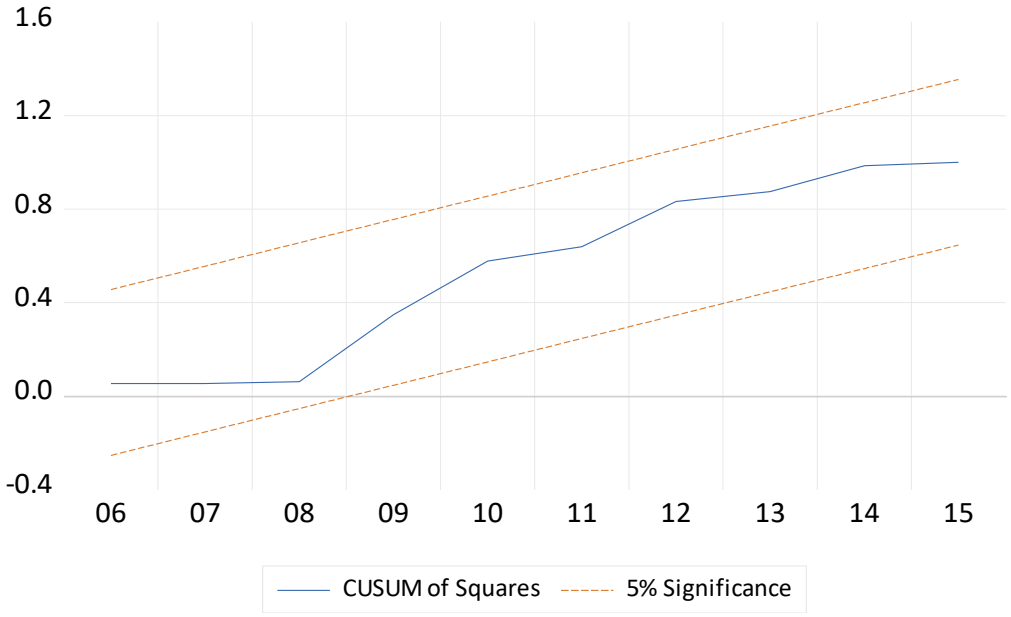


Figure 3: Normality Test

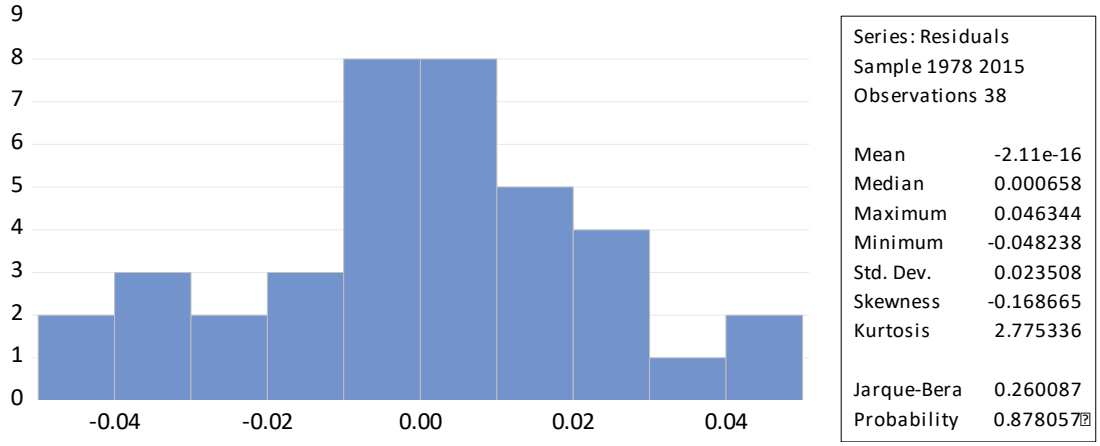
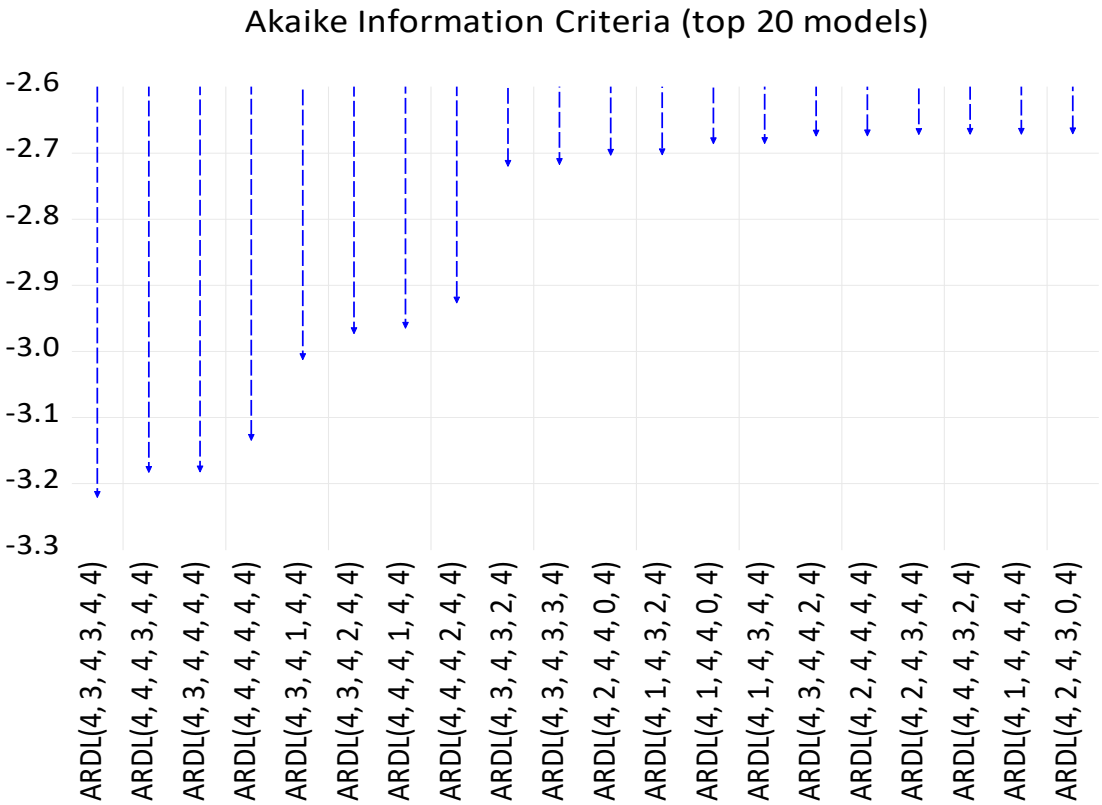


Figure 4: Top 20 ARDL Models



VOLATILITY SPILLOVERS BETWEEN OIL AND STOCK MARKETS: EVIDENCE FROM NIGERIA AND SOUTH AFRICA

Moses K. Tule[1], J.S. Akuns[1], L.R. Balakeffi[1], C.C. Chiemeke[1], S.A, Abdulsalam*[2]

Abstract

This paper investigates the Volatility spillovers between oil and stock markets: Evidence from Nigeria and South Africa. The bivariate form of the VAR–CCC-GARCH was adopted for the study. We find that the shock transmission through oil price changes tends to affect the stock markets both in Nigeria and South Africa significantly, but the level of impact tends to be minimal in the latter than the former. We also observed that the hedging ratios are quite high in South Africa when compared to that of Nigeria. The observed higher values obtained for the hedge ratios in both countries suggest that hedging effectiveness relating to both stock and oil markets in both countries will not deliver the desired outcome to investors. Overall, the paper suggests several significant implications for making optimal portfolio allocations, engaging in risk management and forecasting the future path of commodity markets and volatility in equity for portfolio hedgers.

Keywords: Volatility spillovers, Conditional correlations, Stock indices, Multivariate GARCH Crude oil prices.

JEL Classifications: C22, C32, G17, G32.

1.0 Introduction

The accelerated growth in liquidity recorded in the commodity markets in recent years is largely attributable to the influx of investors who are interested in the market purely for investments with quick returns and not as a means to support economic activity in the real sector of the beneficiaries (Mensi et al., 2013). The integration, boosted by developments in technology and innovations, has led to high volatility in major financial markets, as commodity and equity prices grew more sensitive to innovation and expectations. The rapid integration of emerging and developing economies (largely due to financial liberalisation) into the global international markets has increased significantly, thus fueling volatility (Rasche and Tatom (1977); Hamilton (1988)).

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Theoretically, there are many ways through which the oil price movements could have an impact on the stock returns. For instance, Rasche and Tatom (1977); Hamilton (1988); Kim and Loungani (1992); Rotemberg and Woodford (1996); and Kilian (2014); infer that the transmission of oil price shocks to the real economy is via the supply-side or demand-side channels. The supply-side channel views oil as an intermediate input in the domestic production process such that increases in the price of oil precipitate an increase in the cost of production of goods and services. This has inflationary tendencies which can diminish the purchasing power of consumers. The demand-side perspective is predicated on the premise that higher oil prices would lead to higher energy costs which would reduce households' discretionary income as consumers would have less money to spend after paying their bills resulting in reduced aggregate demand.

Nature of oil dependency and persistent oil price shocks has significant implications for global financial markets, and stock markets in particular. The impact of oil price shocks on stock markets depends primarily on whether a country is an exporter or importer of oil and differs from country to country. In oil-exporting countries, a rise in world oil prices increases the balance of payments' surplus position, accompanied by an accumulation of foreign exchange reserves. This leads to an appreciation of the exchange rate. At the same time, the favourable economic conditions tend to increase households' disposable income and corporate profitability, thus increasing aggregate demand and stock prices. Conversely, falling oil prices would lead to the depletion of foreign exchange reserves, depreciation of the exchange rate, inflationary pressures, reduced household disposable income and corporate profitability, thus, resulting eventually in depressed stock prices. The trend is the reverse in the case of oil importers (Abdelaziz et al. 2008).

Nigeria has been adjudged to be an emerging economy which though, not fully integrated into the global economy, but is partially integrated especially through the financial sector and trade. Also, it is categorised among the top ten oil-producing countries in the world and net oil exporter hence; any instability in commodity traded prices, particularly in crude oil, will impact on the country's macroeconomic developments with a spillover effect on its financial markets. This provides the rationale for the choice of Nigeria, as a result, for the study based on the fact that more than ninety per cent (90%) of the country's exports are crude oil which generates about ninety-seven per cent (97%) of the country's foreign exchange revenue (Gbadebo 2008). It also justifies the basis for an empirical investigation on the correlation between the stock market and oil price shocks, because the return and spillover transmission

between oil and exchange rate provides reasonable and alternative ideas to investors on modalities to aid the diversification of their portfolios or hedging of risks. In addition, the study also introduced the returns and volatility spillover effects in the South African stock markets in the presence of world oil price shocks to gain insight about the degree of volatility spillover effect in both oil-based (Nigerian) and none oil-based (South African) stock markets. Perhaps, more importantly, an empirical investigation and comparison of the volatility spillovers in Nigeria and South Africa will offer more insights to investors, including institutional investors and investment managers on how to build an appropriate assets pricing models, forecast precisely the probable returns and volatility in both markets and construct an optimal portfolio considering the interconnectedness and dynamics in world oil prices and stock markets in recent years. In addition, it will also examine and provide some insight on the optimal weights and hedge ratios for the choice of holding oil -stock in a portfolio. In order to examine possible links and the returns and volatility spillover effects in the presence of world oil price shocks in both Nigerian and South African Stock Markets, a bivariate form of the VAR–GARCH model was adopted.

Most of the literature reviews, focused largely on traditional developing countries in Europe, Asia and Gulf countries (Hammaoudeh and Li, 2004;, Kling, 1985; Sardorsky, 1999; and Eryigit, 2009), thus, leaving a gap for economies in the sub-Saharan Africa (SSA) region including Nigeria. Likewise, most studies on Nigeria focused on the effect of oil price changes and volatility on output and exchange rate (see Adebiyi et al., 2009; and Salisu and Mobolaji, 2013). Also, a comparative analysis of the nexus oil price and stock price between net oil-exporting (Nigeria) and net oil-importing country (South Africa) in SSA is scanty. This is the motivation for the research.

The study is divided as follows: Section two surveys the extant literature on oil price shocks and volatility in stock markets. Section three explains the methodology employed while section four presents the results of the empirical analysis, including the discussions on the optimal weights and hedge ratios for the choice of holding oil -stock in a portfolio both in Nigeria and South Africa. Section five discusses the policy implications of the findings and conclusions.

2.0 Literature Review

Several studies have emerged to empirically confirm or validate the propositions about the interactions between stock and oil price. These studies have adopted different methodologies ranging from the VAR-GARCH families (see for example, Arouri, Jouini, and Nguyen (2011)), SVAR (Basher et al. (2012), fractional co-integration model (Gil-

Alana and Yaya (2014)), co-integration and causality (Apergis and Miller (2009)), etc. The findings from these various studies have been mixed.

For example, Arouri, Jouini, and Nguyen (2011) found a unidirectional from oil to stock markets and bi-directional in Europe and the United States, respectively during 1998 - 2009. The bi-directional results were as expected, as increasing oil price affected consumers' and investors' sentiment and demand for financial products. Arouri, Lahiani, and Nguyen (2011), Masih and Peters (2011) and Lin et al. (2014), find the existence of substantial return and volatility between world oil prices and stock markets. Also, Hammoudeh and Aleisa (2004), Hammoudeh and Huimin (2005), Cong, Wei, Jiao and Fan (2008), Park and Ratti (2008), Donoso (2009), Miller and Ratti (2009), Apergis and Miller (2009), Filis, Degiannakis and Floros (2011), Narayan and Narayan (2010), Masih, Peters and De Mello (2011) and Zhang and Chen (2011), find that crude oil prices have significant positive impact on stock returns. However, Cunado and Perez de Gracia (2014) and Kang, Ratti and Yoon (2015) find a negative relationship.

In Nigeria, Uwubanmwen and Nguyen (2015), Gil-Alana and Yaya (2014) suggest that volatility in oil price produces and stimulates stock price volatility in Nigeria. Also, Boqiang Lin (2014) found significant volatility spillover effect from oil prices to stock market returns in both Ghana and Nigeria. His study also suggests that the transmission of volatility seems more apparent from oil to stock than from stock to oil as the case of Ghana. The study further establishes evidence of the short-term impact of oil price changes on stock price and shows that conditional volatility changes rapidly as a result of significant effects of past volatility rather than past news/shocks for all market returns. The study also shows that there is a slightly more effective hedge in the two stock markets.

In recent times, a number of papers have extended the analysis of oil price–stock market nexus by computing the optimal weights and hedging ratios to provide more insights to investors on how to build appropriate assets pricing models and forecast the returns and volatility in both markets. Further, in Nigeria, empirical research into the oil –stock market price nexus is very recent (see Uwubanmwen and Nguyen (2015) for a survey of the literature) and the issue of both returns and volatility spillover transmission between oil price and stock market price has remained inconclusive in the literature. Also, there is a dearth of empirical studies in some emerging countries such as Nigeria (oil-exporting country) and South Africa (non-oil exporting country) comparing stock markets and oil price dynamics, extended to estimating optimal weights and hedging ratios for both countries. These are the contributions of the present study to the existing

literature. The study also accounts for ARCH LM tests and serial correlation to justify the consideration of time-varying volatility models using recent methodological approaches. Table 1.0 summarises the past findings on the relationship between oil and stock price.

Table 1.0: Summary of Empirical Literature Review

Author	Country	Period	Method	Finding
Gil-Alana and Yaya (2014)	Nigeria	Monthly data, 2007 - 2012	multiple regression	Positive relations
Apergis and Miller (2009)	Germany, Italy, Australia, United Kingdom, Canada, France, Japan, United States	Monthly data, 1981 – 2007	Granger causality test	Positive relationship O → S
Arouri, Jouini and Nguyen (2011)	Netherlands, Norway, Portugal, France, Germany, Greece, Iceland, Austria, Belgium, Denmark, Finland, Ireland, Italy, Luxembourg, Spain, Sweden, Switzerland, United Kingdom, United States	Weekly data, 1998-2009	VAR-GARH model	Significant volatility transmission O → S (Europe) O ↔ S (U.S.)
Awartani and Maghyereh (2013)	Oman, Qatar, Abu Dhabi, Saudi Arabia, Bahrain, Kuwait, and Dubai	Daily data, 2004-2012	spillover directional measure method	Significant volatility transmission O ↔ S

Broadstock and Fillis (2014)	China, United States	Monthly data, 1995 - 2013	scalar- BEKK and structural VAR model	Positive relationship O → S
Caporale, Menla Ali, and Spagnolo (2015)	China	Weekly data, 1997 - 2014	bivariate VAR GARCH-in-mean model	Positive relationship O → S
Apergis and Miller (2009)	Germany, Italy, Japan, the United Kingdom, Australia, Canada, France, United States	Monthly data, 1981 – 2007	Granger causality test	Positive relationship O → S
Arouri, Lahiani and Bellalah (2010)	Bahrain, Oman, Kuwait, Qatar, Saudi Arabia and the United Arab Emirates (UAE)	Weekly data, 2005 - 2008	international multifactor model	Positive relationship O → S
Awartani and Maghyereh (2013)	Saudi Arabia, Bahrain, Kuwait, Oman, Qatar, Abu Dhabi, and Dubai	Daily data, 2004-2012	spillover directional measure method	Significant volatility transmission O ↔ S
Broadstock and Fillis (2014)	China, United States	Monthly data, 1995 - 2013	scalar- BEKK and structural VAR model	Positive relationship O → S
Chang, McAleer, and Tansuchat (2013)	United Kingdom, United States	Daily data, 1998 – 2009	DCC model	Significant volatility transmission O → S
Chiou and Lee (2009)	United States	Daily data, 1992-2006	ARJI model	Negative relationship O → S

Cong, Wei, Jiao and Fan (2008)	China	Monthly data 1996 – 2007	Multivariate VAR model	Positive relationship O → S
Cunado and Perez de Gracia (2014)	Austria, Belgium, Denmark, Finland, France, Germany, Italy, Luxembourg, Netherlands, Spain, Portugal and the United Kingdom	Monthly data, 1973 - 2011	VAR and VECM model	Negative relationship O → S
Dagher and El Hariri (2013)	Lebanon	Daily data, 2006 – 2012	VAR model	Positive relationship O → S
Donoso (2009)	Japan, United Kingdom, United States	Monthly data, 1986 to 2008	VAR model	Positive relationship O → S
Faff and Brailsford (1999)	Australia	Monthly data, 1983- 1996	two factor model	Positive relationship O → S
Filis, Degiannakis and Floros (2011)	Canada, Mexico, Brazil, Germany, Netherlands, United States	Daily data, 1987 – 2009	DCC-GARCH-GJR model	Positive relationship O → S
Kang, Ratti and Yoon (2015)	United States	Daily data, 1973-2013	structural VAR	Significant volatility transmission O → S
Louis and Balli (2014)	Bahrain, Saudi Arabia, Dubai, Abu Dhabi, Oman, Kuwait, Qatar	Daily data, 1999-2010	Granger causality test and pairwise correlation	Positive relationship O → S
Masih, Peters and De Mello (2011)	South Korea	Monthly data, 1988-2005	VAR model, VECM	Significant volatility transmission

			model, and unit root test	O → S
Narayan and Narayan (2010)	Vietnam	Daily data, 2000-2008	VAR model	Positive relationship O → S
Nguyen and Bhatti (2012)	China, Vietnam	Daily data, 2000- 2009	plots and copula method	Positive relationship O → S
Park and Ratti (2008)	Austria, Belgium, Denmark, Finland, France, Germany, Greece, Italy, Netherlands, Norway, Spain, Sweden, United Kingdom, United States	Monthly data, 1986 – 2005	VAR model	Positive relationship O → S
Sukcharoen, Zohrabyan, Leatham and Wu (2014)	Canada, China, Czech Republic, Finland, France, Germany, Hong Kong, Hungary Italy, Japan, Poland, Russia, Spain Netherlands, Switzerland, United Kingdom, United States, Venezuela,	Daily data, 1982- 2007	copula method	Positive relationship O → S
Wang, Wu and Yang (2013)	Canada, China, France Germany, India, Italy, Japan, Korea, Kuwait, Mexico, Norway, Russia,	Monthly data, 1999 - 2011	VAR model	Negative relationship O → S

	Saudi Arabia, United Kingdom, United States, Venezuela			
Others				
Killian and Park (2009)	United States	Daily data	VAR framework	Oil demand shocks do depress stock prices while the oil supply shock has less impact.
Apergis and Miller (2009)	Eight developed countries		structural VAR	The effect of oil market shocks is mild and less significant on the stock market for countries

Notes: (1) → unidirectional, ↔ bidirectional. (2)S represents the stock market, and O represents oil price.

3.0 Methodology

3.1 Modelling Framework

We consider the returns of the two variables of interest, namely oil price and stock market price index, calculated here by taking the first difference of the natural logarithm of the level series:

$$r_s = 100 * \Delta \log(\text{stock price}) \quad (1)$$

$$r_o = 100 * \Delta \log(oil\ price) \quad (2)$$

Here, r_o are the returns on oil prices, r_s are the returns on stock prices and Δ is a first difference operator.

3.1.1 Model Specification: Estimating Spillover Effects

Fundamentally, several models have been developed in the literature to deal with spillover analyses. A key aspect of the study is to examine if volatility in oil prices is transmitted into stock price volatility (is to investigate whether shocks in oil prices transmitted to stock returns or have a spillover effect on the stock market). Accordingly, the CCC model of Bollerslev (1990) and VAR-GARCH model of Ling and McAleer (2003) is presented in this section. Constant conditional correlations were assumed in the models, and it is not affected by the curse dimensionality when compared with the VECH and BEKK models (read McAleer et al., 2008 and Caporin and McAleer, 2009 for more details).

The Bollerslev (1990) CCC-MGARCH model is given below:

Conditional Mean equation: $Y_t = E\left(Y_t \middle| F_{t-1}\right) + \varepsilon_t;$ (3)

$$\varepsilon_t = D_t \eta_t$$

Conditional Variance equation: $Var\left(\varepsilon_t \middle| F_{t-1}\right) = H_t = D_t \eta_t \eta_t' D_t = D_t \Gamma D_t$ (4)

Where:

$y_t = \left(y_{1t}, .., y_{mt}\right)'$ is a vector of series under consideration; $i = 1, \ldots, m$ defines the individual series in the model; m is the number of series being examined; $t = 1, \ldots, n$ represents the period covered by the series; n is the total number of observations; $\eta_t = (\eta_{1t}, \ldots, \eta_{mt})'$ is a series of independently and identically distributed disturbances for the individual series; F_t denotes previous information available at time t; $D_t = diag\left(h_{1t}^{1/2}, .., h_{mt}^{1/2}\right)$ and the elements denote conditional standard deviations for the respective series $(1, \ldots, m)$. In other words, $h_{i,t}$ represents the conditional variance for series i.

The Conditional Mean equations for the two-return series are given below:

Mean equation for stock price return: $r_{s,t} = \lambda_s + \phi_s r_{s,t-1} + \theta_s r_{o,t-1} + \varepsilon_{s,t}$ (5)

Mean equation for Oil price return: $r_{o,t} = \lambda_o + \phi_o r_{o,t-1} + \theta_o r_{s,t-1} + \varepsilon_{o,t}$ (6)

The Variance Equations for VAR-CCC-MGARCH (1, 1) are written as:
The Variance Equations for stock price returns:

$$h_{1t} = c_1 + \alpha_{11}\varepsilon_{1t-1}^2 + \alpha_{12}\varepsilon_{2t-1}^2 + \beta_{11}h_{1t-1} + \beta_{12}h_{2t-1} \quad (7)$$

The Variance Equations for oil price returns:

$$h_{2t} = c_2 + \alpha_{21}\varepsilon_{1t-1}^2 + \alpha_{22}\varepsilon_{2t-1}^2 + \beta_{21}h_{1t-1} + \beta_{22}h_{2t-1} \quad (8)$$

This implies that the conditional variance of each series, $h_{i,t}$, $i = 1,\ldots,m$, indicates a univariate GARCH process, given as:

$$h_{i,t} = \omega_i + \sum_{k=1}^{p}\alpha_{ik}\varepsilon_{i,t-k}^2 + \sum_{r=1}^{q}\beta_{ir}h_{i,t-r}^2; \quad (9)$$

where $k = 1,\ldots,p$; $r = 1,\ldots,q$; $\sum_{k=1}^{p}\alpha_{ik}$ denotes the short run persistence or ARCH effect, of shocks to series i, and $\sum_{k=1}^{p}\alpha_{ik} + \sum_{r=1}^{q}\beta_{ir}$ denotes the long run persistence of shocks to series i. The conditional covariance between the stock and oil market returns can be expressed as:

$$h_{sot} = \rho_{so} \times \sqrt{h_{so}} \times \sqrt{h_{ot}} \quad (10)$$

The constant conditional correlation is represented by ρ_{so}. The fundamental underlying assumption for the implementation of the CCC-MGARCH model is that the conditional correlation is constant over time. This is a very restrictive assumption, and therefore, a formal pre-test must be carried out to verify if this assumption is valid or not. The Engle-Sheppard (2001) CCC test that is chi-square distributed is considered in this regard. This pre-test essentially tests the null hypothesis of constant correlation against the alternative of dynamic conditional correlation (DCC). If the null hypothesis of the Engle-Sheppard (2001) CCC test is not rejected; then, the CCC-MGARCH model is appropriate; otherwise, it is not. More importantly, the CCC-MGARCH model also assumes that negative and positive shocks of equal magnitude have same impacts on the conditional variance. To isolate the asymmetric impacts of positive and

negative shocks, therefore, Hoti, Chan and McAleer (2002) proposed the asymmetric CCC-MGARCH model.

3.2 Data and Preliminary Analyses

In this paper, Stock market price and crude oil (Brent) data are obtained from the Central Bank of Nigeria (CBN) statistical publications and Bloomberg data terminal. All data are at the daily frequency and cover five years ranging from 2010 and 2015 yielding a total of 1532 observations. Some preliminary analyses, including the description of relevant statistical properties of the variables used in the study, are provided in this section. These analyses are conducted in two phases: the first phrase presents the descriptive statistics of the two variables including their returns while the second pertains to performing ARCH LM tests and serial correlation to justify the consideration of time-varying volatility models.

There seems to be evidence of significant variation in the trend of both the stock market and oil price shown by the large differences between their respective minimum and maximum values. Figures 1, 2 and 3 are the graphical representation of the developments in the price of both all-share index (ASI) and Oil price in Nigeria for the period between 2010 and 2015. The graphs largely suggest a positive relationship between oil price and the stock market in Nigeria.

Figure 1: Trends in Daily Nigeria Stock Price, 2010-2015(ASI)

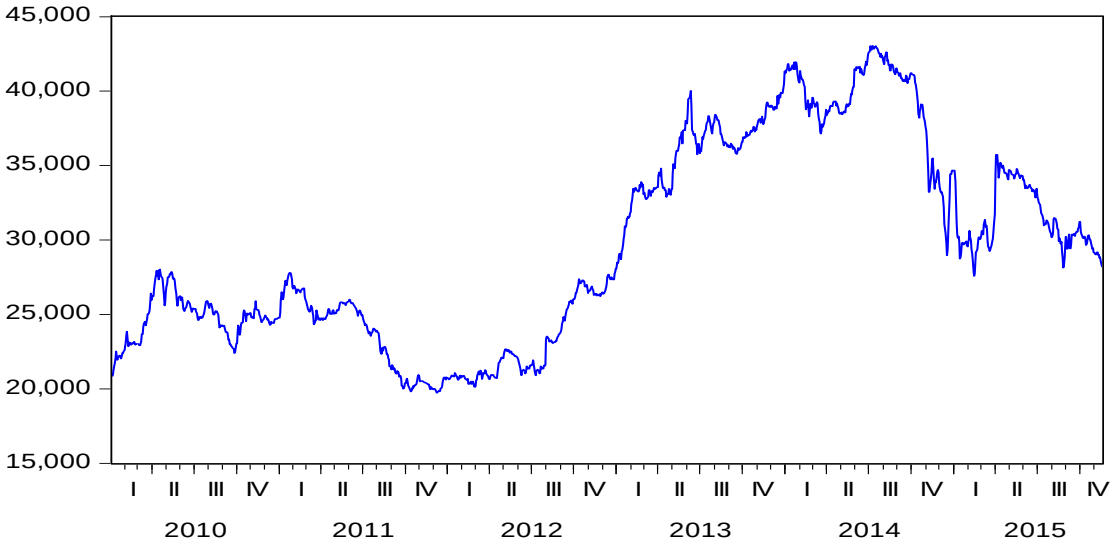


Figure 2: Trends in Oil Price, 2010-2015

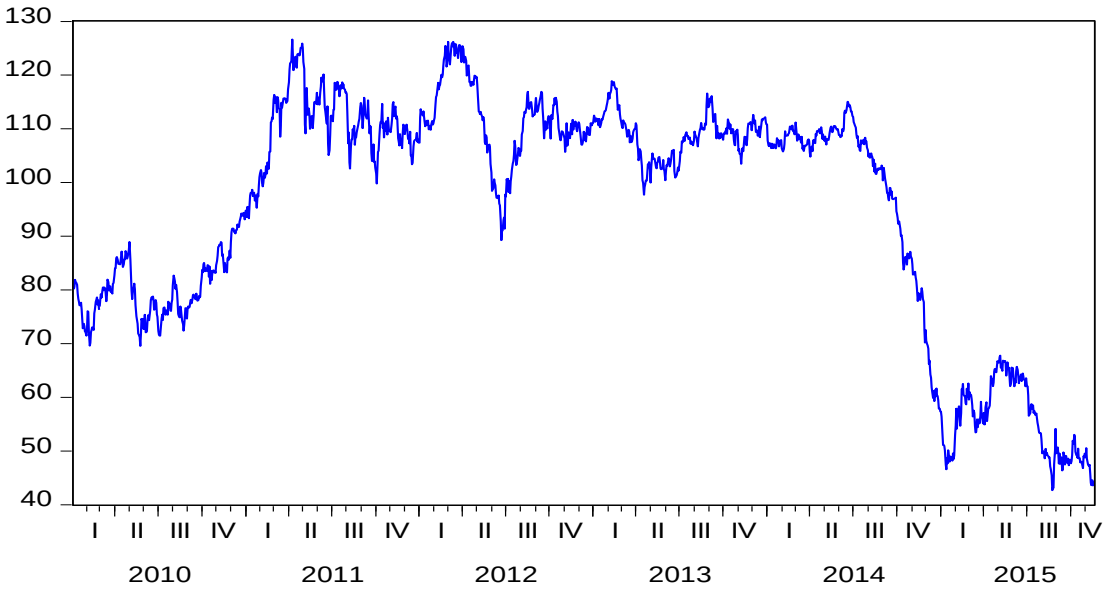


Figure 3:Trends in Daily Oil Price and Nigerian Stock Prices, 2010-2015

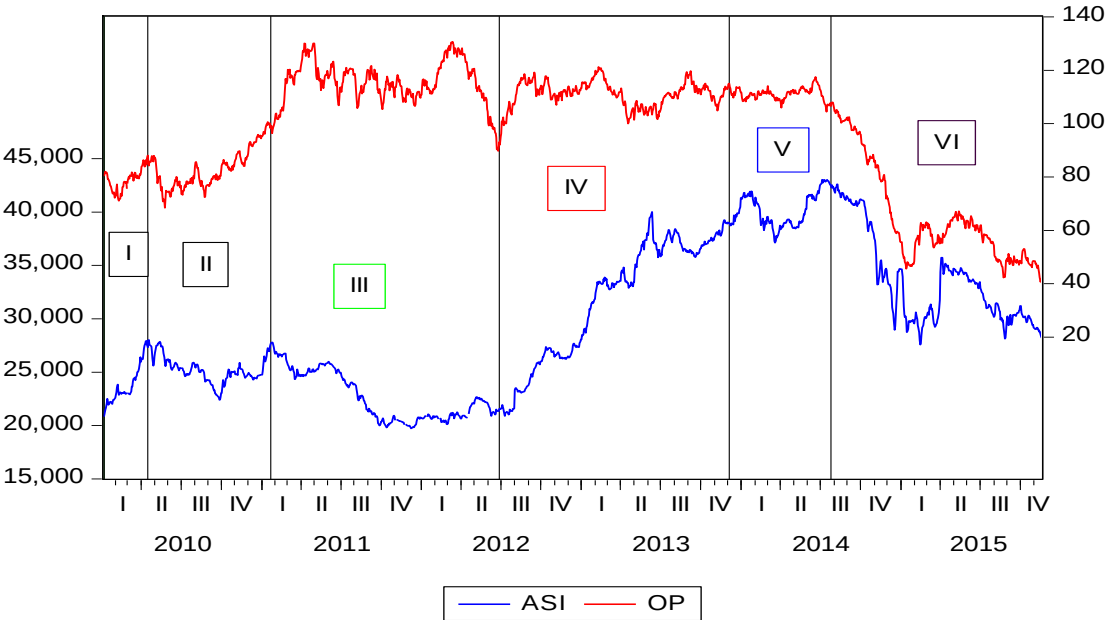


Figure 4: Daily Returns on Nigerian Stock Prices, 2010-2015

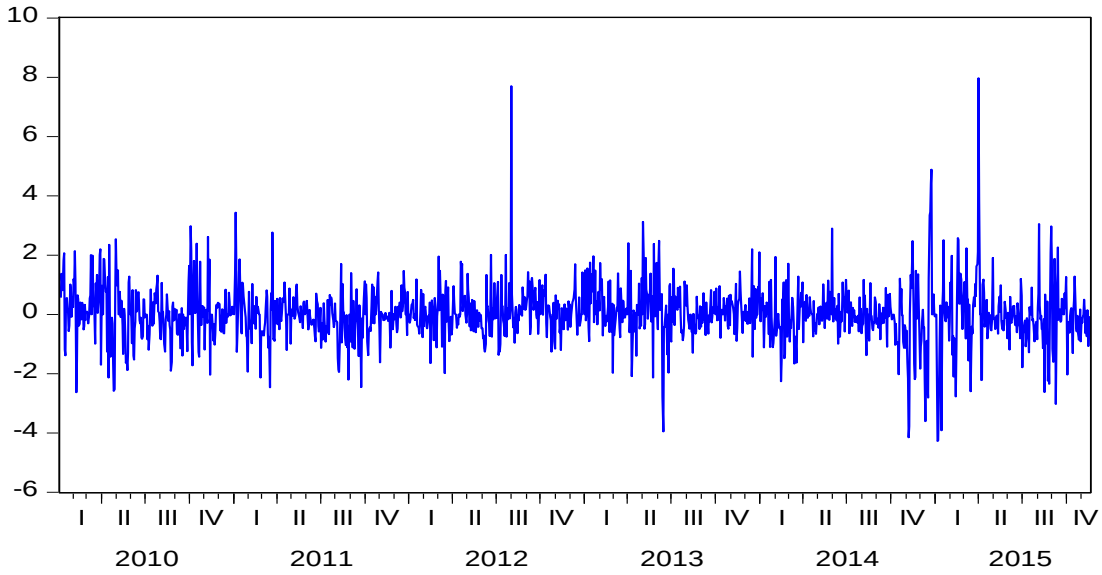


Figure 5: Daily Oil Price Returns , 2010=2015

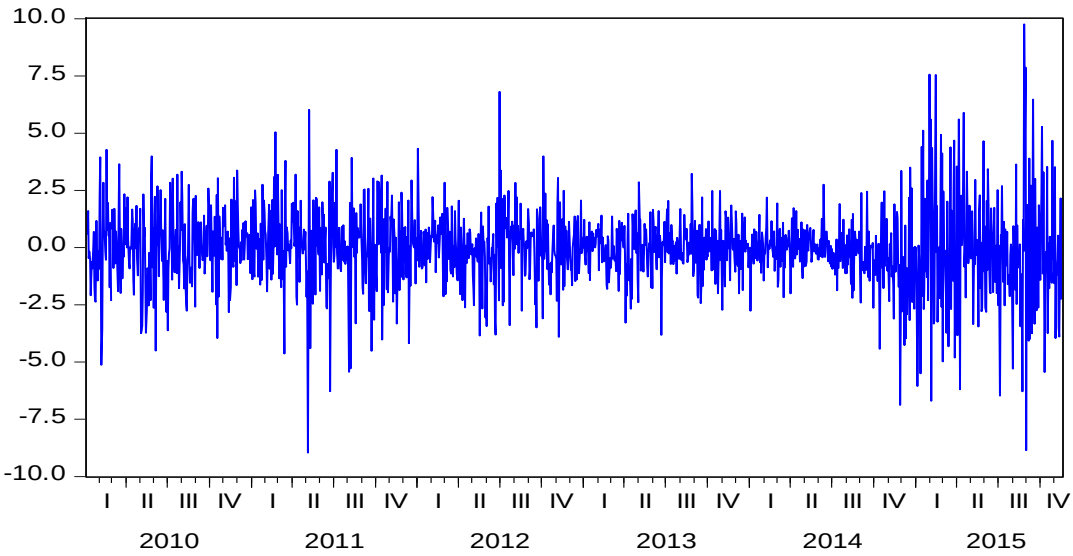
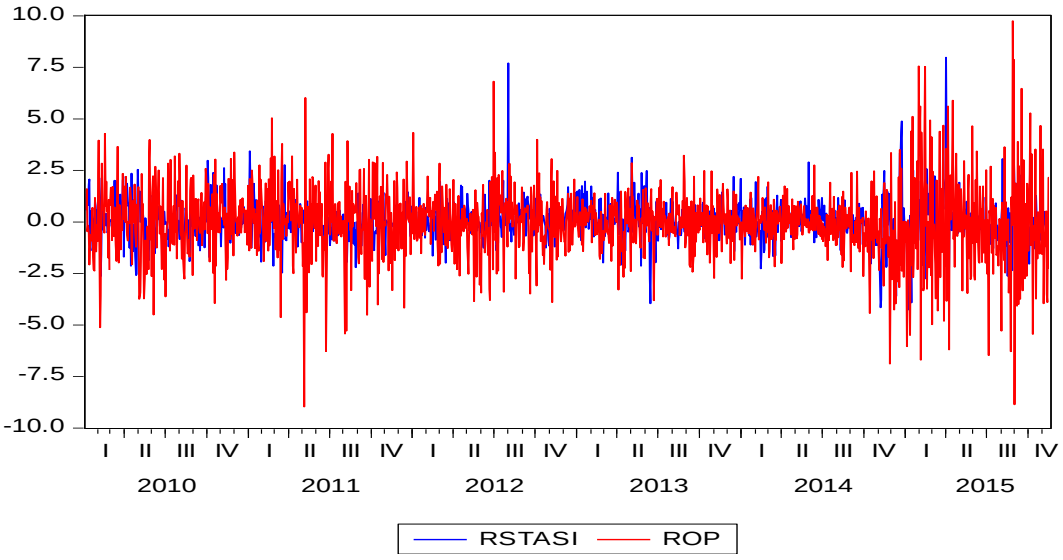
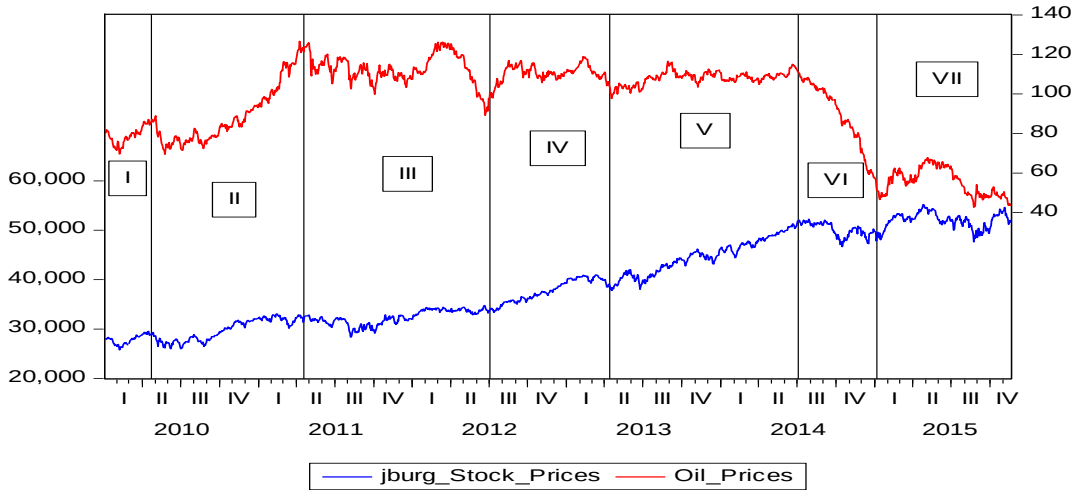


Figure 6: Daily Returns on Oil Price and Nigerian Stock Prices, 2010-2015



Similar evidence of significant variation in the trend of both the stock market and oil price is also observed for South Africa over the period 2010 and 2015. Like Nigeria, the graphical representation also suggests a positive relationship between oil price and the stock market in South Africa (see Figure 7). Figure 8 also illustrates the level of volatility on the returns in the stock market in the presence of oil price shocks. The higher the volatility clustering displayed in both markets reflects, the higher the standard deviation obtained for the oil price series.

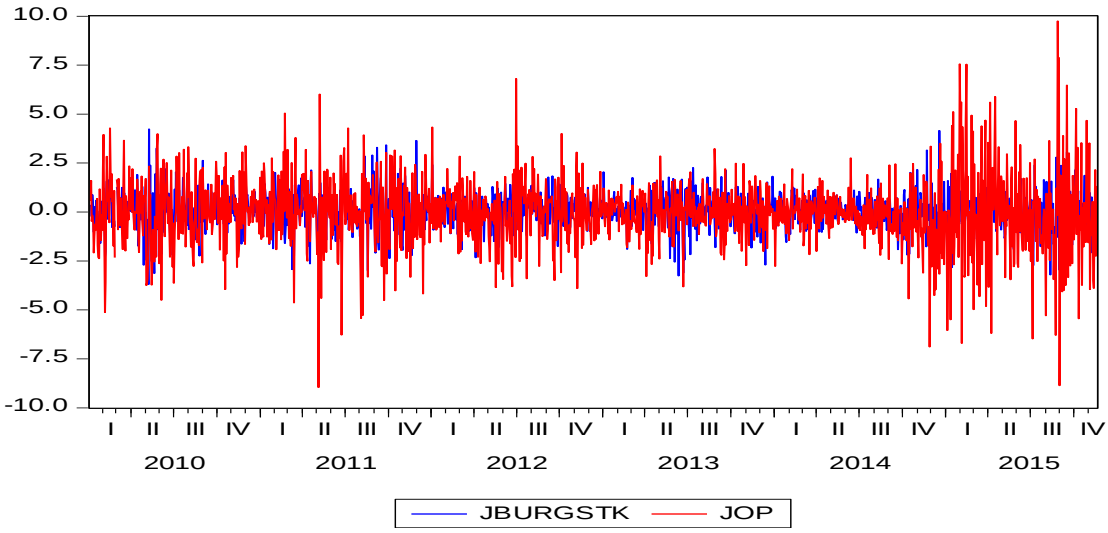
Figure 7: Trends in Daily Oil Price and South African Stock Prices, 2010-2015



We further consider relevant descriptive statistics and formal pre-tests in order to evaluate the statistical properties of the series we are dealing with. Table 1 provides all the relevant preliminary analyses for the return series.

The descriptive statistics for the returns cover the mean, standard deviation as well as the distribution properties on the basis of skewness and kurtosis. The mean values reported in the summary statistics indicate positive average returns in the stock market for the period under consideration.

Figure 8: Daily Returns on Oil Price and South African Stock Prices, 2010-2015



The descriptive statistic tests presented in Table 2 suggest that the oil price is more volatile than stock market, i.e. the standard deviation of oil price is larger than that of the stock market.

A common feature of volatility and volatility clustering were displayed by both series, although volatility clustering in the oil price series appears to be higher in magnitude. Both the mean and volatility of the oil price return are greater than that for the return on the stock assets. This is in line with the graphical plot (Fig. 4).

Table 2: Some preliminary analyses for Stock and Oil Market Returns

2a: Descriptive Statistics			
Statistics	**Stock and Oil Market Returns in Nigeria and South Africa**		
	r_s	r_s	r_o
	Nigeria	**South Africa**	**Oil**
Mean (%)	0.019753	0.040110	-0.038855
Maximum(%)	7.974951	4.233228	9.754143
Minimum (%)	-4.276488	-3.693919	-8.963279
Std. Dev.	0.948625	0.948368	1.748981
Skewness	0.703620	-0.175130	-0.005374
Kurtosis	11.47559	4.654349	6.250852

2b: Conditional Heteroscedasticity and Autocorrelation Tests			
ARCH LM (5)	6.82386 (0.00)	18.6007(0.00)	40.3931(0.00)
ARCH LM (10)	3.96024 (0.00)	15.0146 (0.00)	23.4031(0.00)
LB(5)	0.9096 (0.97)	7.7924 (0.168)	4.8778 (0.431)
LB(10)	2.3525 (0.99)	15.235 (0.124)	12.693 (0.241)
LB2(5)	40.805 (0.00)	132.66 (0.00)	303.05 (0.00)
LB2(10)	54.219 (0.00)	264.53 (0.00)	442.81 (0.00)

2c: Asymmetry test and CCC test			
	Stock_Price	**Stock Price**	**Oil_Price**
	Nigeria	**South Africa**	**Oil**
Sign bias test	0.315(0.7527)	0.693 (0.44885)	2.769 (0.0057)
Negative size bias test	0.601 (0.5479)	1.110 (0.2672)	0.388 (0.6980)
Positive size bias test	0.610(0.5420)	2.978 (0.00295)	1.672 (0.0948)
Joint bias test	0.935(0.8170)	28.998 (0.0000)	11.916 (0.0077)
Engle-Sheppard CCC	0.686 (0.710)	5.360 (0.0686)	
χ_2^2 **test***			
Observations	1533	1533	1533

Note: The ARCH LM tests are related to the Engle (1982) test for conditional heteroscedasticity. The LB and LB2denote the Ljung-Box tests for autocorrelations comprising the standardised residuals in levels and squared standardised residuals, respectively. The null hypothesis for the ARCH-LM test is stated as no ARCH effects in the series (that is, it is not volatile) while the null hypothesis for LB test is stated as "there is no series serially correlation on the series" or the series is not serially corrected. The figures in parentheses represent the actual probability values. $*\chi_2^2$ Number of series and degree of freedom

Table 2 presents some statistics on the autocorrelation function of the two series. We presented both the Ljung–Box Q-statistic and Q^2-statistic which tests for the null hypothesis that there is no autocorrelation at lags 5 and 10. For both the stock price and oil price return series, the null of no autocorrelation was rejected at the 1% level judging by the Ljung–Box Q^2-statistic. There seems, therefore, to be evidence of autocorrelation in the two stock market series (see Table 2b).

Also, the ARCH-LM test indicates that all the series exhibit non-constant variance. In other words, both oil price and stock market returns exhibit conditional

heteroscedasticity, which has to be captured when modelling the returns. This thus indicates the need to use volatility models in the estimation of the stock market and oil price movements as well as the interrelationship between the stock prices and oil price. Furthermore, the superior Ljung-Box[2] tests indicate the presence of serial correlation between the current and past values of oil price and stock prices, further confirming the need for the use of an AR model which is best handled by the VAR-GARCH models.

3.3 Asymmetry & CCC Test

The result of the asymmetric tests presented in Table 2c, suggests that the sign, positive and negative size bias and joint bias for oil price and stock prices are not statistically significant, and thus, the estimation model should be a symmetric GARCH model. Also, the probability value of 0.710 of the Engle Sheppard CCC test suggests that the null hypothesis of conditional constant correlation should not be rejected.

To determine the integration property of the data series, we conducted the ADF test. The ADF test was applied to determine if the null hypothesis for the presence of a unit root could be rejected or not. We are able to reject the unit root null hypothesis for both the series. Also, the inclusion or not of a time trend did change the results. Hence, we conclude that both series are stationary.

Table 3: Unit Root Test

Argumented Dickey-Fuller (ADF)			KPSS STATIONARITY TEST		
VARIABLE	**LEVEL**	**FIRST DIFFERENCE**	**LEVEL**	**FIRST DIFFERENCE**	**I(d)**
Nigeria - r_s	-27.588[b***]	-	0.2562[b***]	-	I(0)
r_o	-40.738[b***]	-	0.6140[b***]	-	I(0)
South Africa - r_s	-40.241[b***]	-	0.039 [b***]	-	I(0)

NB: ***, ** and *, denote significance at 1%, 5% and 10%, respectively. [a] indicates regression without constant and trend; [b] indicates regression with only constant; and [c] indicates regression with constant and trend

4.0 Estimation and Discussion of Results

First, we will start with the discussion of the estimated results of our findings using the bivariate form of multivariate GARCH models to determine the returns and volatility

transmission between oil and stock markets in both the Nigerian and South African stock markets. Specifically, the empirical framework was designed within the VAR (1)–GARCH (1,1) model. Also, the estimated results relating to the optimal weights and hedge ratios for the choice of holding oil -stock in a portfolio will then form the later part of our discussion in this session.

The estimated results from the VAR(1)–GARCH(1,1) are presented in Table 4 for both the oil-stock markets for Nigeria and South Africa. First, we observed from the diagnostics that there are no remaining ARCH effects in the return series of stock, but not for oil price for Nigeria after the estimation of the VAR(1)–GARCH(1,1). Similar results of no ARCH effects could also be obtained in the return series for the stock market, but not for the oil market in the case of South Africa. The McLeod-Li test at different lag orders is used to test for the presence of ARCH effects. In the case of Ljung-Box tests, there is no evidence of serial correlation at different lags for the two-return series in both Nigeria and South Africa. Also, we observed significant explanatory power in the stock market returns for the South African stock market more than in the Nigeria stock market at their current values.

Return spillover between the two markets in both countries is assumed symmetric; that is, positive and negative returns are assumed to have identical impacts. The parameters of interest here are θ_s [return spillover from stock price to oil price] and θ_o [return spillover from oil price to stock prices]. Nonetheless, we include own lagged returns [ϕ_s and ϕ_o] in the conditional mean equations to ensure that spillover effects are not confounded with serial dependence. As observed in Table 4, the return spillover from stock price to oil price estimates are not statistically significant, indicating that the returns in the oil market are not significantly influenced by the returns in the stock market. However, the outcomes from oil price to stock price are statistically significant, indicating that the returns in the stock market are influenced by the returns in the oil market. However, investors in the stock market seem to take into account the immediate past returns of changes in the stock market when making investment decisions.

Table 4: VAR-GARCH Results (Using RATS Software)

Variables	Nigeria Stock	South Africa Stock	Variables	Nigeria Oil	South Africa Oil
Mean Equation Constant (λ_s)	0.0013	0.0603***	λ_0	-0.0137	-0.0105
ϕ_s	0.2707	-0.0475***	ϕ_o	-0.0365***	-0.0454**
θ_s	-0.0466***	0.0554***	θ_o	0.0511	0.0330
Variance Equation Constant (C_1)	0.0481***	0.0193***	c_2	-0.0051***	0.0054**
α_{11}	0.1396***	0.0746***	α_{21}	-0.0406***	-0.0160***
α_{12}	0.0177***	-0.0075**	α_{22}	0.0470***	0.0540***
β_{11}	0.7694***	0.9039***	β_{21}	0.8350***	0.1538***
β_{12}	0.4186***	0.0075*	β_{22}	0.9378***	0.9231***
ρ_{so}	0.0483***	0.3023***	ρ_{so}	-same-	same-
Model Selection Criteria					
AIC	6.195	6.239			
SBC	6.254	6.298			
Hannan-Quinn	6.217	6.261			
Post Estimation Diagnostics					
Ljung-Box Q(2)	2.4529(0.2933)	6.0950(0.0475)		0.6670(0.7164)	1.1228(0.5704)
Ljung-Box Q(5)	4.8511(0.4343)	6.8370(0.2331)		1.2734 (0.9376)	1.9755(0.8525)
McLeod-Li(2)	0.0996(0.9514)	2.6777(0.2622)		14.676 (0.0007)	14.303 (0.0008)
McLeod-Li(5)	1.0510(0.9583)	3.9459 (0.5572)		16.847(0.0048)	16.488 (0.0056)

The optimal lag order for the VAR model is selected using the AIC and SIC information criteria; Note: ***, ** and *denote statistical significance at 1%, 5% and 10% levels. Figures in parentheses represent p-values.

The estimates of the one-period lagged own stock returns are positive for Nigeria, but negative in the case of South Africa and both stock market returns are statistically significant. This result also indicates the interdependence of returns of the two markets. On the other hand, a negative and statistically significant one period lagged of oil price returns was obtained in the estimates in the case of South Africa, while, in the case Nigeria, it was negetive and statistically insignificant. Evidently, a much higher elasticity of the stock market's reactions to oil price change was obtained in this regard at an estimated coefficient of 0.27. The presence of negative shock spillover from oil to stock in South Africa is not unconnected with less reliance on the stock market on oil companies, but on gold companies, financial and service-oriented companies. These features are likely to undermine market operations on investment and speculations. Generally, shock transmission through previous oil price changes tend to have a positive and significant effect on stock markets in Nigeria, but a negative and significant effect in the case of the South Africa's stock market. The level of impact tends, therefore, to be minimal in South Africa's stock market when compared with the Nigerian stock market. It is expected that these results will assist investors to better understand the dynamics in both markets in these countries and be able to forecast future returns on stocks.

Regarding the conditional volatility equations, the volatilities of stock and oil returns are sensitive to both own past shocks as well as past own conditional variance. The estimated results show that both ARCH and GARCH coefficients are significant in most cases. The magnitude of the reactions or interactions of GARCH-term past own conditional volatility seems to be quite significant in both countries. In this regard, we observed that the coefficients of the ARCH-terms, which measure the effect of past shocks on conditional volatility is rather very small and quite reflected in a sluggish change in the general conditional volatility. Also, the relatively sizable GARCH-term estimates, which measure the impact of past volatility on current volatility, are quite significant in both countries and display a steady variation of conditional volatility over time.

In terms of volatility spillovers from oil to stock markets in both countries, the estimated coefficients are much smaller, and thus, the impacts of past shocks and past volatility of oil returns on the volatility of stock markets are quite minimal.

In clear terms, volatilities in these two markets may be accentuated by their shocks. These findings have profound implications. First, unexpected events in the stock market in the current period, for example, have the capability of fueling high volatility in the market in the immediate succeeding period. Secondly, the volatility of the market in one period is capable of driving higher volatility in the immediate later period. Thirdly and technically speaking, the own past innovation and past own conditional variance of the two returns can be employed to forecast their future volatility. Lastly, the constant conditional correlation coefficient is statistically significant; thus, validating the assumption of constant correlations between the two markets. The sign is positive (ρ_{SO} = 0.0483) indicating a direct relationship between the two prices as theoretically postulated in the case of Nigeria. As a result, the positive results from the estimate of constant conditional correlations between oil and stock markets in both countries, suggest some possible co-movement between oil and stock market and potential gains for investors in investing in both stock markets in the presence of oil price shock. However, the Nigerian stock market may offer higher gains than the South African stock market, given the magnitudes of the conditional correlations.

4.1 Portfolio Management Implications

The estimated results from the previous section revealed the possible potential gains to investors through the diversification of their assets by investing in both oil and stock markets in both countries. Also, there are potential risk spillovers from the oil market to the stock market due to the significant influence of oil returns on stock returns. Thus, asset managers will need to devise measures that will minimise the risk without reducing expected returns. We attempt, therefore, to illustrate how an asset or portfolio managers can adequately quantify the optimal weights and hedging ratios of holding the two assets (stock and oil markets) using the methodology introduced by Kroner and Ng (1998) and adopted by Arouri et al. (2011). According to Kroner and Ng (1998), the optimal weight of holding both assets can be specified as:

$$\mathbf{w_{so,t}} = \frac{\mathbf{h^s_{t-}h^{os}_t}}{\mathbf{h^o_t - 2h^{os}_t + h^s_t}} \qquad (\mathbf{11})$$

and

$$\boldsymbol{w_{os,t}} = \begin{cases} \mathbf{0}, & \mathbf{if\ w_{os,t} < 0} \\ \mathbf{w_{os,t}}, & \mathbf{if\ 0 \le w_{os,t} \le 1} \\ \mathbf{1}, & \mathbf{if\ w_{os,t} > 1} \end{cases} \qquad (12)$$

Where $w_{so,t}$ represents the weight of oil in a one dollar consisting of two assets within a

	Nigeria	South Africa
$\omega_{so,t}$	0.07278	0.04778
$\rho_{so,t}$	0.15926	0.73803

portfolio at time t: and h_t^{os} refers to the conditional covariance between oil and stock market returns at time t. This means that the optimal weight of the stock market index within the portfolio under consideration is $1 - w_{so,t}$.

Table 5 reports the values of $w_{so,t}$ (optimal weights) for the two countries. They vary from 7.28 per cent for Nigeria to 4.78 per cent for South Africa. This implies that the optimal weight of holding of oil in a one-dollar oil-stock market portfolio would be 7.28 per cent in the case of Nigeria and the remaining budget of 92.72 per cent should be invested in the stock market. In the case of South Africa, optimal the holding of oil is as low as 4.78 per cent, while the rest of 95.22 is invested in stock market. This overall result suggests that investors should acquire more stocks than oil in their portfolio in both countries to curtail the risk without reducing the expected returns is not surprising. The stock markets in South Africa depend less on oil companies, but more on gold companies, financial and service oriented companies.

Regarding the hedge ratios, we also applied the methodology introduced by Kroner and Sultan (1993) and adopted by Arouri et al. (2011) to examine a portfolio of two assets that include oil and stock market index. Evidently, the likely risk of this portfolio will be negligible if a short position of one dollar in the oil market can be hedged by a long position of ρ_t dollars in the stock market index, and it is specified as:

$$\rho_{os,t} = \frac{h_t^{os}}{h_t^{s}} \tag{13}$$

Table 5: Optimal Portfolio weights and Hedge ratios (With Brent oil prices)

	Nigeria	South Africa
$\omega_{so,t}$	0.08832	0.05182
$\rho_{so,t}$	0.17034	0.72247

Table 5 presents the values of the hedge ratios computed for both countries using equation (11). We observed that the hedging ratios are quite high in South Africa when compared to that of Nigeria. The ratios range from 73.80 per cent in South Africa to 15.93 per cent in Nigeria. The observed higher values obtained for the hedge ratios in both countries suggest that hedging effectiveness relating to both stock and oil markets in both countries will not deliver the desired outcome to investors.

The results obtained above implies that of one dollar short position in the oil market should be longed by 73.80 and 15.93 per cent in both countries.

4.2 Evaluation for Robustness

To further evaluate the robustness of the regression results obtained in the case of the optimal weights and hedging ratios for both countries, we replaced the Brent oil price with WTI oil price. As you will recall, the oil price was measured using Brent oil price as oil price proxy. In this regard, we re-estimated all the equations using WTI oil price as oil price proxy. The results, as shown in table 6, indicate that our analyses are robust to different oil price proxies. This implies that using different oil price proxies to determine an optimal portfolio and hedging ratios for both countries will produce similar inferences for both short and long-run relationships.

Table 6: Optimal Portfolio weights and Hedge Ratios Robustness Check (With WTI Oil prices)

5.0 Summary and Conclusion

This paper investigates Volatility spillovers between oil and stock markets: Evidence from Nigeria and South Africa using daily returns from January 2010 to December 2015. The bivariate form of the VAR–CCC-GARCH(1,1) model introduced by Ling and McAleer (2003) was adopted. We also examined the optimal weights and hedge ratios for the choice of holding oil -stock in a portfolio. The overall results indicate the presence of return and volatility spillovers from oil to stock market in both countries. In essence, own-shocks to stock price and oil price increase the level of volatility of their respective markets. However, when there is a shock to one market, it tends to reduce the risk-adjusted returns of the other market. Also, our findings also suggest that adding oil to a well-diversified portfolio of stocks issued in both countries will not lead to an improvement in the overall risk-adjusted return and oil price risk cannot be hedged effectively in both countries. Our results tend to vary across countries and in the period considered. This outcome seems to support outcomes from other studies.

However, the outcomes from oil price to stock price are statistically significant, indicating that the returns in the stock market are influenced by the returns in the oil market. However, investors in the stock market seem to take into account the immediate past returns of changes in the stock market when making investment decisions. The estimates of the one-period lagged own returns for the two series are positive, but only stock market is statistically significant.

Also, the volatilities of stock and oil returns are sensitive to both own past shocks as well as past own conditional variance. In clear terms, volatilities in these two markets may be accentuated by their own shocks. These findings have profound implications. First, unexpected events in the stock market in the current period, for example, have the capability of fueling high volatility in the market in the immediate succeeding period. Secondly, the volatility of the market in one period are capable of driving higher volatility in the immediate later period. Thirdly and technically speaking, the own past innovation and past own conditional variance of the two returns can be employed to forecast their future volatility. Lastly, the constant conditional correlation coefficient is statistically significant; thus, validating the assumption of constant correlations between the two markets. The sign is positive (ρ_{SO} = 0.048) indicating a direct relationship between the two prices as theoretically postulated.

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OPTIMAL CAPITAL ACCUMULATION AND BALANCED GROWTH PATHS IN AN EXOGENOUS GROWTH SETTING FOR NIGERIA (2017-2030): DGE FRAMEWORK

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Abstract

This study uses the first key equations of the Ramsey–Cass–Koopmans and Solow neoclassical growth models to empirically project the likely optimal growth path for capital stock in Nigeria, if the models' assumptions stay at expected. The study used a Dynamic General Equilibrium (DGE) framework to estimate the optimal capital accumulation and the balanced growth paths over a finite planning period 2017 to 2030. The results of dynamic macroeconomic model show that, the growth path of capital stock is characterised by constant return to scale, decreasing discount factor and increasing rate of savings. The results also show that, an increase in capital *accumulation also leads to an increase* in income*, implying that capital is at optimal to predict a higher growth rate of income in the long-run. The Study concludes with an overwhelming evidence that rapid and sustained capital and income growth is critical to economic growth and the well-being of a nation. Therefore, it is important to devise ways of promoting capitalist economic development. The study recommends that technological and labour effectiveness should be the basis for capital accumulation and balanced growth for the Nigerian economy.*

Keywords: Capital Accumulation, Neoclassical Growth Models, Nigeria, DGE

JEL classification: E13, D50

1.0 Introduction

For many years, economists have dealt with questions regarding the growth path of an economy, the optimal capital accumulation and how these parameters can be influenced. Capital was important in the early ages of growth, but it would also be erroneous to think that it has no special place in today's seemingly-capitalized economies. These developments notwithstanding, the core of the neoclassical growth model remains its original setting (Mankiw, David &Weil, 1992).

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The accumulation of capital goods represents foregone consumption, which necessitates a reward to capital in the form of interest, rent, royalties or capital gains, greater profits or social benefit derived. The rate of accumulation of an economy's physical stock of capital is an important determinant of the rate of growth of an economy and is represented in various production functions and economic growth models. The process of adding to the net physical capital stock of an economy in an attempt to achieve greater total output is term capital accumulation or the accumulation of capital.

This above stated process is a problem in concave programming in linear spaces. Hence, this study problem is formulating an optimal growth model for a developing economy like Nigeria with a finite time horizon. The main objective of this study therefore, is to use the first key equations of the Ramsey–Cass–Koopmans (RCK) and Solow models to empirically project the optimal growth path for capital stock in the long-run for the Nigerian economy or finding a growth path over which the criterion function is maximized among all feasible growth paths, if all other things being equal. Also, the study empirically determins if capital stock and income converge to their steady state equilibrium on the balanced growth paths in the exogenous productivity growth models. That is, whether capital is at optimal to predict a higher growth rate of income in the long-run.

The first key equations of the RCK model is the state equation for capital accumulation, while the Solow model is the model of capital steady state. This study window (2017 to 2030) has been shortened to 2030 agenda for sustainable development goals. The research questions to analyse is as follows: what is the optimal path of traverse for a developing economy, which has a certain capital stock embodying an old technique (i.e. one with a lower labour productivity) and is saddled additionally with disguised unemployment, if it is to be transformed into one where the entire labour force is assumed to be growing at an exogenously given rate? Does the economy reach a long run equilibrium with a constant growth rate, or does growth fizzle out in the long-run?

Given the popularity the RCK and Solow growth models at large, surprisingly little attention has been paid to mechanics of capital accumulation, possibly because of difficulties involved in measurement of the capital stock. One notable exception is a series of study investigating movements of the economy's capital-output ratio (McQuinn & Whelan, 2007, Hall & Jones, 1997); yet, their analyses are based on the speed of convergence equation, not the growth path of the capital-output ratio per

se. Also, there are limited studies on the quantitative analysis and derivation regarding the optimal capital growth paths for the Nigerian economy.

The justification for this study is to add to the body of comparative evidence available on the study of economic growth theories. Economic growth deals with increase in the level of output and it is important to study and devise ways of increasing output. Most growth theories or models equate output growth with the level of capital accumulation. Studying these growth theories or models should not be end in themselves, the application of these theories to the economies of the developing nations like Nigeria, is most important.

Therefore, efforts should be made to increase capital stock in a poor nation like Nigeria. This will help the nation to move to being self-sufficient in capital, that will lead to output growth, if all other things being equal. The gap this study is likely to fill, is to investigate empirically, the application of RCK and Solow growth models on the Nigerian economy, using a dynamic nonlinear optimization approach. This paper equally contributes to the literature on optimal capital growth and national income growth.

The rest of the paper is organised as follows. Section 1 presents the introductory part of the study, while 2 presents brief review of relevant literature. Section 3 is the sets of theoretical framework of the study. Section 4 is the study methodology. Section 5 is the analysis of simulation results, Section 6 is the study conclusion and section 7 is policy implications of the study.

2.0 Review of Literature

In economic growth literature, one of the important contributions to modern growth theory have been the works of Solow (1956) and Swan (1956). The fundamental feature of the Solow-Swan neoclassical growth model, also known as the exogenous growth model, is its special specification, according to which the neoclassical production function makes the assumption of constant returns to scale, diminishing returns to each input and some positive and smooth elasticity of substitution between the inputs. The Solow-Swan production function is applied along with a constant-saving-rate rule in order to generate a simple general equilibrium model of the economy.

A key prediction of these neoclassical growth models which has been frequently applied as an empirical hypothesis in recent years is conditional convergence, in the

sense that the lower the starting level of per capita GDP, compare to the long-run or steady-state position, the faster the growth rate. This is due to the assumption of diminishing returns to capital according to which economies that have less capital per worker tend to have higher rates of return and higher growth rates. The convergence is conditional in the Solow-Swan model, because the steady-state levels of capital and output per worker depend on the saving rate, the growth rate of population and the position of the production function that might vary across economies (Mansour & Hosainpour**,** 2011),

Cass (1965) & Koopmans (1965) applied Ramsey's analysis of consumer optimization to the neoclassical growth model in order to make adequate preparation for an endogenous determination of the saving rate. This extension tends to preserve the hypothesis of conditional convergence, while allowing for strong transitional dynamics. However, it is not easy to create compatibility between the theory of technological change and the neoclassical framework; because the standard assumptions of competition cannot be met since technological progress requires the creation of new ideas which are partially non-rival.

Hall & Jones (1999) showed that differences in physical capital and human capital can only partly explain the variation in output per worker. According to this research, a large amount of variation in the level of the Solow residual can be found across countries. The differences in capital accumulation, productivity and output per worker are caused by differences in institutions and government policies, i.e., by social infrastructure. Social infrastructure was treated as endogenous factor in this research. Across 127 countries selected for this study, a powerful and close association was fund between output per worker and measures of social infrastructure. Countries with long-standing policies are in favour of productive activities, rather than diversion, in order to produce much more output per worker. For example, their analysis suggested that the observed difference in social infrastructure between Niger and the United States is more than enough to explain the 35-fold difference in output per worker.

Using panel data analysis, Hoeffler (2000) addressed this question that whether Africa's growth performance can be accounted in the framework of the augmented Solow model. The findings of the research showed that if unobserved country specific effects and the endogeneity of investment are taken, this model can account for Africa's low growth performance. According to these findings, Africa's low investment ratios and high population growth rates are sufficient to explain Africa's low growth rates. Also, Heston, Summers & Aten (2002) equally show that, the derived capital growth

equations are empirically testable, owing to the well-known reduced form equation to measure the so-called conditional convergence. They show that the data on capital stock of the economy are available. This means a potential for a new method to test conditional convergence (Mankiw, David &Weil, 1992).

Rina & Wisch (2005) compare the optimal capital stock accumulation in a classical Ramsey model with production shocks for a risk neutral expected utility maximizer and a loss averse prospect theory maximizer. They show that in the expected utility case, the capital stock is on average the same as in the deterministic Ramsey growth model. However, with prospect theory, one can expect a capital stock which is higher than in the deterministic Ramsey model and given certain assumptions even higher than Solow's golden-rule capital stock.

Pritchett (2006) showed that, in spite of much progress in the growth literature, there are still a considerable gap between the logic of academic interests and the needs of policy practitioners of the less developed countries. According to him, nearly everything about the first generation growth models was in a dispute with the needs and perspectives of policy makers of the less developed countries. Unlike in the developed countries, neither the long-run growth nor expanding the technological frontiers is the main concern of less developed countries. They are mainly interested in short to medium-term growth and accelerating technological catch-up by adopting existing innovations.

Rao & Cooray (2009) followed Pritchett (2006) and searched for the gap between the theoretical and empirical growth literature. The findings of their research showed that there is a wide gap between the theoretical and empirical growth literature and the policy needs of the less developed countries. Growth literature has focused on the long-term growth outcomes, but the main need of the less developed countries is to accelerate improvements in the growth rate in the short and medium-terms. According to them, this gap can be bridged by paying attention to the dynamic effects of policies. In this relation, using data on Singapore, Malaysia and Thailand, they have shown that an extended version of the Solow (1956) model is more compatible with the status of less developed countries. The results showed that the short to medium-term growth affect investment ratio much more than the long-run growth does and the short to medium-term growth effects persist. Dynamic simulations for Singapore showed that these short and medium-term run growth effects are significantly higher than the steady state growth rate for up to 10 years. In spite of some

limitations, Rao and Cooray believe that their framework is well suited to meet the short and medium term needs of the policy makers of the less developed countries.

Takahashi (2012), derives the first-order approximated paths of both types of capital in the two-capital neoclassical growth model. The derived capital growth paths reveal that the short-run growth effect of capital injection differs considerably depending on which type of capital is enhanced. This result demonstrates the importance of well-targeted capital enhancement programs such as public sector projects and foreign aid.

The aforementioned studies have not focused on the applicability of growth theories in developing countries like Nigeria. In recent times, the combination of theoretical and empirical research have begun to pave the way for researchers to focusing on economic growth and its determinants in less developed countries. Many less developed countries have had a growth experience that was very far from the conditions of a steady-state. This study reviews the literature of growth theories and models to investigate their relevance and applicability to a less developed economy - Nigeria.

3.0 Theoretical Framework

The basic premises of the models (Ramsey–Cass–Koopmans and Solow) can be described as follows: A single homogeneous output, Y(t), is produced with the use of two homogeneous factors, labor, *L(t),* and capital goods, *K(t),* under the direction of a central planning board. The technically efficient possibilities for production, which are unchanging over time, are known to the planning board and are summarized in an aggregate production function. This relation exhibits constant returns to scale, positive marginal productivities, and a diminishing marginal rate of substitution. In addition, it is known that roundaboutness in production is extremely productive when capital is relatively very scarce, while capital saturation only occurs when capital is relatively very abundant. The RCK model differs from the Solow model in that the choice of consumption is explicitly micro founded at a point in time and so endogenises the savings rate.

The Ramsey-Cass-Koopmans (RCK) Model

Ramsey (1928), followed much later by Cass (1965) and Koopmans (1965), formulated the canonical model of optimal growth in continuous time for an economy with exogenous labour-augmenting technological progress. The model was fusion with

Solow's simpler growth model (Solow, 1956) and became a cornerstone in neoclassical growth theory from the mid-1960s.

The RCK model starts with an aggregate production function that satisfies the Inada conditions, often specified to be of Cobb–Douglas type as:

$$Y(t) = F(K(t), L(t)) = K(t)^{\alpha}(A(t)L(t))^{1-\alpha} \quad (1)$$

That is the economy has a perfectly competitive production sector that uses a Cobb-Douglas aggregate production function with factors capital K and labour L (continuity, differentiability, positive and diminishing marginal products, and constant returns to scale). The production function $F : \mathbb{R}_+^2 \to \mathbb{R}_+$ is twice continuously differentiable in K and L, and satisfies

Marginal productivities are positive:

$$\frac{\partial F}{\partial K} = \alpha A K^{\alpha-1} L^{1-\alpha} > 0$$
$$\frac{\partial F}{\partial L} = (1-\alpha) A K^{\alpha} L^{1-\alpha} > 0 \quad (2)$$

Marginal productivities are decreasing,

$$\frac{\partial^2 F}{\partial K^2} = (1-\alpha)\alpha A K^{\alpha-2} L^{1-\alpha} < 0$$
$$\frac{\partial^2 F}{\partial L^2} = -\alpha(1-\alpha) A K^{\alpha} L^{-\alpha-1} < 0 \quad (3)$$

Per Worker Terms

Define $x = \frac{X}{L}$ as a per worker variable. Then

$$y = \frac{Y}{L} = \frac{AK^{\alpha}L^{1-\alpha}}{L} = A\left(\frac{K}{L}\right)^{\alpha}\left(\frac{L}{L}\right)^{1-\alpha} = Ak \quad (4)$$

Per worker production function has decreasing returns to scale. F Exhibits constant returns to scale in K and L. i.e., it is linearly homogeneous (homogeneous of degree 1) in these two variables. With the same properties as in the Solow model (Constant returns to scale)

Constant returns to scale: $F(\lambda K, \lambda L) = \lambda F(K, L) = \lambda A K^{\alpha} L^{1-\alpha}$ (5)

Inputs are essential: $F(0,0) = F(K,0) = F(0,L) = 0$ (6)

To produce output using capital and labour. Labour supply (the same as population) grows exogenously at a constant (continuously compounded) rate n

$$\dot{L}(t) = nL(t), \quad \frac{\dot{L}(t)}{L(t)} = n \tag{7}$$

The amount of labour is equal to the population in the economy and grows at a constant rate n , i.e. $L(t) = L(0)e^{nt}$ where $L(0) > 0$ was the population in the initial period.

And A is an index of labour productivity that grows at rate or Technology/productivity improves at constant exogenous rate g

$$\dot{A}(t) = gA(t), \quad \frac{\dot{A}(t)}{A(t)} = g \tag{8}$$

$$A(t) = A(0)e^{gt} \tag{9}$$

Thus, technological progress allows each worker to produce perpetually more as time goes by with the same amount of physical capital. This is the definition of 'labour-augmenting' (Harrod-neutral) productivity growth; with a Cobb-Douglas production function, it turns out to be essentially the same as 'capital-augmenting' productivity growth, also known as Hicks-neutral, as well as output-neutral ('Solow-neutral') progress. The quantity AL is known as the number of 'efficiency units' of labour in the economy.

Market Structure and Endowments

We will assume that markets are competitive. Constant returns to scale. Households own all of the labour $\bar{L}(t)$, which they supply inelastically. Households own the capital stock of the economy and rent it to firms and denote the rental price of capital at time t be $R(t)$. The price of the final good is normalized to 1 in all periods. Assume capital depreciates, with exponential form, at the rate δ . Out of 1 unit of capital this period, only $1-\delta$ is left for next period. This affects the interest rate (rate of return to savings) faced by the household. Interest rate faced by the household will be $r(t) = R(t) - \delta$. Only need to consider the problem of a representative firm.

Firm Optimization

The stock market value of the firm is given by the discounted value of its cash flows:

$$v(0) = \int_0^{\infty} \left[F(K(t), L(t)) - w(t) - I(t) \right] e^{-R(t)} dt \quad (10)$$

where $R(t)$ is the discounting factor given above and $I(t)$ is gross investment:

$$I(t) = \delta K(t) - \dot{K}(t) \quad (11)$$

The firm maximizes $v(0)$ subject to the capital accumulation constraint. Since there are no adjustment costs on investment, the firm's decision about factor inputs is essentially a static one, i.e. the familiar marginal productivity conditions for labour and capital hold:

$$F_L(K(t), L(t)) = w(t) \quad (12)$$

$$F_K(K(t), L(t)) = r(t) + \delta \quad (13)$$

By writing the production function in the intensive form, i.e.

$$f(k(t) \equiv F\left(\frac{K(t)}{L(t)}, 1 \right), \quad (14)$$

we can rewrite the marginal products of capital and labour as follows:

$$F_K(K(t), L(t)) = f'(k(t)) \quad (15)$$

$$F_L(K(t), L(t)) = f(k(t)) - k(t) f'(k(t)) \quad (16)$$

Capital accumulation

The first key equation of the RCK model is the state equation for optimal capital accumulation

$$\dot{k}(t) = f(k(t)) - c(t) - (\delta + n)k(t) \quad (17)$$

$$r(t) = f'(k(t)) - \delta \quad (18)$$

Equation (17) is the Fundamental Differential Equation (FDE) for the capital stock. Equation (18) shows that the real interest rate is the net marginal product of capital. A non-linear differential equation akin to the Solow model, where. $c(t)$ is per capita consumption, $k(t)$ is the capital-labour ratio, and $r(t)$ is the interest rate. $\dot{k}$ is capital

intensity (i.e., capital per worker), $\dot{k}$ is change in capital intensity over time $\left(\frac{dk}{dt}\right)$, is c consumption per worker, $f(k)$ is output per worker for a given, k and δ is the depreciation rate of capital. Under the simplifying assumption that there is no population growth, this equation states that investment, or increase in capital per worker is that part of output which is not consumed, minus the rate of depreciation of capital. Investment is, therefore, the same as savings. The main interest of the model is the dynamics of capital intensity, the capital stock per unit of effective labour. Its behaviour over time is given by the key equation of the Solow model:

The Solow Growth Model

The Solow model is a very important tool to understand the determinants of long term growth. The main interest of the model is the dynamics of capital intensity, the capital stock per unit of effective labour. Like the RCK model, the model starts with an aggregate production function that satisfies the Inada conditions.

Dynamics of Capital

Assume constant and exogenous savings rates, (i.e. not a result of individual optimization decision) and constant depreciation rate of capital (δ):

$$\dot{K}(t) = sY(t) - \delta K(t) \tag{19}$$

Dynamics of capital per unit of effective labour, $k = \frac{K}{AL}$ (20)

$$\dot{k}(t) = \frac{\dot{K}(t)}{A(t)L(t)} - \frac{K(t)}{\left[A(t)L(t)\right]^2}\left[A(t)\dot{L}(t) + \dot{A}(t)L(t)\right] \tag{21}$$

$$= \frac{\dot{K}(t)}{A(t)L(t)} - \frac{K(t)}{A(t)L(t)}\left[\frac{\dot{L}(t)}{L(t)} + \frac{\dot{A}(t)}{A(t)}\right] \tag{22}$$

$$= \frac{sY(t) - \delta K(t)}{A(t)L(t)} - k(t)(n+g) \tag{23}$$

$$= sf(k(t)) - (n + g + \delta)k(t) \tag{24}$$

Equation (24) is the central equation of motion for the Solow model, the steady state. This is a nonlinear first order differential equation in the variable $k(t)$ that describes the

process of capital accumulation in the economy: capital accumulation is the engine of growth, since output per capita depends on the per-capita capital stock $k(t)$. According to Solow, to understand the growth process, we need to understand the reasons for capital accumulation.

The first term, $f(k(t))$ is the actual investment in physical capital per unit of effective labour. The second term, $(n+g+\delta)k(t)$ is the effective depreciation of capital per unit of effective labour. Steady-state (equilibrium) occurs at such value of capital per effective labour, Steady state: a capital stock k^* where, when reached, $\dot{k}(t)=0$, that is $sf(k^*)-(n+g+\delta)k^*)=0$

4.0 Methodology

4.1 Analytical Technique

The analysis is based on a dynamic nonlinear optimal growth model. The primary interest of this study is to use the first key equation of the RCK and Solow models to find the growth path for capital accumulation and income over which the criterion function is maximized among all feasible growth paths from 2017 to 2030. The systems are based on aggregative behavioural equations. This study builds an internally consistent, Dynamic General Equilibrium (DGE) framework, where forward-looking agents make their optimal decisions, taking both current and future variables into account. This entails dynamic equations involving today's and tomorrow's capital stock etc. In other words this would bring us directly into the realm of income dynamics over time, i.e., economic growth. In particular, we shall examine how the period-by-period capital stock dynamics generate a growth path for the economy and what happens to this growth trajectory in the long-run.

4.2 Specification Model

The analysis and specifications of the model are done with a standard macroeconomic model structure derived from Kendrick & Taylor (1971). The model is a non-linear programming (NLP) of seven (7) simultaneous complete equations. It is model of optimum savings with a finite planning horizon. The empirical models adopted in this study after a minor modification of (17), (18) and (24) are specified as follows;

$CAPB(t)$: CapitalStock Balance Equation

$$CAPB(t): CAP(t+1) = INC(t) - CON(t) + (1-\delta)CAP(t) \quad (25)$$

$$CAP \cdot 1(t): \left(\frac{(INC \cdot 1(t)}{\alpha(t)} \right)^{(1/\beta)} \quad (26)$$

$INCD(t)$: IncomeDefinition Equation

$$INCD(t): \ INC(t) = \alpha(t)CAP(t)^{\beta} \quad (27)$$

$$INC \cdot 1(t) = INC0(1.06)^{(tt(t)-1)} \quad (28)$$

$PID(t)$ =Performance Index Definition Equation

$$PID(t) = PI(t) = \sum \left(t, r(t-1)CON(t-1)^{(1-\sigma)} \right) \quad (29)$$

$SAVR$ **=** Saving rate

$$SAVR = \frac{INC \cdot 1(t) - CON \cdot 1(t)}{INC \cdot 1(t)} \quad (30)$$

$CON(t)$ = Consumption Equation

$$CON \cdot 1(t) = INC \cdot 1(t) + (1-\delta)CAP \cdot 1(t) - CAP \cdot 1(t+1) \quad (31)$$

Definition of the Variables

$CAP(t)$ = Capital stock in continuous time

$INC(t)$ = Income in continuous time

$PI(t)$ = Performance index in continuous time

$CON(t)$ = Consumption in continuous time

Scalar

δ = rate of depreciation

β = exponent on capital

n = labour force growth rate

σ = elasticity of substitution

z = technical progress

ρ = welfare discount

$INC0$ = initial per capita income
$CAP0$ = initial capital

Parameter
ϕ = efficiency parameter in the production function
$\phi = INC0 / CAP0^{\beta}$
$r(t)$ = discount factor
$r(t) = (1+\rho)^{(1-tb(t))/(1-\sigma)}$
$\alpha(t)$ = production function parameter
$\alpha(t) = \phi(1+n)(1-\beta)+z)^{(tt(t)-1)}$
$SAVR$ = Saving rate

4.3 Model Calibration
Thus, whether capital is at optimal to predict a higher growth rate of income, not only temporarily, but also in the long run, depends on the flexibility of the values of the scalar variables. In order to apply the RCK and Solow framework to the Nigerian economy, the model is modified to fit the real data and to handle the policy issues.

The model is calibrated using the existing data for 2017 as a base year/period $(tb(t))$, while the terminal period $(tt(t))$ is 2030. So the model is calibrated with respect to scalar values (see Table 1)

Table 1: The Base Period (2017) Scalar Values

δ	Rate of Depreciation	0.06
β	Exponent on Capital	0.25
n	Labour Force Growth Rate	0.028
σ	Capital Elasticity of Production	0.5
z	Technical Progress	0.1
ρ	Welfare Discount	0.1
$INC0$	Initial Income	3.454
$CAP0$	Initial Capital	24.94431

Sources: NBS, WBI and Literature

4.4 Data Requirement and Sources

Data were obtained for rate of depreciation of the capital stock, exponential growth of capital, labour force growth rate, elasticity of substitution between factors of productions, technical progress, welfare discount, initial income and initial capital for Nigeria. They are compiled from World Bank's Development Indicator (WBI). Other sources include data from the Nigerian National Bureau of Statistics (NBS) and from literature.

Gross capital fixed formation is used as a proxy for capital stock with an initial value of ₦2494431 million. Nominal gross domestic product is used as a proxy for income at the initial value of $345.4 billion (₦124,344 billion). Labour force growth rate is computed from the Nigeria's total labour force reported by the World Bank development indicators of 2017, compiled from officially recognized sources with a value of 29,591,190 in 1990 to a value of 58,959,450 in 2017. Technical Progress is calculated as the ratio of real GDP to working population or labour force, given as: Technical Progress = ln(Real GDP/Labour Force). Average rate of depreciation of the capital stock of Nigeria increased from 0.03 rate in 1965 to 0.06 rate in 2017 growing at an average annual rate of 1.83 %. (See the Database of Penn World Table 9.1).

Other scalars value were taken from literature as a result of many data scanty problems in Nigeria, related to growth linkage. Welfare function of income or welfare discount measured on a 0.1 scale is based on Hagenaars (1988). While, exponent on capital is given as 0.25, which was subsequently confirmed by the National Bureau of Economic Research to be 0.75 exponent of labour (Cobb & Douglas1928). Note, our study assumes perfect competition and scale, that is $\alpha + \beta = 1$, α and β can be shown to be capital's and labour's shares of output. Meaning that doubling the usage of capital and labour will also double output.

4.5 Definition of Policy Simulation Experiments

The scenario involves using the sector properties that is the scalar values to run an experiment to forecast an optimal and balanced growth path for capital and income in order to ascertain the short, the medium and long-run optimal growth path for capital and income. The "base year 2017" in the set serves as comparator.

The deviations are dynamic effects from 2017-2030. The normalized variables are $CAP0 \cdot 1(t) = 1, INC0 \cdot 1(t) = 1, CON0 \cdot 1(t) = 1$, since the model is homogeneous of

degree zero. $INCf(t) = INC \cdot 1(tb)$ and $INCf(tt) = INC \cdot 1(tt)$,while, t is the 'extended horizon' 2017 to 2030. The base year values 2017 = 0.

This study endogenises the savings rate as it is in the RCK model and unlike in the Solow model, i.e., savings is a function of income within the economy. The saving rate may not be constant along the transition to the long-run steady state, but the outcome is Pareto optimal or Pareto efficient. The main difference between the two models is that RCK allows to pin down, endogenously, the savings rate; hence, to determine a unique efficient path of long-run economic activity (capital stock and income) as a function of the economic fundamentals (essentially, preferences, technology, initial stocks etc.).

5. Analysis of Simulation Results

The study use RCK and Solow's growth models to predict capital stock. As for the prospect framework, the optimal capital accumulation is dependent on whether the production function (F) exhibits constant returns to scale in K & L. Whether, $F(\bullet)$ is linearly homogeneous (of degree 1) in these two variables (see equations 1- 9).

The results in Tables 1 to 4 can be made to show immediately the paths that are efficient. The efficiency of these paths depends on the efficiency parameter in the production function (ϕ) discount factor (r) and production function parameter (α). In an exogenous productivity growth, it is expected that current and future optimal capital stock and income could be lower or higher, dependent on the level of the base year scalar values used in the scenario calibration.

The results in Table 1 shows the annual growth paths of capital stock (CAP) and income (INC) with their corresponding rate of savings rate (SAVR), discount factor (r) and production function parameter (α) from 2017 to 2030. The result shows that, the growth paths are characterised by constant return to scale (CRS), increasing rate of savings and decreasing discount factor. Table 1 and Fig.1 show that the variables followed a definite and upward trends from 2017 to 2030. This implies that the production function exhibits CRS i.e., it is linearly homogeneous.

The result show that an increase in stock of capital increase income. It implies that capital is at optimal to predict a higher growth rate of income in the long-run.

Table 1: Annual Growth Path of CAP, INC and SAVR

	CAP	INC	SAVR	r	α
2017	24.944	3.454	0.710	5.000	0.304
2018	25.953	3.605	0.723	4.950	0.308
2019	27.000	3.768	0.735	4.901	0.312
2020	28.148	3.945	0.746	4.853	0.317
2021	29.404	4.136	0.758	4.805	0.321
2022	32.926	4.382	0.771	4.757	0.326
2023	35.612	4.69	0.801	4.710	0.331
2024	38.442	5.092	0.811	4.664	0.335
2025	40.427	5.577	0.821	4.617	0.340
2026	42.578	5.884	0.830	4.572	0.345
2027	44.907	6.215	0.839	4.526	0.350
2028	47.428	6.571	0.848	4.482	0.355
2029	50.153	6.954	0.856	4.437	0.360
2030	53.097	7.353	0.864	4.393	0.365

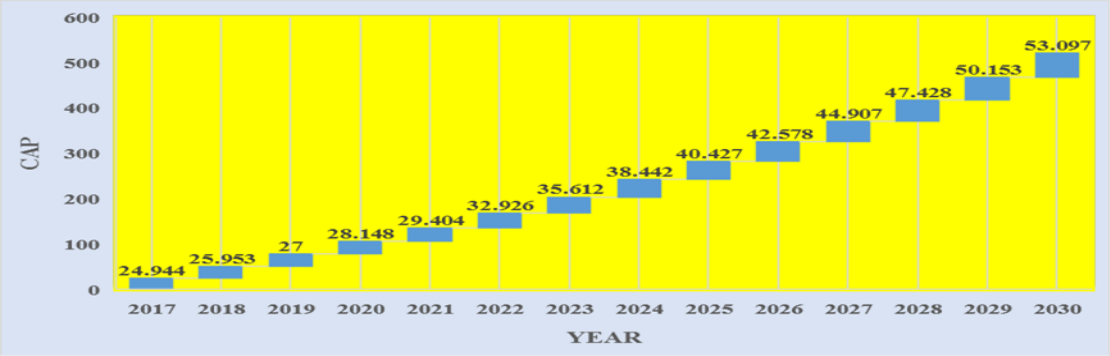
Source: Author's Computation

Optimal Capital Growth Path

The annual growth paths of capital stock in Table 1 and Figure 1 show that from 2017 to 2030 capital stock grows from ₦2494431 million to ₦5309700 million. For this growth path to be realistic and meet this optimal capital stock of ₦5309700 million by 2030, the annual growth paths of capital must exhibit positive and significant result, with alpha (α) exhibiting constant return to scale as shown by the production function parameter and with a positive efficiency parameter (0.304). The Nigeria efficiency parameter in the production function should not be less than 30% otherwise the trend in Figure 1 is not realistic.

The results in the Table 1 also show that the further in the future the capital is received or accumulated, the lower the discount rate used to calculate its present value as shown by discount factor (r). Also, saving rate should have positive and direct relationship with accumulation of capital.

Figure 1: Capital Growth Path 2017-2030



Source: Author's Computation

Table 2 shows the yearly difference. Capital stock has a positive yearly difference with an average of ₦216600 million. Table 2 also shows the yearly difference of the discount factor at a decreasing rate and the yearly difference of production function exhibiting a constant return to scale with an average of 5%.

Table 2: Yearly difference

	CAP	INC	SAVR	r	α
2017	0.000	0.000	0.000	0.000	0.000
2018	1.009	0.151	0.013	-0.050	0.004
2019	1.047	0.163	0.012	-0.049	0.004
2020	1.148	0.177	0.011	-0.048	0.005
2021	1.256	0.191	0.012	-0.048	0.004
2022	3.522	0.246	0.013	-0.048	0.005
2023	2.686	0.308	0.030	-0.047	0.005
2024	2.830	0.402	0.010	-0.046	0.004
2025	1.985	0.485	0.010	-0.047	0.005
2026	2.151	0.307	0.009	-0.045	0.005
2027	2.329	0.331	0.009	-0.046	0.005
2028	2.521	0.356	0.009	-0.044	0.005
2029	2.725	0.383	0.008	-0.045	0.005
2030	2.944	0.412	0.008	-0.044	0.005
Average	**2.166**	**0.301**	**0.012**	**-0.047**	**0.005**

Source: Author's Computation

Optimal Income Growth Path

The annual growth paths of income in Table 1 and Figure 2 show that from 2017 to 2030 income grows from$345.4 billion (₦124,344 billion)to$735.3 billion (₦264,708 billion) respectively.

If Nigeria want to maintain this growth path and meet this optimal income of $735.5 billion by 2030, the growth paths must exhibit positive and significant result, with the alpha (α) exhibiting constant return to scale as showed in the production function and with a positive efficiency parameter (0.304). That is, the efficiency parameter in the production function should not be less than 30%. Also saving rate should have a positive and direct relationship with income.

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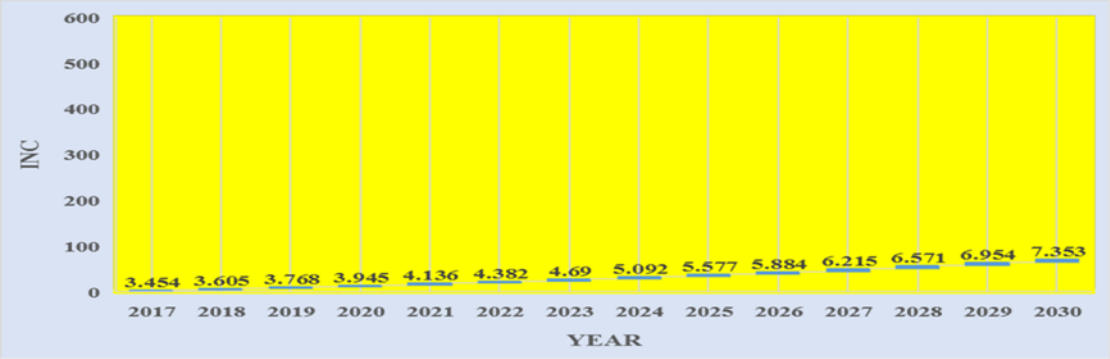
The result shows that between 2017 and 2030, income averaged $511.7 billion dollar. This implies that for the country to meet $735.3 billion dollar in 2030, income should not be less than $511.7 billion dollar going by this average. Table 2 shows the yearly difference. Income has a positive yearly difference with an average of difference of $30.1 billion dollar.

Figure 2: Income Growth Path 2017-2030



Source: Author's Computation

Balanced Growth Path and Steady State

It is important to define the concept of 'long-run equilibrium' in the context of growth models. Long-run equilibrium in a growth model is typically defined as a balanced growth path (BGP), where all endogenous variables grow at some constant rate. This constant growth rate may differ from variable to variable. More importantly, this constant growth rate could even be zero for some variables. A situation when the

constant growth rate is zero, it is called the steady state in the conventional dynamic analysis (which is a special case of a BGP) (Mausumi, 2016). The standard RCK and Solow model predicts that in the long run, economies converge to their steady state equilibrium.

What determines the value of the BGP and steady state of CAP^* and therefore INC^* ? The increase in rate of depreciation (δ), the increase in labour force growth rate (n), and increase in technical progress (z). Intuitively, we think that more depreciation should lead to less capital accumulation and lower steady-state CAP^* & INC^*. Faster technological progress should allow economy to grow faster, both in aggregate and in per capita terms. And more rapid population growth should allow economy to grow faster because labour input is growing faster. That is, capital and income grow at the rate of growth of technological progress and index of labour productivity, $z+n$, which is independent of SAVR. So each factor expands by $z+n$ each year, with constant returns to scale. Growth in this model is "exogenous" capital and income growth = $z+n$ are taken as given from outside the model.

Tables 3 and 4 shows the annual percentage growth rate and the deviation of each year from the base year value (2017) and percentage deviation from base year values (2017). Tables 3 and 4 show the balanced growth paths, steady state of capital stock, income and saving rate values.

The annual percentage growth rate in Table 3 shows the annual percentage growth rate of capital, income and the corresponding saving rate from 2017 to 2030. The result shows that capital stock has a constant growth rate (on the BGP) from 2025 to 2030 and with an average annual growth rate of 5.53% from 2025 to 2030, while income has a constant growth rate (on the BGP) from 2026 to 2030 and with an average annual growth rate of 5.67% from 2026-2030 and with a corresponding rate of saving on the BGP of 1.06% approximately.

Table 3: Annual Percentage Growth Rate

Year	CAP	INC	SAVR
2017	0.00	0.00	0.00
2018	4.05	4.37	1.83
2019	4.03	4.52	1.66
2020	4.25	4.70	1.50
2021	4.46	4.84	1.61
2022	11.98	5.95	1.72
2023	8.16	7.03	3.89
2024	7.95	8.57	1.25
2025	5.16	9.52	1.23
2026	5.32	5.50	1.10
2027	5.47	5.63	1.08
2028	5.61	5.73	1.07
2029	5.75	5.83	0.94
2030	**5.87**	**5.74**	**0.93**
Average 2025-2030	5.53	5.67	1.06

Source: Author's Computation

Table 4 shows the deviation of each year from the base year value (2017) and their corresponding percentage deviations. Table 4 shows capital stock deviation from the base year value of ₦1548300 million in 2025, ₦1763400 million in 2026, ₦1996300 million in 2027, ₦2248400 million in 2028, ₦2520900 million in 2029 and ₦2815300 million in 2030, with their corresponding percentage deviation of 62%, 71%, 80%, 90%, 101% and 113% respectively, while income has $212.3, $243.0, $276.1, $311.7, $350.0 and $389.9 billion in 2025, 2026, 2027, 2028, 2029 and 2030, with their corresponding percentage deviation of 61%, 70%, 80%, 90%, 101% and 113% respectively on the BGP with constant saving rate along the transition to the long run steady state.

Table 4: Deviation and Percentage Deviation from Base Year Values (2017)

YEAR	CAP		INC		SAVR	
	Deviation from Base Year Value	**% Deviation**	**Deviation from Base Year Value**	**% Deviation**	**Deviation from Base Year Value**	**% Deviation**
2017	0.000	0.000	0.000	0.000	0.000	0.000
2018	1.009	4.05	0.151	4.37	0.013	1.83
2019	2.056	8.24	0.314	9.09	0.025	3.52
2020	3.204	12.84	0.491	14.22	0.036	5.07
2021	4.460	17.88	0.682	19.75	0.048	6.76
2022	7.982	32.00	0.928	26.87	0.061	8.59
2023	10.668	42.77	1.236	35.78	0.091	12.82
2024	13.498	54.11	1.638	47.42	0.101	14.23
2025	15.483	62.07	2.123	61.46	0.111	15.63
2026	17.634	70.69	2.430	70.35	0.120	16.90
2027	19.963	80.03	2.761	79.94	0.129	18.17
2028	22.484	90.14	3.117	90.24	0.138	19.44
2029	25.209	101.06	3.500	101.33	0.146	20.56
2030	28.153	112.86	3.899	112.88	0.154	21.69

Source: Author's Computation

6.0 Conclusion

The main objective of this research is to use the first key equations of the Ramsey-Cass-Koopmans and Solow models to empirically project the likely optimal capital growth path and the steady-state for Nigerian economy. Under the assumptions that the rate of capital accumulation is independent of the saving rate, and they are positively related. With a constant return to scale on the production function, that are connected with the rate of exogenous technological progress. Also, the capital growth path derived, offer the basis to analyse the long-run growth of income.

This study carried out a scenario and derived the balanced growth paths for capital and income, in an exogenous growth setting for Nigeria, that are optimum with respect to base period scalar values over a finite planning period 2017 to 2030, while 2017 in the set, serves as comparator or base value.

The study reveals that the long-run capital accumulation considerably depends on the values of the scalars. The result of the study shows that from 2025 to 2030, capital stock and income grow at a constant rate. This show that the growth models predict a unique steady-state capital and income level. In contrast to the suggestion that capital accumulation plays a minor role in economic growth, the study find that income has a large and statistically significant effect, but more importantly on its long-run growth rate to the steady state be a function of the scalar values.

The forecasted growth paths show that capital and income followed some definite and upward trends from 2017 to 2030 and that, an increase in capital accumulation, also leads to an increase in incomes. This implies that optimal growth paths for capital and income could only be sustain and achieve if and only if the aggregate production function exhibit a constant or an increasing return to scales. Therefore, the fundamental feature of these models is its competitive framework and its assumption of constant returns to scale and diminishing returns.

Due to these assumptions, the two-capital neoclassical growth models predict that in the absence of continuing improvements in technology, per capita growth must eventually come to an end. But this prediction is not confirmed by facts.

Finally, this study provide overwhelming evidence that rapid and sustained capital and income growth is critical to economic growth and the well-being of a nation. Therefore, it is important to study and devise ways of promoting capitalist economic development, because capital stock would be the engine of growth for developing countries.

7.0 Policy Implication

The study shows the optimal traverse path for capital accumulation in Nigeria. It presents evidence that an increase in capital stock predicts/leads to a higher income growth, not only temporarily, but also in the long-run. The evidence that capital stock has a long-run effect on growth rates is consistent with the main implication of some exogenous growth models. This question is that can this upward trend be achievable in any developing economy like Nigeria.

The fact that the derivatives are positive and consistent with one of the main predictions of the neoclassical models, the study shows that the higher the reinvestment rates, the higher the steady-state levels of capital. This have a vital policy implication in the sense that the predictions of the neoclassical models depend on the

dynamics of technology and effective labour possessed by the economy. Therefore, the optimal traverse path for capital stock growth in Nigeria is achievable only through technological progress, the index of labour productivity and only if the aggregate production function exhibits CRS. This implies that technological and labour effectiveness should be the bases for capital accumulation and balanced growth path for the Nigerian economy.

Government policymakers and planners around the world use capital accumulation projections to gauge future demand for investment and to forecast future income that would in turns affect economic growth. Capital accumulation projections help policymakers craft policies that can be adapted for various projection scenarios, because government need to look at the real factors that let countries create new wealth. In most growth models, forecasting exercise was originally based on two major components, capital and labour.

Capital accumulation is often suggested as a means for developing countries to increase their long-term growth rates and the policy to be optimal capital must be optimal at every stage. To increase capital accumulation it is necessary to: increase savings ratios, maintain good banking system and system of loans, avoid corruption, good infrastructure to make investment more worthwhile.

In general, contemporary growth theories and models have not been successfully able to assess the determinants of growth, particularly in less developed counties. Because, the definition and the measurement of theoretically predicted determinants are much difficult and different in less developed countries from those in developed countries. But the fact is that the primary origin of almost all growth theories and models are the needs and the requirements of developed countries.

This gap can be bridged by paying attention to the dynamic effects of policies. Considering that many less developed countries have had a growth experience that was very far from the conditions of a steady-state, it is of great importance for policy makers of less developed countries to find out the factors optimal capital. Equally important, the derived capital growth equations are empirically testable provided that data on capital stock of the economy are available. This means a potential for a new method to test conditional convergence.

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POLICY BRIEF
ECONOMIC GROWTH AND EMISSIONS: TESTING THE ENVIRONMENTAL KUZNETS CURVE HYPOTHESIS FOR ECOWAS COUNTRIES.

Prof. Douglason G. Omotor*[1]

Abstract

The relationship between economic growth and environmental sustainability is premised on the environmental Kuznets curve (EKC) hypothesis. Two variants of emissions related to contribute to environmental degradation in the extant literature are sulfur dioxide (SO_2) and carbon dioxide (CO_2). Sulfur dioxide has the potential to acidify rain, soil and lakes, and it can counteract some of the warming effects of carbon dioxide. If unabated, the problem of environmental degradation could aggravate and become unsustainable as income per capita increases. To stimulate economic growth while minimizing environmental pollution, it is important policy makers know much as to what drive these emissions in order to enact effective policy and regulation that will support sustainable development.

For this much-needed information to be provided, this CEEPA study examines the validity of the EKC hypothesis and the driving factors of SO_2 and CO_2 emissions in the ECOWAS sub-region. Based on panel fixed and random effects estimation techniques, the results show there is evidence of the validity for the two indicators of environmental quality- SO_2 and CO_2 in the sub-region. These emissions in the ECOWAS sub-region are induced by fuel processing and fuel combustion and rapid population growth. In the light of this and the need to stimulate economic growth while minimizing environmental pollution, there is need for strong institutions to enact effective policy and rules and regulation that will support sustainable development.

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[2]The research work was carried out with the aid of a grant from the Centre of Environmental Economics and Policy in Africa (CEEPA – www.ceepa.co.za), financed by the Swedish Development Cooperation Agency (SIDA) and the International Development Research Center (IDRC). The work benefitted immensely from review comments of various resource persons, among them, Wisdom Akpalu, David Starrett, Edwin Muchapondwa, Joe Cook, Marty Lackat and other participants at the 25 – 29 August, 2014 CEEPA's 15th Research and Training Workshop, Pretoria, South Africa. I also wish to thank Sam Omoruyi for the editorial review.

Consequently, a functional population policy is recommended for implementation generally for the ECOWAS sub-zone and particularly in Nigeria.

Heavy industry
Green environment

Emission
Degraded environment

Context and What the Problem Is

The Environmental Kuznets Curve (EKC) hypothesis posits the existence of an inverted U-shaped curve between environmental pollution or degradation and economic growth. As discussed in the extant literature, environmental degradation results from deterioration in the quality of environmental resources. Natural resource exploitation without abatement exacerbates production and accumulation of greenhouse gases, which in turn leads to global warming. The proposition of the EKC suggests that, at the early stage of the development process, economic growth is associated with low incomes, and as development moves through the intermediate stage of industrialization, the environment gradually worsens, and ultimately begins to deteriorate at some higher levels of income threshold (heavy industry). This theorizing has been the subject of series of debates as some scholars support the existence of the EKC, just as others hold a contrary view.

Although it may have been easily anticipated, the statistical and econometric evidence of the EKC relationship is mixed and its interpretation ambiguous. Consequently, little may be done in breaking new ground in attempt to synthesize the evidence and assess where matters stand. However, the contribution of this paper to the EKC- SO_2 and CO_2 empirical literature to our knowledge is novel in its application to the ECOWAS sub-region.

Second, in their quest for economic integration and diversification, the ECOWAS economies move into the next stage of economic growth with probable increase in per capita income, mitigating environmental degradation in the sub-region through appropriate policy design becomes inevitable.

Third, the spectre of rapid population growth (Nigeria is Africa's most populous country) coupled with increased urbanization in the sub-region are a cause for concern as both can, on the one hand, contribute to over-exploitation of the ecosystems through complex feedbacks that have important implications for sustainable resource use, and on the other hand, further deteriorate the relationship between their levels of economic growth and emission of pollutants.

The enjoyment of relatively cheaper price of fossil fuels due to government resource subsidies led by Nigeria implies that the sub-region could experience relative higher rates of atmospheric fossil fuel and irreversible environmental damage. This, however, is a matter of empiricism which this paper seeks to address.

The State of the Environment in ECOWAS

The environment-development paradigm which shifted to sustainable development began in the 1970s with the aim of formulating sustainable development policies that will curtail emissions in the development process. The dialogues which followed the discourse were to conserve the deteriorating environment and these resulted in a series of government commitments covering at least nine treaties. This culminated in a series of Treaties, Conventions, Multilateral Environmental Agreements and Protocols. The ECOWAS sub-region and political leadership since the launch of the ECOWAS Environmental Policy (2008) have displayed some signs of commitment and appreciation of the consequences of environmental problems.

Profile of SO_2 emissions in ECOWAS countries

A comparative examination of the evidence shows that SO_2 emission in ECOWAS countries ranked relatively lower than what obtained in some industrial countries. For example, the mean or average SO_2 concentration for the period, 1960-2005 for Benin, Cote d'Ivoire, Ghana, Nigeria, Senegal and Togo stood at 2.5, 20.1, 18.8, 361.7, 20.5 and 202 Gg respectively; while those of China, Germany, Japan, UK and USA, stood at 14224.6, 5597.1, 2057.6, 4070.7 and 22147.7, respectively.

A fundamental lesson deduced from the SO_2 concentrations for the selected ECOWAS countries when compared with the selected Industrial nations has been that, ECOWAS countries may have the benefit of learning early and by involving in environmental activism and awareness may not need to wait for too long for per capita income to improve to the levels recorded in industrial nations before they begin to appreciate cleaner environment.

Profile of CO_2 emissions in ECOWAS countries

It has been argued that, given the current level of economic development in the ECOWAS sub-region, recorded carbon per capita may be rising in recent years. This fear reflects the fact that as the region's economy grows, carbon dioxide per capita may escalate as a result of industrialization. In 1960 for instance, carbon dioxide per capita rate of increase per year in the sub-region was 0.71 PPM (parts per million) and by 2005, the rate of increase stood at 2.14 PPM per year. As the sub-region's quest for rapid industrialization increases, the ECOWAS may do better by deliberately stepping up measures to curb the trend towards increased carbon intensity.

Study Framework and Methodology

The general objective has been to relate environmental degradation to economic growth measured by increases in per capita income and to establish the validity of the EKC hypothesis of an inverted U-shape for the two indicators of environmental quality- SO_2 and CO_2. The study uses annual panel data for selected ECOWAS countries to estimate the environmental Kuznets curves. The data are obtained from publications of the World Bank and the African Development Bank, among others.

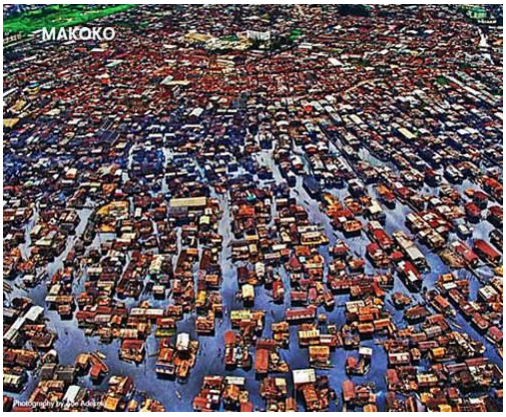
Study Findings

The results are in tandem with the EKC Hypothesis for the two environmental indicators- SO_2 and CO_2 using ECOWAS sample data. The computed income per capita turning point of the SO_2 Fixed Effects model average $5,650 dollars over the period. The turning point value on average is higher than the region's average gross domestic product (GDP) per capita which ranges from USD 800 in Niger to USD 4,400 in Cape Verde. For carbon dioxide, perverse turning point was established.

The major drivers of SO_2 in the sub-region are fuel processing and fuel combustion led by Nigeria. For CO_2 emissions, it is driven by rapid population growth which is equally induced by Nigeria. The polity variable which interacted significantly with the income variable to create the inverted-U shape EKC signals the importance of public institutions on environmental quality.

Policy Recommendation

From the foregoing brief discussions, some policy implications arise from the findings of this study. First, the existence of an EKC for the two indicators of environmental quality implies that policy prescription needed to abate these form of environmental emissions, should be such which enhances growth and incomes. Second, and arising from the first, the need to stimulate economic growth while minimizing environmental pollution requires strong institutions to enact and implement effective policy, rules and regulation that will support sustainable development. Third, the concern for policy making should be how the productive process of pollution emitting firms and those of other economic agents whose actions relate to the environment for instance, can be managed in the interest of the environment. The study further recommends implementation of a functional population policy generally for the ECOWAS sub-zone and particularly for Nigeria.



Lagos Makoko Water Village with over 85,000 inhabitants

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