WEST AFRICAN INSTITUTE FOR FINANCIAL AND ECONOMIC MANAGEMENT (WAIFEM)

WEST AFRICAN FINANCIAL AND ECONOMIC REVIEW

Volume 21 ■ December 2021 ■ 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.

Editor's Comment

Apart from the regular peer reviewed articles published in the WAFER Journal, this edition has a special section that focusses on peer reviewed articles on Dynamic Stochastic General Equilibrium (DSGE) modelling analyses on some West African Institute for Financial and Economic Management (WAIFEM) member countries, a product of WAIFEM's capacity building activity in 2021.

In July 2021, WAIFEM organised a fifteen (15) day Regional Virtual Course on Macroeconomic Modeling and Forecasting for Policy Analysis for Senior Economists and Other Professionals (DSGE Model). The course was designed to introduce participants to a variety of data modeling and forecasting techniques. The course helped participants to understand how monetary and productivity shocks affect key macroeconomic outcomes such as output gap, inflation and exchange rate. Overall, the course enlightened participants on how productivity and monetary shocks influence the behaviour of economic agents as well as performance of the economy. The participants were also exposed to within-sample and out-of-sample forecasting techniques.

One of the outcomes of the course was the formation of teams on country basis to undertake empirical studies by applying country data to a canonical DSGE model. The purpose was to assess the ability of the participants to apply the knowledge gained to monetary policy analysis and forecasting. The papers were put through the peer-review process.

This publication showcases the commitment and dedication of the participants, a proof that linking capacity building to empirical research activity has helped in building a nucleus of DSGE Modelers within the WAIFEM member states. Participants from three WAIFEM member countries namely Liberia, Sierra Leone and Nigeria successfully implemented the drafting of papers on the countries' DSGE models.

The papers sought to achieve the following:

1. Estimate a structural model, the Dynamic Stochastic General Equilibrium model, to analyze monetary policy, productivity, and exchange rate shocks on inflation and output gap in Liberia.

2. Undertake an Analysis of Monetary Policy and Productivity Shocks for Nigeria using a DSGE Approach.

3. Analysis of Monetary Policy and Productivity Shocks on Output, Inflation and Monetary Policy Rate in Sierra Leone: A DSGE Approach

The findings for Liberia reveal that the impact of monetary policy shock on output gap is transient and significant up to three quarters, whereas the impact of the same shock on monetary policy rate persists up to the fifth quarter. Productivity shock on inflation and monetary policy rate are positive and persistent over the 8-quarter horizon. Similarly, exchange rate shock has persistent positive impact on price and monetary policy rate over the 8-quarter horizon but negative impact on output gap up to the fifth quarter.

In the case of Nigeria, the study suggests that monetary policy shocks have transient effects, while productivity shocks have lasting effects on monetary policy rate and inflation.

For Sierra Leone, both monetary and productivity shocks have permanent effect on output, inflation and interest rate, though the effect of productivity shock appears not to be statistically significant.

In general, the studies suggest that productivity shocks seem to have persistent impact on inflation in all the countries, whereas the impact of monetary policy shocks on inflation vary. This suggests that monetary authorities in these countries can not discount supply side factors in their bid to tame inflationary pressures.

WAIFEM highly commends the efforts of our indefatigable facilitators and committed participants in getting these three papers out.

Baba Yusuf Musa Ph. D
Editor-in-Chief

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Volume 21 **December 2021** **Number 2**

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

DOES FINANCIAL DEVELOPMENT PROMOTE EXPORT DIVERSIFICATION IN NIGERIA?

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Abstract

The drive towards export diversification in Nigeria cannot be realized without a well-developed financial sector that is able to mobilize and efficiently channel resources to the export sectors for the production of export- related goods and services. It is on this premise, that this study, investigates whether or not financial development encourages export diversification in Nigeria. Employing the Auto Regressive Distributed Lag (ARDL) approach to cointegration and error correction model, on annual time series data spanning the period 1980 to 2021, the empirical results show that financial development drives export diversification in Nigeria in the short-and long runs, respectively. Openness of the domestic economy is positively and significantly related to export diversification in the short and long runs, respectively. Other variables that promote export diversification are gross fixed capital formation (proxy for domestic investment), foreign direct investment and growth rate of output. Exchange rate and the institutional quality variable are positively related to export diversification, although the effect of exchange rate is not significant. It is also evident that that inflation rate (proxy for macroeconomic policy environment) is negatively related to export diversification, albeit a weak effect. The paper recommends sweeping financial development policies and measures, particularly those that encourage greater financial intermediation for the production of exportable commodities, increased openness to export trade, capital accumulation, greater production capacity, sound and stable macroeconomic environment and solid institutional framework to encourage export diversification in Nigeria.

JEL Classification: E44, G2, F14

Keywords: Financial development, Export diversification, Non-oil exports, ARDL

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1.0 INTRODUCTION

The role of financial development in export diversification in developing and emerging economies has become the subject of extensive interest and empirical investigation in recent times, among economists, policy makers and the academia (see Matvos et al., 2016; Tule & Oboh, 2017; Paudel, & Alharthi, 2021). The interest has been spurred by the traditional role of financial intermediation in stimulating real sector growth, through the private sector led-economic diversification. The financial sector has an onerous role to play in the mobilization of savings, efficient and optimal allocation of resources and the diversification of risks for trade, industry, business and investment. Financial development (or the deepening of the financial sector) is therefore, critical to the drive towards economic diversification via its capacity to mobilize domestic and foreign resources for real sector productivity through improved credit channelling. Improved financial intermediation in a private-sector led growth is projected to enhance efficiency and promote greater real sector growth through higher levels of allocative and financial resource/intermediation.

On the role of financial development in economic diversification, various studies (see Gilchrist, Sim & Zakrajsek, 2011; IMF 2014) suggest that financial market development promotes the efficient allocation of resources among productive units, thereby enhancing productivity and growth. In fact, the development of the financial sector, supported with a conducive macroeconomic environment and good legal institutional and political framework are important to the drive of export diversification. The pronounced variation in the depth and sophistication of financial developments between the developed and developing countries, and across countries in the world account for the large disparity in the level of real sector productive base, according to a large body of literature (Gilchrist, et al., 2011; Ozekhome, 2021). Accordingly, the limited and inadequate access to credit explains the low productivity and low contributions of small- and medium- scale enterprises to private sector development in oil exporting countries, in addition to the weak export capacity arising from the absence of meaningful economic diversification, with the resulting low level of domestic resources, savings, growth and poverty reduction. These studies have therefore, focused on the role of finance in product diversification and economic expansion.

Recent studies (see, Bougheas & Falvey, 2010, Matvos et al, 2016) have opined that substantial variations across countries in terms of the level of financial development and its drivers significantly correlate with country (regional) differences in real sector productivity, production patterns and product space. Expounding this assertion, Amaral and Quintin (2010), Buera, et al. (2011) have developed quantitative

theoretical models, which show that a large portion of the cross-country differences in total factor productivity could possibly be due to resource misallocation, arising from imperfect and under-developed financial markets. This implies that productivity growth and expansion in the product space could be reached by improving the existing level of financial development in lagging countries and regions. Several cross-country studies (Chandra, et al., 2007; Tule & Oboh, 2017) have argued that financial development is an important ingredient for diversifying the export base of a country.

On the issue of export diversification, proponents have argued that the adverse effects of volatile markets through internationally generated and transmitted shocks as a result of large fluctuations in price and volume of commodity exports affect terms of trade, foreign exchange earnings, import capacity, productivity, employment and growth (FAO, 2004; IMF, 2014). A large export base, accordingly, has the capacity to maintain uninterrupted export earnings that can sustain long-run growth and macroeconomic stability (IMF, 2014). Oil and resource rich economies aim to reduce dependence on mineral resources through the expansion of the sources of their exports and fiscal revenues. In Nigeria, despite the efforts made so far, to diversify the productive base of the economy, several systemic and structural challenges, particularly, poor macroeconomic policy environment and weak quality of institutions have been bedevilling.

While quite a few studies have examined the determinants of export diversification, only a handful of the studies have examined the specific role of financial development on the diversification of exports. The few studies available are cross-country based. Country-specific studies are important and timely considering the fact that the impact of financial development on export diversification could vary across countries due to differences in the level of financial development. In particular, the financial development-export diversification nexus is yet to be examined using Nigerian data. Such a study is important given her economic and structural characteristics. This leaves a gap in the literature that this study intends to fill.

Aside the introductory section, the rest of the paper is structured as follows: Section 2 provides some stylized facts on export diversification and financial development (proxied by private sector credits to GDP ratio) in Nigeria. Section 3 reviews the literature, consisting of the theoretical and empirical issues associated with the financial development-export diversification nexus. The empirical methodology, model specification and data are presented in Section 4, while Section 5 contains the empirical results and analysis. The conclusion and evidence- based policy recommendations are presented in section 6.

2.0 Stylized Facts

Nigeria is a rich country in terms of natural resource endowments. She is one of the largest producers of crude oil in the World. Before and immediately after independence, agriculture was the dominant sector in the country, contributing nearly over 60 percent to total GDP; over 80 percent of export revenues, and about 70 percent to employment. Following the oil boom in the 1970s, the agricultural sector witnessed a 'displacement effect', with the increased reliance on the production and export of crude oil. The increased dependence on oil as source of foreign exchange earnings greatly led to the near-total neglect of the agricultural sector, which had more dynamic multiplier effects. As at 1990, total reliance on oil exports rose to over 90 percent of total exports.

With the volatile influence of an over-bearing dependence on oil arising from international market developments (i.e growth, demand and economic deceleration), the country started experiencing decline in oil export earnings. This had tremendous negative effects on economic growth and macroeconomic stability. In order to diversify the economic base from the mono-dependence on oil and reduce the adverse effects of international-induced and transmitted shocks, ensure long-run growth and macroeconomic stability, a structural transformation and diversification policy strategy was proposed as one of the antidotes by the World Bank-IMF economic transformation programme, adumbrated in the famous Structural Adjustment Programme (SAP) in the 1980s. The government adopted other policy measures and strategies, such as the Exports Incentives and Miscellaneous Provisions framework Decree No. 18 of 1986.

With the return to democracy in 1999, a number of policy responses and initiatives aimed at the diversification of the economy have been adopted and implemented by the government. A typical example is the National Economic and Development Strategy (NEEDS), with the underlying drive for an export-led growth strategy (Tule & Oboh, 2017). Other policy initiatives and strategies also focused on the promotion of economic diversification in order to expand the productive base of the economy and insulate the economy from volatile oil export-earnings and the resulting vulnerability in the economy. As a follow-up of previous initiatives and policy responses, the Buhari administration in 2017 launched the Economic Recovery and Growth Plan (ERGP), with the objective of economic diversification on key non-oil sectors growth drivers, to include agriculture, energy, micro, small and medium -scale enterprises (MSMEs) and industrialization.

Despite the efforts and policy responses so far made to diversify the economy, it is still predominantly dependent on foreign exchange earnings from oil. The rather sluggish pace of economic diversification is linked to poor policy implementation, lack of consistency in approach and drive, infrastructural deficit, weak access to finance, poor manufacturing and industrial capacity, weak domestic capital base, structural inflexibilities, particularly, poor macroeconomic policy and weak institutional environment. An insight into dominant share of oil exports in total export basket; an indication of the over-dependence on oil, which is also a reflection of the extent of diversification of the economy away from oil exports, over the focus period, in terms of non-oil exports is shown Table 1.

Table 1: Oil and Non-Export Earnings in Total Export Earnings (1980- 2021)

Year	Total Exports (N'B)	Oil Exports (N'B)	Oil (% of Total Exports)	Non-Oil Exports (N' B)	Non-Oil Exports (% of Total Exports)
1980-1984	9.5	9.2	96.7	0.3	3.3
1985-1989	28	26.3	93.7	1.8	6.3
1990-1994	172.4	167.9	97.3	4.5	2.8
1995-1999	1,088.5	1,062.7	97.5	25.8	2.6
2000-2004	2,649.7	2,578.6	97.3	71.1	2.8
2005	256.5	7,140.6	98.5	106.0	1.5
2006	7,324.7	7,191.1	98.2	133.6	1.8
2007	8,309.8	8,110.5	97.6	199.3	2.4
2008	10,387.7	9,861.8	94.9	525.9	5.1
2009	8,606.3	8,105.5	94.2	500.9	5.8
2010	12,011.5	11,300.5	94.1	711.0	5.9
2011	15,236.7	14,323.2	94.0	913.5	6.0
2012	15,139.8	14,260.0	94.2	879.3	5.8
2013	15,262.0	14,13.8	92.6	1,130.2	7.4
2014	12,960.5	12,007.0	92.6	953.5	7.36
2015	8,845.2	8,184.5	92.5	660.7	7.5
2016	8,845.6	8,178.8	92.6	656.8	7.43
2017	13,988.1	12,913.2	92.3	1,074.9	7.60
2018	19,280.0	17,845.9	92.6	1,434.2	7.44
2019	20,105.5	18,372.3	91.4	1,780.6	8.86
2020	24,255.6	21,905.4	90.3	2,350.2	9.71
2021	25,110.3	22,720.8	90.5	2,389.5	9.52

Source: National Bureau of Statistics (NBS); Central Bank of Nigeria (CBN) Statistical Bulletin (various issues) and World Bank World Development Indicators (WDI).

As can be gleaned from Table 1, oil-exports have consistently dominated the total export earnings over the years, accounting for an average for over 93 percent between 1980 and 2021. This position is in sharp contrast to the non-oil exports, which accounted for an average of less than 6 percent, during the period under focus. Invariably, the over-dependence of the economy on the production and export of a single volatile commodity, oil, has lingered on. The over-bearing dependence on oil exports and the resulting externally generated shocks resulting from variations in commodity prices, which is largely due to the fact that oil is internationally priced, implies that the growth of the Nigerian economy tend to be considerably hinged on the patterns and developments in the international markets, and the associated cyclicality. Apparently, the various policy responses, initiatives and strategies aimed at diversifying the productive economic base of the country over the years have not yielded the expected outcomes, due partly to lack of political will, policy consistency, transparency and accountability required to bring them into genuine attainment. A further analysis of the situation is provided in Table 2, in terms of sectoral contribution to total GDP, which is a further explanation of the extent of diversification in terms of sectoral GDP.

Table 2: Sectoral Share in GDP (1980-2021)

Year	Agric GDP (%)	Mining GDP (%)	Oil GDP (%)	Manufacturing GDP (%)	Construction GDP (%)	Trade GDP (%)	Services GDP (%)
1980-1984	22.10	0.40	32.50	8.79	3.59	3.09	0.48
1985-1989	19.12	0.22	31.28	9.45	2.36	4.12	0.66
1990-1994	18.68	0.14	32.72	8.81	2.45	3.70	1.50
1995-1999	19.96	0.09	31.26	7.12	2.66	4.02	4.68
2000-2004	23.82	0.08	28.13	6.28	2.63	3.82	11.6
2005	25.40	0.08	24.80	6.27	2.32	3.34	19
2006	25.56	0.08	22.191	6.44	2.45	3.34	22.8
2007	25.53	0.09	119.74	6.58	2.58	3.32	25.7
2008	25.31	0.09	17.27	6.69	2.73	3.31	28.8
2009	24.73	0.09	16.01	6.67	2.82	3.24	32
2010	23.89	0.09	15.39	6.55	2.88	3.13	34.7
2011	23.35	0.10	14.95	7.33	3.16	3.53	36.7

2012	23.91	0.12	13.64	7.98	3.32	3.65	41.5
2013	23.33	0.13	11.24	9.22	3.59	3.58	46.3
2014	22.90	0.14	10.44	9.95	3.82	3.56	50.2
2015	23.11	0.15	9.61	9.54	3.88	3.65	55
2016	24.45	0.13	8.35	9.28	3.71	3.73	60.8
2017	25.08	0.13	8.67	9.18	3.72	3.69	63.3
2018	25.13	0.14	8.60	9.20	3.73	3.56	66.3
2019	26.20	0.15	8.58	9.20	3.72	3.70	66.5
2020	25.85	0.16	8.65	9.21	3.73	3.82	67.1
2021	27.23	0.17	8.63	9.15	3.79	3.92	67.3

Source: National Bureau of Statistics (NBS); Central Bank of Nigeria (CBN) Statistical Bulletin (various issues) and World Bank World Development Indicators (WDI).

From Table 2, it is observed that, with the exceptions of the Manufacturing and Services sectors that witnessed growth (though marginal), all other sectors witnessed decline in their contribution to GDP. The contribution of the manufacturing sector is seen to have been negligible over the years, with the fluctuation remaining until 2010. Beginning from 2011, a relative stability in growth of the manufacturing sector contribution to GDP was witnessed, albeit a negligible share. The relative growth in the Services sector is notable. The contribution of the Agricultural sector to GDP declined in 2005 from 25.4 percent to 22.90 percent by 2014. The sectoral contribution of mining to GDP, remained infinitesimal all through the period examined, declining from 0.40 percentage share to a negligible 0.09 percent in 2010; and 0.15 percent in 2019. The contribution of the construction sector also had a weak and unimpressive growth all through the period, declining from a 3.59 percentage share in the 1980-84 period to 2.32 percent in 2005, reaching 3.77 percent in 2021. Overall, the data highlight the diminishing contributions to GDP in all the sectors, particularly, the manufacturing, agriculture and mining sectors, which are believed to hold many dynamic growth and employment opportunities, through their inherent positive spillover effects, thus posing a source of policy concern. The extent of financial intermediation, adumbrated in credit to the private sector, a measure of financial development in Nigeria is shown in Table 3.

Table 3: Credit to Private Sector as index of Financial Development

Year	Credit to Private Sector as ratio of GDP (%)
1980-1984	19.03
1985-1989	19.00
1990-1994	14.25
1995-1999	11.18
2000-2004	13.32
2005	12.62
2006	12.34
2007	17.81
2008	28.57
2009	36.89
2010	34.78
2011	25.21
2012	26.10
2013	19.28
2014	18.25
2015	17.22
2016	15.62
2017	14.20
2018	12.52
2019	12.70
2020	13.01
2021	12.88

Source: Author's computation: Underlying data from the Central Bank of Nigeria (CBN) Statistical Bulletin (various issues) and World Bank World Development Indicators (WDI).

Table 3 shows that bank credit to private sector as ratio of GDP fell from 19.03 percent in the 1980-84 period to 12.34 percent in 2006; and improved to 36.89 percent in 2009, before falling marginally to 34.78 percent in 2010. Increased credit to private sector was recorded in the mid-1990s up to 2010. The period, 2011- 2021 is seen to be characterized by weak private sector credit, due apparently to high interest rate on borrowing, stringent bank requirements for loans and prohibitive collateral demands by banks, among others. In all, credit to the private sector, as ratio of GDP remains abysmally low; a factor that may contribute to the poor diversification outcomes in Nigeria.

3.0 LITERATURE REVIEW

The theoretical underpinnings for export diversification is rooted in the Structuralist economic thesis by Presbich (1950) and Singer (1950), which holds the view that the concentration of exports on a single or few primary commodities could cause secular deterioration in the terms of trade in developing countries. In line with the proposition, the economies of developing countries are subjected to external and domestic shocks, arising from fluctuations (volatilities) in the price of primary commodities in the international market. Export diversification, thus offers protection against economic volatility. The idea is that developing countries' economies that are heavily dependent on primary commodities will be severely affected as prices of primary commodities decline relative to manufactures, resulting in poor economic growth, foreign exchange and employment volatilities. Accordingly, the diversification of exportable products will reduce the volatile influence of an overbearing dependence on single or few primary exportable products that are characterize by low elasticity of demand and synthetic substitutes. Other authors, such as Chenery (1979) and Dawe (1996) have provided theoretical support for economic diversification.

On the theoretical nexus between financial development and export diversification, the argument (see Manganelli & Popov, 2010) is hinged on the view that countries with well-developed and well-functioning financial system are more likely to be diversified than those with less degree of financial development. This supposition is anchored on the fact that an improved financial architecture has greater capacity to mobilize and channel resources for business, industry, trade and investment, thereby, encouraging economic diversification. In theory, increased financial intermediation to the private sector, particularly for trade and export-related activities will promote diversification. Thus, efficient and improved financial intermediation brought about by financial development will make trade credits possible, thereby facilitating greater level of exports (Ozekhome & Oaikhenan, 2020).

Improved export product diversification is important as it enables the production of diversified goods and services that can mitigate shocks, and the resulting secular deterioration in trade, particularly, where such goods have synthetic substitutes. Diversification is important for resilience and mitigates vulnerability to external shocks, where for instance, the COVID-19 pandemic induced significant disruption in oil-dependent economies. Beyond protection against shocks, diversification of a country's economy is increasingly recognized as an elixir for sustained economic growth, particularly in low-income and resource- dependent countries, as it can help fuel economic growth and trigger significant poverty reduction (Usman & Landry, 2021). Export diversification, in line with the extant literature, encourages long-run

growth and structural transformation through increasing scale economies, dynamic spillover-effects, increased production technologies and efficiency in the use of production inputs. In other words, the dynamic effects of export diversification are beneficial to domestic industries in the tradable and investment sectors, through the channel of knowledge spillovers, new production techniques, innovation and managerial enterprise (Guitierrez-de Pineres & Ferrantino, 2000).

Through increased international competitiveness, exporting countries will greatly benefit from diversification as increased competition stimulates productivity, economies of scale and greater efficiency, and permitting the integration of international value chains of local firms. It also has the capacity to strengthen the few strategic sectors in any economy like agriculture, mining, oil, manufacturing, construction and services and thus, promote greater export trade (Ozekhome, 2021,). By uniquely taking advantage of her position through export product diversification, Nigeria can leverage its rich agricultural and mineral resources through improvement in basic infrastructure, efficiency and agro-processing capacity for greater growth. Furthermore, exports diversification is important as it enables countries build resilience to movements in demand, due to economic downturns in importing countries, including price dips. In the case of commodity exporting countries, it supports a shift from an over dependence on commodities to higher-value-added products and services. Export diversification allows for more inclusion of small and medium-sized enterprises and encourages innovation as exposure and access to greater markets are permitted (UNCTAD, 2019). Diversification also matters as it generally go together with industrial upgrading on account of technological diffusion and a shift toward higher productivity sectors and higher paying jobs.

On the empirical relationship between financial development and export diversification, only a hand full of studies exists, given the paucity of empirical works in this direction. The focus of most studies have been on the determinants of export diversification (see, for example, Al-Kawaz, 2008; Agosin et al., 2011; Alaya, 2012; Balavac, 2012; Kamuganga, 2012; Arawomo et al, 2014, Aigheyisi, 2018). Other studies examined the different quantitative measures of export diversification such as the Theil Index, the Herfindahl Index and the Gini Index (see Hausmann, 2006; Rodrik; 2008). Yet, some other studies investigated the impact of export diversification on economic growth (see Hesse, 2008; Agosin, 2009; Agosin et al., 2011; Cadot et al., 2011; Paterka and Tamberi, 2011; Nwanne, 2014).

The few existing studies on the role of financial development on export diversification include Manganelli and Popov (2010), that used a sample of 28 OECD economies

over the period 1970-2007, and found that financial development, measured as private credit to GDP percent encourages specialization rather than diversification. The study by Noureen and Mahmoud (2014), investigated the effect of country-based determining factors of export diversification in a sample of South-East Asian Nations (SEAN) and South-Asian Association for member countries regional Cooperation (SAARC), and found from the Ordinary Least Squares and cointegration results that, a unit percent increase in the level of financial development results to a 0.0008 and 0.004 unit rise in export diversification in the countries of both sub-regions.

The study by El-Said et al (2013) on the link between the ease of the availability of bank credit and export diversification for a sample of SMEs in Egypt, using a logit model, found that access to banking credits positively and significantly increases the probability of a rise in exportable commodities and consequently, export product diversification. A similar study by El-Said et al (2015) on the nexus between trade and access to finance of SMEs found that increased access to trade finance, particularly exports, has the capacity to stimulate trade diversification. A study by IMF (2014), which focused on sustaining long-run growth and macroeconomic stability in less developed countries in the context of the role of structural transformation and diversification, found that a well-developed and improved financial system (measured by private credit as ratio of GDP) is a positive and significant factor that influences the diversification of exports. In Nigeria, Tule and Oboh (2017) examined the connection between financial development (proxied by credits to the private sector) and export diversification in Nigeria, employing the Auto Regressive Distributed Lag Model (ARDL) on annual time series data that span the period 1981 to 2015. The results showed that financial development is positively and significantly related to export diversification. In particular, a unit percent rise in domestic credit to the private sector led to a 0.046 percent rise in export diversification in the long-run. Based on the findings, the authors recommended proper design of macroeconomic policies that will stimulate affordable credit channelling to the private sector.

In a study on export diversification, Feenstra and Kee (2018) found that, on the average, a 10 percent increase in export variety, led to a 1.3 percent increase in productivity due to better use of resources and allocative efficiency. Better use of resources and allocative efficiency, accordingly, could result from efficient financial intermediation to the export tradeable sectors. Ruch (2020) and Usman and Landry (2021), found similar results for a sample of Africa, developing and emerging countries, respectively. In a seemingly contrary result, Paudel and Alharthi (2021), utilizing the ARDL approach to cointegration on annual time series data spanning the period 1980 to 2017 for Nepal, found that financial development had no strong long-run positive

impact on export performance. Financial institutions and financial market also showed a negative relationship with exports.

From the review of the pertinent literature, it can be observed that there is paucity of empirical studies on the financial development-export diversification nexus in Nigeria. Besides, the existing few studies (e.g. Arawomo, et al., 2014; Tule & Oboh, 2017) did not account for the role institutional framework plays in export diversification, given that robust institutional settings through appropriate legal framework, policy transparency and accountability, and stable political system can promote diversification. In the light of current policy imperatives to delink the economy from the manifest dependence on volatile oil exports, whose fortune depends on global market patterns and developments, and the consequent vulnerability to externally generated and transmitted shocks due to variations in commodity prices, and the critical importance of finance and credit in the diversification equation, this study/paper becomes highly compelling to policy and the literature.

4.0 EMPIRICAL METHODOLOGY

4.1. Model Specification, Measurement of Variables and Estimation Procedure

To examine the systematic relationship between financial development and export diversification, a stylized financial development- export diversification model is specified in the form:

$$EDI_t = f(FDEV_t, Xt) \quad (1)$$

Where EDI is export diversification index, measured here, as the Theil Index. The Theil Index is chosen among the other two measures conventionally used in the literature, the Herfindal Index and the Gini Index. The choice of the Theil Index is based on the fact that it is a synthesis of the 'extensive' and 'intensive' margins of diversification. The intensive margins accounts for existing product lines, while the extensive margins take into cognizance new product lines (see Tule & Oboh, 2017). In line with the IMF (2014, 2020), a higher value of export diversification index is an indication of a high level of concentration, which implies a less diversified export product base. Consequently, the inverse of the Theil Index is used in this study as a direct measure of export diversification, with a higher inverse of the Theil index indicating a greater degree of export diversification (Songwe & Winkler, 2012).

FDEV is financial development, measured by credit to the private sector as ratio of GDP percent; t, is time period, and X is a vector of additional macroeconomic variables, in line with the literature that influence the diversification of exports in the product space. They include openness to trade (OPEN), measured as total trade to GDP percent; economic/ output size, measured as annual growth rate of nominal

GDP (GGDP) (in percent); gross fixed capital formation (GFCF)- measured as the ratio of GDP (i.e. proxy for domestic investment); foreign direct investment to GDP (FDI); Exchange rate, measured as the nominal exchange rate of the naira to the dollar (i.e. ₦/$); inflation rate (INF)- measured as the percentage change in the consumer price index; and a measure of institutional quality (INSTQ), measured by averaging five measures of institutional quality; rule of law, political stability, government effectiveness, regulatory quality and control of corruption using an index scale of -2.5 to 2.5. The inclusion of institutional quality, which previous studies, such as Noureen and Mahmood (2014) and Tule & Oboh (2017) neglected, is a novel feature of the current study. Robust and supportive legal, institutional and political framework (which include policy responses, initiatives and strategies) are critical to encouraging economic diversification. Without strong institutional legal and political backing, supported with effective government capacity to implement appropriate policies and strategies aimed at diversification, in addition to transparency, accountability and strong resolution, diversification may not see the light of the day. The various policy and institutional initiatives, such as the Exports Incentives and Miscellaneous Provision are examples of such supporting frameworks aimed at encouraging economic diversification in Nigeria. In the light of this, the expanded functional form of the model is:

$$EDI_t = f(FDEV_t,\ OPEN_t,\ GGDP_t,\ GFCF_t,\ FDI_t,\ EXR_t,\ INF_t,\ INSTQ_t) \quad (2)$$

The succeeding empirical specification is captured in the form:

$$EDI_t = +\alpha_1 FDEV_t + \alpha_2 OPN_t + \alpha_3 GGDP_t + \alpha_4 GCFC_t + \alpha_5 FDI_t + \alpha_5 EXR_t + \alpha_7 INF_t + \alpha_8 INSTQ_t + \epsilon_t \quad (3)$$

where FDEV, OPEN, GGDPG, GFCF, FDI, EXR, INF and INSTQ are as earlier defined. $\alpha_1 - \alpha_8$ are the parameters to be estimated, and ε is the unobserved error term. The *apriori* expectations are (a_1, a_2 a_3, a_4. a_5, a_6, a_8) > 0; and (a_7) < 0.

The study utilizes the Autoregressive Distributed Lag (ARDL) approach to cointegration proposed by Pesaran and Shin (1999) and Pesaran, Shin and Smith (2001). The ARDL model is selected because of its several advantages over the Engle and Granger Two Step Residual-based cointegration and Johansen multivariate cointegration. First, the approach can be applied irrespective of whether the individual regressors are integrated of order I(0), I(1), or of mixed order of integration {i.e I(0) and I(1)}, provided they are not integrated of order 2 {i.e I(2)}. Second, the ARDL model takes sufficient number of lags to capture the data generating process from a general to specific modelling framework. Third, the ARDL approach produces superior long-run

coefficient estimates, despite the fact that some of the variables may be endogenous (Pahlavani et al. 2005; Adam et al., 2012). In addition, the diagnostic tests of the estimated equation are more reliable Fourth, using the ARDL model, it is easy to derive the dynamic error correction model (ECM) through a simple linear transformation. The ECM, in this direction, captures the dynamic the short-run relationship among the variables. Fifth, the ARDL model is not sensitive to nuisance parameters in finite sample as in the case of the Engle and Granger and Johansen approach to cointegration. The ARDL framework is captured in the form:

$$\begin{aligned}\Delta EDI_{t=}\ \alpha_0 &+ \sum_{i=1}^{k} \alpha_1 \Delta EDI_{t-i} + \sum_{i=1}^{k} \alpha_2 \Delta FDEV_{t-i} + \sum_{i=1}^{k} \alpha_3 \Delta OPEN_{t-i} \\ &+ \sum_{i=1}^{k} \alpha_4 \Delta GGDP_{t-i} + \sum_{i=1}^{k} \alpha_5 \Delta GFCF_{t-1} \\ &+ \sum_{i=1}^{k} \alpha_6 \Delta FDI_{t-i} + \sum_{i=1}^{k} \alpha_7 \Delta EXR_{-i} + \sum_{i=1}^{k} \alpha_8 \Delta INF_{t-i} \\ &+ \sum_{i=1}^{k} \alpha_9 \Delta INSTQ_{t-i}\end{aligned}$$

$$+ \psi_1 EDI_{t-1} + \psi_2 FDEV_{t-1} + \psi_3 OPEN_{t-1} + \psi_4 GGDP_{t-1} + \psi_5 GFCF_{t-1} + \psi_6 FDI_{t-1} + \psi_7 EXR_{t-1} + \psi_8 INF_{t-1} + \psi_9 INSTQ_{t-1} + \varepsilon_t \quad (4)$$

where Δ is first difference of a variable; α_0 is a constant, k is the maximum lag order; $\alpha_1 - \alpha_9$ are the short-run coefficients, while $\psi_1 - \alpha_8$ are the long-run coefficients that are to be estimated; $i\ is\ time\ trend;\ and\ \varepsilon_t\ is\ the\ white\ noise\ at\ time, t.$

The implementation of the ARDL approach involves two stages. First, the existence of the long-run nexus (cointegration) between the variables under investigation is tested by computing the F-statistics for analyzing the significance of the lagged levels of the variables. If the F-statistic is above the upper-bound critical value for a given significance level, the conclusion is that there is a non-spurious long-run level relationship with the dependent variable. If the F-statistic lies below the lower bound critical value, it implies that there is no long-run level relationship among the variables. If it lies between the lower and the upper bounds, the result is interpreted as inconclusive. The archetypical form of the null and alternative hypotheses for the F-statistic test are:

$$H_0 : \Psi_1 = \Psi_2 = \Psi_3 = \Psi_4 = \Psi_5 = 0$$

$$H_1 : \Psi_1 \neq \Psi_2 \neq \Psi_3 \neq \Psi_4 \neq \Psi_5 \neq 0$$

Second, the existence of cointegration among the variables is a plausible justification to embark on further analysis of the long-run and short-run (error correction) relationship among the variables. The error correction represents the short-run dynamics, as well as the contemporaneous speed of adjustment to long-run equilibrium, after a temporary disequilibrium and perturbation.

4.2. Theoretical Justification of the variables Used in the Model

In theory, several variables influence the diversification of exports, apart from financial development. On the measure of financial development, a number of basic indicators of the size of the financial development of a country, and the question of selecting the most appropriate measure arise when the country/countries being studied are at different levels of financial systems (Odhiambo, 2005, Ozekhome, 2021). A traditional measure of financial development is liquid liabilities (which is currency, held outside the banking system, plus demand and interest-bearing liabilities of banks and other financial intermediaries to GDP). This measure reflects the overall size of the financial intermediary sector, but it does not distinguish the allocation of capital to the private sector, particularly to sub-national governments. Given that private individuals mostly source credits, particularly export credit from banks, it is more appropriate to focus on the extent of financial intermediation in the private banking sector as a measure of market-based financial development.

This study, thus, uses the ratio of credit to the private sector to GDP as a measure of the level of financial development as it represents the claims of the private sector on the banking sector. In so doing, a better representation of the overall development of banking sector in the private sector is captured. This measure of financial development is typically preferred and considered superior in the empirical literature (see McDonald & Schumache, 2007), since the formal financial institutions, especially banks, generally provide credit for business, trade-related and investment activities. Financial development via credit to the private sector enables the efficient allocation of trade credits to different sectors of the economy. Thus, the allocation of credit and finance to the exporting sectors has the capacity to stimulate their productive capacity, and induce the diversification of export products.

Following the new trade theory, (see Helpman & Krugman, 1985; Ofa, et al.; 2012), the extent of product diversification is hinged on economic size or growth rate of output, measured by the growth rate of GDP. Increased economic output permits product and output expansion, with diverse range of products. The growth rate of GDP is therefore added to the model as increased output permits and generates extensive range of products. The resulting product competitiveness in new markets and the

exportation of new and innovative products implies export diversification (Ozekhome, 2019).

Openness of the economy is a key factor in export diversification efforts, as economic openness to trade engenders product expansion, product destination and market expansion (Dennis & Shepherd, 2011). The inclusion of openness variable to the model is thus theoretically backed.

Gross capital formation (a proxy for domestic investment) influences export diversification since increased capital stock engenders greater productive capacity, and accordingly, export product diversification. Foreign direct investment is important to export diversification via its role as a channel for advanced technology, innovative capacity, positive spill over effects and productivity growth (Ozekhome, 2016). As a result, technological improvements, efficiency and productivity made possible by foreign direct investment, can stimulate export product diversifications. Through knowledge diffusion effects, foreign direct investment can foster better production techniques and efficiency of domestic firms, and thus, greater exports. The inclusion of foreign direct investment, is thus, based on strong theoretical background.

Exchange rate is an important variable that influences export diversification as international trade theory asserts that the devaluation of the domestic currency will facilitate greater exports of commodities that have become cheaper relative to foreign goods, due to a cheaper currency. The resulting increased in export of commodities, given an elastic trade demand, will, lead to a transfer of resources towards the production of exportable commodities and industries, and thus, export diversification. Inflation a proxy for macroeconomic policy environment is a hypothesized determinant of export diversification given that a sound and stable macroeconomic environment engenders a stable and consistent policy framework (i.e. policy responses and initiatives) that leads to export product diversification. The inclusion of inflation in the model is thus theoretically justified. Finally, the degree and quality of legal institutional framework and political stability are important determinant of export diversification since good legal provisions and political stability, devoid of socio-ethnic and political crises, have greater positive effects on the intensity of export products, and by extension, export diversification.

4.3. Data Sources

Data used for the study are annual time series data covering the period 1980-2021. The relevant data were collected from various sources to include, IMF Data base, World Bank World Development Indicators (WDI) and the Central Bank of Nigeria (CBN)

Statistical Bulletin. Precisely, data on export diversification index were obtained from the IMF Database. Data on credit to private as ratio of GDP, openness of the economy, growth rate of GDP, gross fixed capital formation, foreign direct investment and institutional quality, were sourced from the World Bank World Development Indicators (WDI), while data on nominal exchange rate and inflation were gathered from the CBN Statistical Bulletin (various issues).

5.0 Empirical Results and Analysis

5.1. Descriptive Statistics

Table 4 presents the descriptive statistics of the data in order to have a gloss of the variables and their characterization. The mean value of export diversification index (i.e. the inverse of the Theil Index) is 0.16; an indication of low level of diversified exports. The maximum and minimum value are 0.17 and 0.16, respectively. The mean value of credit to the private sector as ratio of GDP (a measure of the level of financial development) is 12.85 percent, with a median value of 11.44 percent. The maximum and minimum values are 35.7and 6.22 percent. This value is an indication of low level of financial intermediation to the private sector, particularly for trade-relative activities. The corresponding average values of the degree openness to trade, growth rate of GDP, gross fixed capital formation, foreign direct investment, exchange rate and inflation are 59.65, 4.32, 12.60,10.92, 175.72, 15.5 and -0.39, respectively.

Table 4: Descriptive Statistics of the Variables

	Mean	*Median*	*Max.*	*Min.*	*Std. Dev.*
EDI	0.16	0.16	0.17	0.16	0.01
FDEV	12.85	11.44	35.70	6.22	5.88
OPEN	59.65	58.72	69.30	3.25	6.05
GGDP	4.32	5.20	9.25	-1.55	4.25
GFCF	12.60	11.95	36.21	5.50	6.15
FDI	10.92	9.60	22.21	4.22	3.50
EXR	175.72	162.52	395.05	2.02	10.22
INF	15.50	13.26	72.80	4.70	9.22
INSTQ	-0.39	-0.41	2.50	-1.90	3.16

Source: Author's computation

5.2. Unit Root Test for Stationarity

Unit root test is a preliminary test for stationarity of variables used in regression analysis. Stationarity of time series is hinged on the fact that non-stationary time series cannot be applied to an extended period apart from the present. This makes forecasting and policy inferences based on such series to be of weak practical value. Added to this, is the fact that, the regression of a non-stationary time series on another may produce spurious and nonsense correlations. The results of the unit root test are presented in levels and first difference in Table 5, using the Augmented Dickey Fuller (ADF) and Phillips- Peron (PP) tests.

Table 5: Unit Root Tests for Stationarity

Variables	ADF	PP	ADF	PP	Inferences
	Levels		First Difference		
EDI	-3.9812**	-4.1872**	-	-	I(0)
FDEV	-1.9980	-0.7157	-5.5201**	-6.6502**	I(1)
OPEN	-1.5214	-1.2179	-5.2340***	-7.2213***	I(0)
GGDP	-0.9823	-1.8919	4.9202**	-7.5510***	I(1)
GFCF	-4.2112**	-1.7851	-	-10.250***	I(1)
FDI	-1.0711	-0.9814		8.2634***	I(1)
EXR	-1.8352		-5.1722***	6.2230**	I(1)
INF	-1.2203		-4.5202**	7.0714**	I(1)
INSTQ	-0.9221		-3.9705**	7.1673**	I(1)

Note: *** and ** indicates 1% and 5% % significance levels, respectively.
Source: Author's computation

The results of the ADF and PP unit root test indicate that export diversification index (EDI) and gross fixed capital formation (GFCF) are stationary at levels {(i.e I(0)},using the ADF. For the PP test, only EDI is stationary at levels. The remaining variables are stationary at first difference, implying that they are integrated or order {i.e I(1)}. The fact that two of the variables (EDI and GCFC) are I(0) and the remaining variables integrated (1), rules out the possibility of using either the Engle-Granger or Johansen cointegration techniques. This is because both techniques require all variables to be I(I) before they can be applied. As earlier stated, this is one of the advantages of the ARDL, which allows for the inclusion of mixed order of integrated variables {i.e I(0)and I(1)} in the same cointegrating equation. Following this, the ARDL Bounds test to cointegration is carried out in this study. The procedure consists of two steps.

First, the null hypothesis of no long run (equilibrium) relationship among the levels of the variables is conducted using the F-test, with a non-standard distribution. Pesaran et al (2001) provided two sets of asymptotic critical values where all the variables are I(1) and for situations where all the variables are I(0). If the computed F-statistic exceeds the uppers critical value, then the null hypothesis of no significant long run relationship is rejected, as long as all the variables are I(0) and I(1) .Conversely, if the F-statistic is lower than the critical values, the null hypothesis cannot be rejected. As long as a long run relationship exists, the second step is executed. This requires the estimation of the ADRL model, using maximum order of lags to obtain the long run and short-run dynamic {i.e. error-correction model (ECM)} coefficient estimates.

5.3. ARDL Results

In accordance with the ARDL method, cointegration tests are conducted to examine the existence of a long run (equilibrium) relationship between the variables by computing the F-statistic for the joint significance of lagged levels of variables. The result of the Bound test for cointegration is presented in Table 6.

Table 6: Bound Test Results for Cointegration

Test Statistics	Value	Lag	Significance Levels	Bound Critical Values	
F-Statistics	4.150	2		Lower Bound I(0)	Upper Bound I(1)
			1%	2.66	3.64**
			5%	2.15	3.09
			10%	2.01	2.47

(**) Denotes Significance level at 5 percent

Source: Author's computation

The test result clearly shows the rejection of the null hypothesis of no plausible cointegration, since the computed F-statistic of 4.15 is greater than the upper critical bound (3.64) at the 5 percent significance level. Thus, the existence of a significant long-run equilibrium relationship among the variables cannot be rejected. The confirmation of the existence of co-integrating vectors among series gives enough background for analysing the long-run estimates, as well as the short-run dynamic adjustment model. The long-run estimates are provided first in Table 6.

5.4. The Long-run Estimates of the ARDL

The result of the long-run model estimation is presented in Table 7. In the result, only the coefficient estimates and the asymptotic t-ratios are reported.

Table 7: Long Run Model Results

Dependent Variable: EDI			
Variable	Coefficient	T-ratio	Prob.
FDEV	0.0331	3.1231***	0.00
OPEN	0.2250	2.4102**	0.04
GGDP	0.1202	2.5607 **	0.02
GFCF	0.0261	2.37221**	0.03
FDI	0.0372	1.7562*	0.09
EXT	0.0144	0.5225	0.48
INF	-0.0254	-1.3240	0.27
INSTQ	0.0163	1.0173	0.30
C	0.9655	1.4802	0.17

Note: ***, ** and * indicates 1%, 5% and 10% significance levels, respectively.
Source: Author's computation

From the results, the coefficient of financial development (measured as credit to the private sector) is positively signed and significant at the 5 percent level. Thus, improved level of financial development encourages the diversification of exports through greater access to trade and investment credits. This finding confirms the results of IMF (2014), Noureen and Mahmood (2014), and Tule and Oboh (2017), and contrast with the findings of Manganelli and Popov (2010). A unit percent increase in credit to the private sector (i.e improvement in financial development) induces export diversification by 0.03. Openness of the domestic economy to trade is positively signed according to theoretical expectation, and is significant at the 5 percent level. Invariably, higher level of domestic openness, with the associated benefits of trade in terms of reduced trade obstructions, greater international competition, economies of scale, quicker adaptation to technology and innovation that enhances the diversification of exportable products. This result is consistent with the findings of Alaya (2012) and Ozekhome and Oaikhenan (2020), and contrast with the findings of Kamuganga (2012). A unit increase in the degree of openness stimulates export diversification by 0.23. The coefficient of the growth rate of the economy (a measure of output expansion) is appropriately positively signed and significant at the 5 percent level.

The coefficient of output expansion, measured as the growth rate of GDP has a positive sign, in line with theoretical expectation. Thus, increased economic output engenders export diversification as output expansion leads to the production of new, innovative, diversified, and competitive range of products (i.e. product diversification), and thus, export diversification. This finding supports the position of Ofa et al. (2012) and Ha, Chung and Seo (2016). A unit percent increase in output/market size induces a 0.1 percent increase in the diversification of exports. The coefficients of gross fixed capital formation (proxy for domestic investment) and foreign direct investment (FDI) are both positively signed, in line presumptive expectation, with that of domestic investment passing the significance test at the 5 percent level, while that of FDI passes the significance test 10 percent level. Thus, greater level of domestic and foreign direct investment are critical to export diversification through domestic productivity growth, external spillover effects from foreign investment, efficient production techniques and technological improvements that combine to improve export diversification. The findings support the findings of Ozekhome (2016), and Ozekhome and Oaikhenan (2020). A unit percent increase in domestic capital formation and FDI stimulates export diversification in the long-run by 0.026 and 0.027, respectively.

5.5 The Error Correction Model (ECM) Results

The results of the error correction model, which shows the short-run dynamic thee response of export diversification index (EDI) to financial development and other explanatory variables, as well as the adjustment to long-run equilibrium due to temporary disequilibrium and perturbation in the short-run is shown in Table 8.

Table 8: Short-run Dynamic (Error Correction) Representation for the ARDL

Dependent Variable: EDI			
Variable	Coefficient	T-ratio	Prob.
D(EDI (-1))	0.0541	1.9024*	0.07
D(FDEV)	0.0224	2.2840**	0.03
D(OPEN)	0.3063	2.4228**	0.02
D(GGDP)	0.2753	1.8801*	0.09
D(GFCF)	-0.0201	-1.8062*	0.09
D(FDI)	0.0152	0.7362	0.48
D(EXR)	0.0053	0.6211	0.54
D(INF)	-0.0016	-1.2511	0.22
D(INSTQ)	0.0007	0.461	0.67
ECM(-1)	-0.6514	-2.8212**	
R-squared	0.9314		

Adjusted R-squared	0.8623		
F-statistic	65.20 (0.000)		
Breusch-Godfrey Serial Correlation LM Test Statistic	4.7023 (0.410)		
Heteroscedasticity Test	1.625 (0.122)		

Note: ***, **, and * indicates 1%, 5% and 10% significance levels, respectively.
Source**:** Author's computation

The adjusted R^2 value shows that the independent variables and the ECM explain over 86 percent of the net systematic variations in export diversification in the short-run, thereby making the predictive capacity of the model good. The F-value of 65.2 is highly significant at the 1 percent level, validating the hypothesis of a significant linear relationship between export diversification and all the explanatory variables, a confirmation that the regressors are pertinent to export diversification in Nigeria. The serial correlation test statistic of 4.70 shows that there is no serial correlation in the model and the Heteroscedasticity test statistic of 1.65 indicates the absence of heteroscedasticity in the model. The model is thus fit for structural and policy analysis.

The coefficient of the first lag of financial development is positively related to export diversification and significant at the 10 percent level. Thus, past realization of economic diversification constitutes a veritable springboard for further diversification, especially when policies, initiatives and strategies are consistently sustained. The coefficient of private sector credit is positively signed and significant; a confirmation that increased financial intermediation to the exporting sectors induces the diversification of exports in the short-run. This is in sync with the findings of IMF (2014). Based on the estimates a 1 percent increase in private sector credits generates export diversification by 0.05.

The coefficient of trade openness is positive and significant to export diversification. This implies that the removal of obstructions to trade (policy-induced or artificial), will cause export expansion in Nigeria. Through the removal of export trade distortions, export sectors are encouraged to produce more for exports, thus leading to the optimal allocation of resources in that direction. The result corroborates that of the long-run finding, and is consistent with findings of Liu and Shu (2003), and contrast with the findings of Tule and Oboh (2017). The coefficient indicates that a 1 percent increase in export trade openness triggers export diversification in the product space

by 0.3 percent. The coefficients of output expansion and gross fixed capital formation (capital stock) are positively connected to export diversification but achieve statistical significance only at the 10 percent level. Thus, increased output composition and capital accumulation has moderate impact on export diversification in the short-run due, perhaps to the undiversified nature of output and weak capital development (particularly physical capital) in Nigeria. Apparently, output expansion and capital accumulation engender export diversification with greater impacts in the long-run than in the short-run. The coefficients of exchange rate, foreign direct investment and institutional quality are positively related to export diversification but not significant, while inflation rate is negatively related to export diversification.

Apart from the diagnostic statistics, the coefficient of the error term is appropriately negative and significant at the 5 percent level. Its coefficient of 0.70 shows that the contemporaneous speed of adjustment of export diversification to long-run equilibrium in a given year, after temporary disequilibrium caused by shocks is 82 percent.

5.6 Test of Robustness

As robustness check to confer the reliability, cogency and tenability of results obtained, sectoral allocation of credit to the export sector (CREXPS) is utilized as an alternative measure in place of credit to the private sector, and the relationship re-examined in a separate regression. This is hinged on the fact that credit allocation to the private sector may not necessary imply increase credit to the export sector, as examination of sectoral allocation of credit to the export sector, especially in less developed financial system like Nigeria, show evidence of a declining export credit even when credit to the private sector is growing. Thus, export diversification is regressed on credit allocation to the export sector as a share of GDP and other explanatory variables as robustness check in a separate regression. This would enable more focused policy prescriptions. The result is presented in Table 9.

Table 9: Results of Regressing EDI on Credit Allocation to the Export Sector and other Variables

C	*CEXPS*	*OPEN*	*GGDP*	*GFCF*	*FDI* *EXR*	*INF*	*INSTQ*
0.125	0.131**	0.2580**	0.311**	0.0284* 0.021	0.051	- 0.063	0.072

Note: ***, **, * **Statistical significance at the 1%, 5 %, and 10% level, respectively.**
Source: Author's computation

The results show that the coefficient of sectoral allocation of credit to the export sector is positively and significantly related to export diversification. Thus, increased allocation of credit and finance to the tradeable export sector has the capacity to encourage diversification, through greater productivity of export products, new product development, and efficient financing. A 1 percent increase in sectoral credit allocation to export sector triggers export diversification by 0.13 percent.

The coefficient of domestic openness is positively signed and significant. Invariably, the elimination of export trade barriers, (such as export quotas) engenders greater capacity to export and thus export diversification through product competitiveness, efficiency in scale and output and optimal allocation of resources. A unit percent increase in domestic openness encourages export diversification by 0.26 percent. The coefficient of growth rate of output is appropriately positively signed and statistically significant. Thus, output expansion, as in earlier results, enhances product variety (diversity), through greater product composition and thus, export diversification. A 1 percent output growth engenders export diversification by 0.31 percent. The coefficient of gross capital formation is positively related to export diversification and significant at the 10 percent level. Thus, improved capital stock that permits greater productivity and efficiency enhances export diversification. A 1 percent increase in domestic capital stock encourages the diversification of exports by 0.03.

Finally, the coefficient of institutional quality is positively related to export diversification and passes the significance test only at the 10 percent level. Apparently, robust institutional settings, encompassing appropriate legal and political frameworks, government effectiveness and capacity to implement policies, as well as transparency and accountability of government policies and control of corruption have moderate impact on export diversification in Nigeria. A 1 percent improvement in institutional quality stimulates export diversification by 0.07 percent.

5.7 Policy Implications of Findings

A number of important policy implications can be deduced from the empirical findings. First, improved financial development that enables greater financial intermediation in the form of credit and finance to the private sector has the capacity to stimulate the diversification of exports in Nigeria. By providing credit and finance to the exporting production sectors, export diversification is encouraged. By pooling and mobilizing of saving resources, allocating capital to productive ventures and enabling risk diversification, financial development helps to promote export diversification and safeguard the financial system from instability. On its part, export diversification mitigates economic shocks, as it enables countries build resilience to changes in

demand, arising from economic downturns in importing countries, including price dips. In the case of commodity exporting countries, it supports a shift from an over dependence on commodities to higher-value-added products and services and helps innovation as more markets become open. Diversification is also productivity-enhancing (UNCTAD, 2019). In this regard, appropriate financial development policies and strategies geared towards financing export sectors are important. Improved and efficient supervision and regulation by the monetary authority is critical in this respect.

Second, the greater the degree of domestic openness to trade, the greater the export capacity, as domestic firms are encouraged to produce more for exports. In general, a more open economy allows considerable level of exports in the product space, than in situations of trade/export restrictions. Consequently, export diversification is enhanced. Efficient and result-oriented trade policy reforms that encourages export through the elimination of export trade barriers are therefore important to stimulate export diversification in Nigeria.

Third, increased domestic and foreign direct investments are critical to export diversification. Increased capital stock encourages export diversification since it permits greater level of production and product competitiveness. Greater degree of foreign direct investment inflows, on its part, through its positive spillover effects, stimulate export through increased efficiency that induces greater production level of exportable commodities that results in export expansion. Through improved production and efficiency, greater knowledge spillovers, technological know-how, innovation, economies of scale and greater productivity that result from capital accumulation and increased foreign direct investment, export diversification is enhanced. Investment- enhancing policies (both domestic and foreign) should therefore be articulated and implemented in Nigeria through appropriate policies, initiatives and strategies.

Finally, a robust and solid institutional framework, reinforced in government capacity and effectiveness to genuinely implement policies, in addition to a stable political and corruption-free system, as well as policy transparency and accountability through institutional strengthening and reforms is critical to export diversification.

6.0 CONCLUSION

The paper has examined whether financial development (proxied by private sector credit to GDP) drives export diversification in Nigeria for the period 1980-2021. The empirical results from the ARDL approach shows that financial development is a positive and significant factor in the drive towards export diversification in Nigeria, both

in the short and long runs, respectively. Other important factors that influence export diversification in the long-run are openness of the economy to trade, gross capital formation, foreign direct investment and output expansion (measured by the growth rate of GDP). Exchange rate has a positive but non-significant impact on export diversification due the dependence of the economy on a single or few primary commodities (e.g. oil, cassava, coal, and groundnuts), with weak elasticity of demand. These products suffer secular terms of trade deterioration due to externally generated and transmitted shock in the global economy. Inflation is negatively signed with export diversification, implying that macroeconomic instability adversely affects the diversification of exports, albeit a weak effect. The institutional quality variable, which encompasses legal framework, political stability, government effectiveness, regulatory control, transparency and accountability and control of corruption, is positively related to export diversification, but not significant, due apparently to the weak institutional environment in Nigeria.

Against the backdrop of these findings, government and policy makers in Nigeria should implement robust policies that will increase the financial intermediation role in terms of increased credit channelling to the export sector. Specifically, sectoral allocation of credit and provision of finance to the export sector should be improved through concessional lending rates. In addition, there is need for increased investment in human and physical capital accumulation to stimulate the productivity of exportable products. The removal of export trade impediments, such as export tax and export quotas is also important. Finally, a robust and supportive legal and institutional framework is important to promoting the diversification of exports in Nigeria.

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REMITTANCES AND THE REAL SECTOR PERFORMANCE IN SUB-SAHARAN AFRICA

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Abstract

Over the years, sub-Saharan African governments have struggled to service their external debt. Due to the high cost of foreign debt and its impact on economic development, countries in the region must create other means such as remittance to finance development to reduce reliance on external borrowing. Therefore, this study examines the impact of remittances on the real sector in sub-Saharan Africa from 1990 to 2018. The study employs panel data of 32 sub-Sahara African countries for estimation. The study adopts Industrial value-added, agricultural value-added, total factor productivity, and service value-added as proxies for the real sector. The findings show that remittances has significant impact on all real sector proxies except agricultural value-added in the model with control variables. In the model without control variables, remittances has significant effect on industrial value-added and total factor productivity. The policymakers in the region should ensure that remittance funds are properly utilised to further enhance the productivity of the real sector to achieve sustainable economic growth.

Keywords: Remittances; real sector, panel data, sub-Saharan Africa
Jell Classification: F24, O47, C23, O55

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1.0 INTRODUCTION

The external debt levels of sub-Saharan Africa (SSA) countries have risen significantly during the last few decades. The rapid growth of external debt raises concern among policymakers, as the debt burden is becoming a threat to the region's prosperity. According to Senadza, Fiagbe, and Quartey (2017), sub-Saharan Africa's total external debt in 1990 was US$176.36 billion. However, overall external debt climbed to US$235.94 billion in 1995, indicating a jump from 58.2 percent to 72.0 percent of regional GDP. At the end of 2010, the total external debt was US$269.08 billion. The external debt climbed to US$367.51 billion in 2013, according to the World Bank (2015). The overall external debt has risen to US$ 625 billion in 2019. According to Heitzig, Ordu and Senbet (2021), with the impact of COVID-19, the debt burden could become considerably greater in the coming years unless immediate action is taken in the region. The Covid-19 pandemic has had adverse impact on the sub-Saharan African economy. Economic activity has slowed, resulting in drop in GDP. Oil exporters in sub-Saharan Africa are currently seeing a drop in revenue. Other countries that export different commodities are also seeing significant declines. The countries that rely on tourism aren't happy. Therefore, the region might need other sources of finance apart from borrowing to stimulate the economy and achieve constant economic growth.

Remittances can be one of the viable sources of financing development in sub-Saharan Africa. For more than a decade, remittances have dominated total international money flows. According to Giuliano and Ruiz-Arranz (2005), Kadozi (2019), and Olayungbo and Quadri (2019), remittance inflows to developing nations have surpassed other significant sources of revenue such as export earnings, foreign direct investment (FDI), and foreign aid. Due to the significant increase in remittance inflows, various studies have been conducted to evaluate the impact of remittance on economic growth. For example Pradhan, Upadhyay and Upadhyaya, (2008), Fayissa, (2016), Garba, Adekunle and Adeniyi, (2020) and Kadozi, (2019), have examined the effect of remittance on economic growth. Even though studies on the relationship between remittances and economic growth abound in the literature, studies have not really focused on the impact of remittances on the real sector in sub-Saharan Africa. A very close study is Asongu and Odhiambo, (2021) who investigates the relationship between remittances and value-added across economic sub-sector in sub-Saharan Africa. This study intends to fill this gap in the literature by examining the impact of remittances on the real sector performances in sub-Saharan Africa. Remittance can help the real sector thrive in a variety of ways. First, remittance can be used to fund consumer spending, which can lead to a rise in demand for real-estate goods and services (Matuzeviciute and Butkus, 2016). Due to the multiplier effect on output, an increase in demand is extremely favourable to industries. Second, because the real

sector is one of the economy's components, remittances have the ability to expand real sector investment prospects. The real sector is made up of individuals and other business agents who participate in economic activities to generate goods and services to satisfy public demand. If households invest a significant portion of their remittance in the real sector, remittance can boost investment in the real sector. According to the permanent income hypothesis, households treat remittances as transitory money and are more likely to save and invest a larger portion of remittances in the real sector than other sources of family income (Chowdhury, 2016).

The purpose of this study is to examine the impact of remittances on the real sector in sub-Saharan Africa. This research adds to the body of knowledge in the following ways. First, this study presents empirical evidence of the impact of remittances on the real sector productivity in sub-Saharan Africa. In the literature, the real sector has received little attention despite that the real sector is where resources and raw materials are combined to produce goods and services which determines the level of output. Previous studies focused on the impact of remittances on aggregate output without taking into account that remittances might need to enhance the productivity of the real sector before it can enhance economic growth. Therefore, this study focuses on sub-Saharan Africa to address the question of whether remittances boost productivity in the industrial, agricultural, service sectors and total factor productivity of the economy. This is necessary as employment and output are decreasing while many manufacturing and industrial organisations are collapsing (Ozurumba and Anyanwu, 2015 and Akinlo, Yinusa and Adejumo, 2021) as remittances inflow is increasing. In addition, the inflow of remittances into sub-Saharan Africa has significantly increased in the past decade according to Asongu *et al*. (2019) and Efobi *et al*. (2019). The inflow of remittances into sub-Saharan Africa is higher than other regions like Latin America and the Caribbean; Europe and Central Asia and East Asia and the Pacific. This makes the choice of sub-Saharan African region for this study interesting as this study reveals whether the inflow of remittances is beneficial to the growth of the real sector or not. Second, according to World Development Indicator (2019), the real sector is the least developed and less productive among the regions. Developing the real sector is one of the ultimate aims of the policymakers in the region since the aggregate output of the economy depends on the productivity of the real sector. Therefore, knowing the relationship between remittances and the real sector will assist the policymakers to formulate policies that can help in channelling remittances to investment in the real sector and hence boost the productivity of the real sector. It would also provide adequate information for the policymakers to make adequate policy decisions that can increase the growth and transformation of the real sector in the region.

The research is organised in the following order. Following the introduction section is the second section which presents the review of the literature. The third section focuses on the overview of the data. The fourth section provides the theoretical framework and methodology used in the study. The fifth section presents the results of the study while section six concludes the study.

2.0 Literature Review

Evidence from the literature reveals that research that focused on the relationship between remittance and economic growth can be classified into two categories. The first category includes the research that focused on the effect of remittances on economic growth. The second category includes studies that looked at the causal relationship between remittances and economic growth. Starting with the first category, Vargas-Silva et al. (2009) evaluates the impact of remittances on economic growth in 20 Asian nations between 1988 and 2007. Remittances have a positive impact on economic growth, according to the study. Ahortor and Adenutsi (2009) evaluates the influence of remittance on economic growth between 1996 and 2006 in 31 countries from Africa, Latin America, and the Caribbean. Remittances boosted economic growth, according to the study. Similarly, in a study that included 80 countries and spanned the years 1970 to 2004, Barajas et al. (2009) examines the link between remittances and economic growth. However, contrary to previous research outcomes, the study finds a negative link between remittances and economic growth. Chami et al., (2003), one of the first studies to look at the influence of remittances on economic growth, showed that remittance had negative impact on economic growth. Panel OLS techniques were utilised in the study, which included 113 nations and spanned the years 1970 to 1998. Similarly, Karagoz, (2009) uses OLS techniques on a sample from 1970 to 2005 to confirm negative association between remittances and economic growth in Turkey. Fayissa and Nsiah, (2010) investigates the aggregates impact of remittances on economic growth within conventional neo classical framework using panel data of 36 sub-Saharan African countries from 1980 to 2004. The study found positive relationship between remittances and economic growth. Using balanced panel data from 1977 to 2016, Sutradhar, (2020) explores the impact of workers' remittances on economic growth in four South Asian rising countries. The impact of remittances is estimated using pooled OLS, fixed effects, random effects, and dummy variable interaction models. Remittances has detrimental impact on economic growth in Bangladesh, Pakistan, and Sri Lanka, according to empirical regression study. Remittances, on the other hand, has positive impact on India's economic growth. Ekanayake and Moslares (2020) examines the effects of workers' remittances on economic growth and poverty in 21 Latin American nations for the period 1980–2018. Panel least squares and panel fully-modified least squares (FMOLS)

approaches were used in this investigation. The study also uses the Autoregressive Distributed Lag (ARDL-ECM) approach to co-integration analysis to evaluate the short- and long-run effects of workers' remittances on economic growth and poverty in individual nations. The findings show that remittances from employees have positive long-run impact on economic growth in the majority of the nations investigated, but have mixed effect in the short-run. Abduvaliev and Bustillo (2020) investigates the impact of remittances on CIS countries' economic growth and poverty reduction. The study uses a panel data set including estimates of economic growth and poverty in ten former post-Soviet republics, namely the Commonwealth of Independent States (CIS). According to the report, a 1% increase in remittance flows increases per capita GDP by 0.25 percent on average.

On the other category, Jawaid and Raza (2012), examines the relationship between worker remittances and economic growth in China and Korea from 1980 to 2009. To test for Granger causality between the variables, the researchers used the Vector Error Correction Model (VECM). In the instance of Korea, the analysis discovered positive cointegrating association between remittances and economic growth, but in the case of China, the study discovered a negative cointegrating relationship. In both Korea and China, the analysis found a unidirectional causality between worker remittances and economic growth. Using data from 1976 to 2006, Siddique, Selvanathan, and Selvanathan (2012) explored the causal link between remittances and economic growth in Bangladesh, India, and Sri Lanka. The study found a unidirectional causality between remittances and economic growth in Bangladesh using a Vector Autoregression (VAR) technique. In India, there was no causal relationship between remittances and economic growth, however, in Sri Lanka, there was bidirectional causation between remittance and economic growth. In Ethiopia, Yadeta and Hunegnaw (2021) investigated the short and long-run links between remittances and economic growth, as well as the nature of causality. The ARDL model and the Granger causality test were used in this investigation, which spanned the years 1980 to 2015. In the long run, remittance had a beneficial influence on economic growth, but in the short run, it had the opposite effect. In terms of causality, the study discovered a one-way relationship from remittance to economic growth.

It is evident from the literature that most of the studies either focus on the relationship between remittances and economic growth or the causality between remittances and economic growth. It is also obvious that there is no consensus in the literature as some studies found negative relationship between remittances and economic growth while some studies found positive relationship. We can also deduce from the literature

review that studies are not paying attention to the effect of remittances on the productivity of the real sector.

3.0 DATA AND DATA SOURCE

3.1 Data on Remittance

This study covers the period from 1990 to 2018 and uses annual data for 32 countries in sub-Saharan Africa. One of our key variables in this study is personal remittances. Personal remittances include personal transfers and the compensation of employees. Personal transfers comprise all current transfers in cash or in-kind made or received by resident households to or from non-resident households. It has to do with current transfers between residents and non-residents. Employee compensation refers to the earnings of the border, seasonal, and other short-term workers engaged in a non-resident economy, as well as residents employed by non-resident organisations. Personal remittance is measured as a percentage of GDP. We obtained data on remittance from World Development Indicators.

3.2 Data on real Sector

This study proxied the real sector of the economy by four sectors. The agriculture value-added ratio to GDP is the first indicator of the real sector. This includes value-added activities such as forestry, hunting, fishing, cereal cultivation, and livestock rearing. The choice of agriculture value-added is based on the fact that agriculture employs the bulk of the population in sub-Saharan African countries and is also a source of foreign exchange revenues. The industrial value-added ratio of GDP is the second real sector proxy. We choose industrial value-added because industrial economic activities are the primary source of revenue for the majority of Sub-Saharan African countries. Other studies, such as Ductor and Grechyna (2015) and Akinlo (2020), used industrial value-added as a proxy for the real sector. The third proxy for the real sector is the service value-added as a percentage of GDP. We choose service value-added as a proxy for the real sector because of its increasing proportion to total output in recent years. The fourth proxy for the real sector is total factor productivity (TFP). The Penn World Table database uses TFP as a standard productivity measurement (Feenstra et al., 2015). Meniago and Asongu, (2019), Asongu, (2020) and Akinlo et al., (2020) used total factor productivity as a proxy for productivity. Data on agricultural value-added, industrial value-added and service value-added are obtained from World Development Indicator while data on total factor productivity is obtained from The Penn World Table database.

3.3 Control Variables

Other common growth literature variables are included in the estimations to act as control variables. The first is gross capital formation as a percentage of gross domestic product (GDP). The government expenditure, which is the final government consumption expenditure, is the second. The domestic credit to the private sector (DCP) to GDP ratio is the third. The entire amount of credit made accessible to the private sector by banks and other financial institutions is referred to as domestic credit to the private sector. This indicator measures the financial institution's depth. The fourth indicator is the annual population growth rate for year t refers to the exponential rate of growth of the mid-year population from year t-1 to t, expressed as a percentage. The last control variable is the political institution which is measured by polity IV. The Polity IV data is obtained from the polity iv dataset constructed by Marshall et al., (2018). It measures the degree of democracy and autocracy and is scaled from -10 to 10. A score of 10 signifies a strong democratic system while -10 represents a high level of autocracy. The summary of the variables is presented in table 1 below.

Table 1: Descriptive statistics

Variables	Mean	Std. Dev.	Min	Max	Obs
Agricultural value-added	22.816	13.973	1.828	61.416	907
Industrial value-added	24.723	11.503	4.556	77.414	903
Service value-added	45.603	10.304	12.435	77.020	891
Total factor productivity	0.486	0.245	0.099	1.494	700
Domestic credit to private sector	19.461	24.562	0.403	160.125	880
Remittance	4.180	13.655	0.001	167.432	822
Gross capital formation	20.696	8.811	-2.424	58.188	907
Government Expenditure	15.378	6.490	0.911	47.197	909
Population growth	2.332	1.078	6.766	8.118	928
Polity IV	1.487	5.888	-10	10	899

4.0 THEORETICAL FRAMEWORK AND METHODOLOGY

4.1 Theoretical Framework

This section focused on the theoretical background on the relationship between remittances and the real sector. Based on intuition, according to studies like Efobi *et al*., (2019), Beck, Demirgüç-Kunt and Levine (2007) and Tchamyou (2020), remittances can provide access to financial resources for the real sector when there is no access to formal financial services. According to studies such as Kusi and Opoku-Mensah

(2018), Asongu et al. (2018) and Asongu and Odhiambo (2021), this is very important as the existence of information asymmetry in sub-Saharan Africa and other constraints to financial access can limit the economic agents in the real sector to have adequate access to finance in the financial institutions. Remittance has been classified as a major part of international capital movement and is seen as a major source of economic growth based on its importance, according to Iheke (2012) and Loto and Alao (2016). In a traditional neoclassical growth model, the role of remittances has been incorporated as a source of growth. The following are some of the theories about economic migrants' remittances: To propel the economy forward, we have the Classical doctrine, which beliefs in capital transfer and industrialization to poor countries. The Neoclassical idea assumed that in migrant-sending societies, marginal labour productivity and wage levels would rise. Migration and remittances, according to Neo-Marxist theory, will promote and support the capitalist manner of dealing with inequalities. The motives for drive remittances are directly tied to the Cyclical Remittance Theory. Motives also have direct ramifications for the timing, volume, and distribution of goods and services among countries and their economic states, whether the receiving or donor country. Pure Altruism theory states that remittances can enhance economic growth as migrants remit money back home in concern of the welfare of the remaining family members (Hagen-Zanker and Siegel, 2007; OECD, 2006). Remittances are "compensatory transfers," according to the theory because they increase when the migrant's home country experiences economic disruptions such as droughts or a financial crisis (Chami et al., 2003). As a result, the compensatory character of remittances under the Pure Altruism model indicates that remittances are countercyclical, meaning that they increase when economic conditions in the business cycle deteriorate (Vargas-Silva, 2008; Chami et al., 2003). Pure Self Interest theory states that the inflow of remittances increases due to the good economic condition of the recipient country, which implies that at times remittances are not always countercyclical. According to the theory, there may be positive relationship between remittance volumes and home country economic performance, with low volumes of remittances resulting from poor economic conditions. According to Lucas and Stark (1985), remittances might also be motivated by migrants' self-interest. Migrants remit money in this context in order to invest in or inherit assets back home, as well as to return home with dignity.

4.2 Model

To explores the relationship between remittances and the real sector, we follow Giuliano and Ruiz-Arranz (2006) to specify our model as follows;

$$y_{i,t} = \beta_1 y_{i,t-1} + \alpha_1 rem_{i,t} + \alpha_3 X'_{i,t} + \mu_i + \varepsilon_{i,t} \quad 1$$

From this equation 1, $y_{i,t}$ stands for the real sector for country *i* at the period t. $y_{i,t-1}$denotes the real sector lagged by one period. $rem_{i,t}$ denotes personal remittances. $X'_{i,t}$ is the vector of control variables that are associated with the real sector. μ_i signifies country-specific effect, $\varepsilon_{i,t}$ is the error term.

Remittance has become a major source of income in developing countries for a decade now (Giuliano and Ruiz-Arranz, 2005). It was recognised during the UN Third International Conference in Addis Ababa in 2015 that remittance is a significant source of income for families in developing countries (Sobiech, 2019). An increase in income is a potential for an increase in investment in the real sector. We expect remittances to contributes significantly to the real sector's growth.

We employ certain variables that are regularly used in the literature on the real sector as control variables. Gross capital formation is one of these variables. The real sector and gross capital formation are expected to have a positive association. The availability of infrastructure is critical to the success of the real estate business. The availability of infrastructure, according to Bello and Osinubi (2016), determines whether the real sector succeeds or fails. The effect of gross capital formation can be positive or negative in this study. This is based on deficient infrastructural facilities in sub-Saharan African countries.

Other important variables like government expenditure, population growth and polity IV (political institution) are also included as control variables. Whether government expenditure will stimulate the real sector or not depends on the direction of the government spending. If the government is spending more on recurrent expenditure, the effect of government expenditure might be negative. However, if the government is spending more on infrastructure which can enhance productivity, the effect of government expenditure can be positive. Hence, we expect the effect of government expenditure to be positive or negative. Polity IV captures the impact of political institutions on the real sector. This is included to capture the impact of political rights. Acemoglu and Robinson (2012) emphasised the importance of institutional quality. Lack of political rights can limit the security of life and property and thereby limiting the rate of accumulation and investment in the real sector. Polity IV may harm productivity due to the low level of institutional quality measures in the region.

We use the two-step system GMM based on the dynamic structure of the model coupled with the specification of the panel data in which the number of countries (N) > period (T) (Arellano and Bover, 1995; Blundell and Bond, 1998). One of the major

advantages of this method is that it allows for weakly exogenous regressors and takes account of the endogeneity of the lagged dependent variable at the same time. Moreover, it models initial observations for the sake of including the first period. To include as many observations for unbalanced panels as possible, forward orthogonalization can be used instead of first differences.

The second lags of endogenous variables are used, which is consistent with economic growth literature. Exogenous variables (control variables) act as instruments in and of themselves ("ivstyle"). To maintain the overall number of instruments at a manageable level, the "collapse" option is employed. This means that the GMM is set up so that instrumental variables (iv or ivstyle) capture the strictly exogenous factors, while gmmstyle articulates the endogenous explanatory variables. We keep the number of instruments below the number of groups to avoid the problem of having too many instruments.

We employ two vital criteria to determine the validity of the estimated models. First, the null hypothesis of the first-order autocorrelation test (AR(1)) for the presence of autocorrelation must be accepted. The null hypothesis of the second-order autocorrelation test (AR (2)) for the absence of autocorrelation in the residuals must not be rejected. Second, the *p*-values of Hansen over-identification restrictions tests should not be significant because their null hypotheses are the positions that instruments are valid or not correlated with the error terms.

5.0 EMPIRICAL RESULTS

We present the results of the effect of remittances on the real sector in tables 2 and 3. In table 2, we present the result of the effect of remittances on the real sector without the inclusion control variables while in table 3, we include control variables in the estimation. Both tables 2 and 3 have four columns, in the first column, industrial value-added is used as the dependent variable. In the second column, agricultural value-added is used as the dependent variable. Total factor productivity and service value-added are used as dependent variables in the third and fourth columns respectively. At the lower part of the tables, we present the results of the diagnostic tests. For instance, the p-values for the Hansen test for the null hypothesis of the validity of the overidentifying restrictions. In all the estimations we do not reject the null hypothesis as the p-values of Hansen is insignificant. Regarding the p-values for AR(1) (first-order autocorrelation and AR(2) (second-order autocorrelated), the first-order autocorrelation is present while there is no evidence for significant second-order autocorrelation. This implies that our test statistics hint at a proper specification.

In the first column of table 2, remittances has positive and significant effect on industrial value-added. This implies that remittances contribute to industrial value-added. Remittances fails to enhance agriculture value-added as its coefficient is insignificant in the second column. Remittances contributes to total factor productivity as its coefficient is positive and significant at 1% in the third column. In the last column, the coefficient of remittances is insignificant which indicates that remittances has no effect on service value-added.

Table 2: The effect of remittance on the real sector (without control Variables)

	Industrial value-added model	**Agriculture value-added model**	**Total Factor Productivity model**	**Service value-added model**
Lagged Industrial value-added	0.888*** (0.000)			
Lagged Agriculture value-added		1.0059*** (0.000)		
Lagged Total Factor Productivity			0.957*** (0.000)	
Lagged Service value-added				1.023*** (0.000)
Remittances	0.145*** (0.000)	-0.010 (0.763)	0.006*** (0.000)	0.032 (0.635)
AR(1)	(0.081)	(0.001)	(0.005)	(0.000)
AR(2)	(0.912)	(0.454)	(0.495)	(0.610)
Hansen test	(0.253)	(0.427)	(0.488)	(0.464)
No of instruments	22	22	22	22
No of observation	791	791	590	775
No of countries	32	32	32	32

***, indicate significance at 0.01%. The probability values are in brackets. The Hansen test report the p-values for the null hypothesis of instrument validity. AR(1) and AR(2) are the first-order and second-order autocorrelations. The values reported for AR(1) and AR(2) are the p-values for first and second order autocorrelated disturbances in the first differences equations.

Table 3 presents the results of the effect of remittances on the real sector with the inclusion of control variables as we indicated earlier. Our key variable of interest, remittance, increases industrial value-added because its coefficient is positive and

significant at 1%. Remittance can be used as a source of alternative financing to boost industrial value-added. Remittance has negative impact on agriculture value-added in the second column, as its coefficient is negative and significant. This contrasts with the findings of Asongu and Odhiambo (2021), who found no influence of remittance on agricultural value-added. This finding suggests that remittances are harmful to agricultural value-added. One possible explanation is that remittance is not invested in the agricultural sector. This is not surprising as the agricultural sector has been suffering from insufficient funding over the years which has led to a decline in the productivity of the sector. For instance, Akpan, Okon and Udoka (2014) found that the growth rate of remittances is faster than those of indicators of agricultural productivity in their study. However, in the fourth and fifth column, remittances contributes to the growth of total factor productivity and service value-added respectively. According to UNCTAD (2013), remittance receipts can promote TFP growth through effects on the efficiency of domestic investment as well as through effects on the size of domestic productive sectors that generate dynamic production externalities.

Table 3: The effect of remittance on the real sector (with control variables)

	Industrial value-added model	Agriculture value-added model	Total Factor Productivity model	Service value-added model
Lagged Industrial value-added	0.884*** (0.000)			
Lagged Agriculture value-added		1.039*** (0.000)		
Lagged Total Factor Productivity			0.861*** (0.000)	
Lagged Service value-added				1.028*** (0.000)
Remittances	0.150*** (0.000)	-0.092*** (0.000)	0.001*** (0.000)	0.159*** (0.000)
Gross capital formation	0.116*** (0.000)	-0.104*** (0.000)	-0.002*** (0.000)	-0.027*** (0.000)
Financial Development	0.054*** (0.004)	-1.008* (0.072)	0.001*** (0.000)	0.001 (0.989)
Government expenditure	-0.102*** (0.000)	0.150*** (0.000)	0.002*** (0.000)	0.026*** (0.000)

Population	0.307*** (0.001)	-0.592*** (0.000)	0.023*** (0.000)	0.867*** (0.000)
Polity IV	-0.070 (0.827)	0.023** (0.076)	-0.001 (0.391)	-0.024 (0.660)
AR(1)	(0.088)	(0.001)	(0.012)	(0.001)
AR(2)	(0.961)	(0.395)	(0.495)	(0.645)
Hansen test	(0.689)	(0.584)	(0.878)	(0.727)
No of instruments	28	28	28	28
No of observation	711	711	545	695
No of countries	32	32	32	32

***, **, and * indicate significance at 0.01%, 0.05%, and 0.10%. The probability values are in brackets. The Hansen test report the p-values for the null hypothesis of instrument validity. AR(1) and AR(2) are the first-order and second-order autocorrelations. The values reported for AR(1) and AR(2) are the p-values for first and second order autocorrelated disturbances in the first differences equations.

On the control variables, gross capital formation enhances the growth of industrial value-added. However, its effect on agriculture value-added, total factor productivity and service value-added are negative. This implies that gross capital formation is detrimental to the growth of all the proxies of the real sector except industrial value-added. Financial development contributes to the growth of industrial value-added and total factor productivity. However, while its effect is harmful to agriculture value-added, it produces no effect on service value-added. Ibrahim and Vo (2020) found that financial development contributes to industrial value-added in sub-Saharan Africa while Han and Chen (2015) and Ezzahid and Elouaourti (2018) found positive a relationship between financial development and total factor productivity. Government expenditure contributes to the growth of the real sector except when the real sector is proxied by industrial value-added. Population growth contributes significantly to industrial value-added, total factor productivity and service value-added. On the contrary, population impacts agriculture value-added negatively. The effect of political institution is significant when the real sector is proxied by agriculture value-added while it has no effect on other proxies of the real sector.

6.0 CONCLUSION AND RECOMMENDATIONS

This study investigates the impact of remittance on the real sector in sub-Saharan Africa. The empirical analysis is carried out with the help of the GMM system. The analysis uses annual data for 32 nations in sub-Saharan Africa from 1990 to 2018. Industrial value-added, agricultural value-added, total factor productivity, and service

value-added are used as indicators of the real sector. The baseline results show that remittances enhances industrial value-added and total factor productivity but has no effect on agriculture value-added and service value-added. The result from the system GMM estimates with control variables indicates that remittances contributes to industrial value-added, total factor productivity and service value-added while it exerts a negative effect on agriculture value-added. This finding shows that remittances can play a significant role in the growth of the real sector in sub-Saharan Africa by supplementing diminishing external sources of capital in the form of foreign aid, foreign direct investment, and/or private investments. Furthermore, remittance might be used as a substitute for foreign borrowing, which has become a burden in the region. Therefore, improving the inflow of remittances into the region's countries should be a top priority. A strong finance system, for example, can encourage remittance inflows to sub-Saharan African countries. It can also help to reduce transaction costs and channel remittances to investments that will generate the highest returns, boosting real sector growth rates. Based on the detrimental impact of remittances on agricultural value-added, policymakers in the region should divert more remittance funds to help the agricultural sector's development. Inadequate infrastructure and low production plague the agricultural sector. More investment in the sector will boost its contribution to economic growth while also lowering poverty levels in the region.

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DOES TAX REVENUE MATTER FOR ECONOMIC GROWTH? EVIDENCE FROM WEST AFRICA

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Abstract

This paper investigates the relationship between tax revenue and economic growth using panel data from 12 West African countries for 2005 to 2020 period. The Panel Autoregressive Distributed Lag (ARDL) model reveals that tax revenue has a positive and statistically significant effect on economic growth in the long run. An increase in tax revenue by 1 percent would increase economic growth by 14.5 per cent, ceteris paribus. In addition, the results indicate that taxes on income, profits, and capital gains have a positive and statistically significant effect on GDP per capita growth in the long run. On the contrary, the results further indicate that taxes on international trade and on goods and services do not exert statistically significant effects on GDP per capita growth in the long run. Thus, based on the findings, the study recommends that governments of West African countries should strengthen efforts to curb leakages in tax revenue generation. The study also recommends that fiscal authorities should widen the tax base by formalizing the informal sectors, where the bulk of earned incomes, profits and capital gains are untaxed. Fiscal authorities should also increase broad-based consumption taxes regarding goods and services (GST) or value-added tax (VAT). Lastly, the study recommends that governments in West Africa should minimize their over reliance on international trade taxes, since they do not positively influence GDP per capita growth. The study observes that implementation of these policies would thrive in an environment where macroeconomic stability and economic diversification exist.

Keywords: Tax Revenue, Economic Growth, Panel ARDL, PMG Estimator, West Africa
JEL Classification: C13, E62, H20, O40, O55

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1.0 INTRODUCTION

Today, many developing countries, especially in Africa, cannot adequately finance their development programs to meet the needs of their populations due to huge financing constraints. In West Africa, for instance, the average tax revenue as a percentage of Gross Domestic Product (GDP) over the last two decades stands at 14.4 per cent, which is below the minimum 15 per cent threshold for economic growth and, by extension, poverty reduction according to the World Bank. In addition, the low levels of domestic resource mobilization have forced countries in the sub-region to finance public spending either through aid flows or borrowing from external and domestic sources. Thus, these countries face debt distress and crowding out private investment. Hence, domestic resource mobilization is considered the best development financing strategy amid rising debt levels and volatile external financing (aid flows). However, it is unclear what impact the mobilization of tax revenues is likely to have on Africa's economic growth and West Africa particularly.

A wealth of literature highlights the relationship between tax revenue and economic growth, but there has been no consensus. The Neoclassical Growth Model by Solow (1956) provided a theoretical basis for estimating the effect of tax revenue on economic growth. It however suggested that tax policies do not impact long-run growth. In contrast, empirical growth models anchored on the Endogenous Growth Theory, led by Romer (1990) suggested that tax policy and government spending have permanent growth effects. Thus, according to Myles (2009), it is better to apply the theory to data to investigate the nature of tax-growth linkages.

Of particular interest for this paper is to build on the abundant literature to examine the relationship between tax revenue and economic growth in West Africa. Notably, this study covers the effects of tax revenue, taxes on incomes, profits, and capital gains, taxes on goods and services, and taxes on international trade on economic growth in 12 West African countries[2]. To the extent that countries in the sub-region faced difficulty to improve development outcomes following the Ebola epidemic in selected countries in 2014 and the COVID-19 pandemic, the mobilization of domestic revenues through taxes is essential and seems imperative for financing development. However, how beneficial the current tax structure is to growth or what effects taxes would have on growth in the sub-region remains unanswered. Thus, this study

[2] Benin, Bukina Faso, Cabo Verde, Cote d'Ivoire, The Gambia, Ghana, Guinea, Liberia, Mali, Senegal, Sierra Leone, Togo.

contributes to the discussion about taxation and economic growth, emphasizing that West Africa, as countries in the sub-region embarked on reforms aimed at domestic resource mobilization in the face of rising debt levels and dwindling aid flows. Specifically, the contribution of this study is to analyze the impact of tax revenue on growth broadly, but also to analyze the effects of specific types of taxes including taxes on income, profits, and capital gains, taxes on goods and services, and taxes on international trade on economic growth in 12 of the 15 West African countries using a panel ARDL model from 2005 to 2020.

In the following sections, we present the literature review (Section 2), whilst Section 3 describes the data and the estimation method. Also, we show and discuss the empirical results in Section 4, and Section 5 offers the paper's conclusion.

2.0 LITERATURE REVIEW

The literature suggests no consensus on the relationship between tax revenue and economic growth (Myles, 2000). They show that taxes can have negative and positive effects on economic growth and limited or no growth effects in other circumstances (Milesi-Ferretti and Roubini 1998 and Baxa, 2010). The Neoclassical Growth Model of Solow (1956) suggested that tax policies have no impact on long-term growth. Also, the Endogenous Growth Theory pioneered by Romer (1986) and Lucas (1988) helped capture the effects of taxation on growth and argued that the level of taxation or composition of tax can affect economic growth. Several studies reported negative relationship between taxation and economic growth (Koester and Kormendi, 1989; Easterly and Rebelo, 1993; Engen and Jonathan, 1996; Ma, 2001; Padovano and Galli, 2001; Tomljanovich, 2004; Bania et al., 2007; Poulson and Kaplan, 2008; Arnold, 2008; Dackehag and Hansson, 2012; and Ferede and Dahlby, 2012).

In contrast, few studies found a direct relationship between taxes and economic growth (Kocherlakota and Yi, 1997; Lee and Gordon; 2005, and Martinez-Lopez, 2005). In addition, some studies indicated that the growth effects of taxes depend on other factors such as the tax system or tax structure. For example, countries with efficient tax administration that collect revenues from a broader tax base are likely to grow faster than those with a limited tax base and inefficient tax administration (Easterly and Rebelo, 1993; Mendoza, Milesi- Ferretti and Asea, 1995; Engen and Jonathan, 1996). According to Fjeldstad (2013), an effective tax system is crucial for sustainable growth and development as it helps developing countries mobilize domestic revenue and reduce both aid and natural resource dependency. Also, the uses of taxes to finance certain public investments, such as spending on infrastructure, education, health, are likely to have positive growth effects (Lucas, 1988; Barro,1990). Worlu and Emeka (2012)

also found that tax revenue drives economic growth through infrastructural development. On the other hand, Tomljanovich (2004) found a somewhat ambiguous and uncertain relationship between taxes and economic growth.

Nantob (2014) analyzed the effects of taxes on economic growth in 47 developing countries, considering taxes revenue generally and other specific types of taxes, including taxes on goods and services, income, profits, capital gains, and international trade. The results indicated that taxes on income, profits, capital gains, and taxes on international trade lowered economic growth in the short run, but the effects lessened over time as these taxes increased.

Aregbeyen and Fasanya (2013) investigated the link between tax revenue and economic growth in Nigeria during the period 1970- 2010. The dynamic Ordinary Least Square (OLS) technique was employed. The results obtained indicate that total tax had a positive but insignificant impact on economic growth though the impacts of most of its components were significant. However, considering the study's sample size of 41 observations, the estimated coefficients of total tax and its components would be relatively less reliable compared to the estimated coefficients, if the ARDL model was employed. This is because whilst a large data set is necessary in order to obtain reliable results with the OLS technique, the ARDL model does not require a large data set to obtain reliable results.

The dearth in the literature reviewed above indicates that not many studies have been conducted using the West African sub-region as a scope to analyze the effect of tax revenue on economic growth. In view of this, the study therefore attempts to fill the gap in the literature by analyzing the effect of tax revenue on economic growth in the West African sub-region.

3.0 METHODOLOGY

3.1 The Model

Following Pesaran, Shin, and Smith (1999), suppose that given data on time is, *t*=1, 2,…, *T*, and groups, *i*=1, 2,…, *N*, then the generalized ARDL (p, q, q,…q) model is specified as:

$$y_{it} = \sum_{j=1}^{p} \delta_i y_{i,t-j} + \sum_{j=0}^{q} \beta'_{ij} X_{i,t-j} + \varphi_i + \varepsilon_{it} \quad (1)$$

where y_{it} is the dependent variable, $(X'_{it})'$ is a k x 1 vector that is allowed to be purely I(0) or I(1) or co-integrated, δ_i is the coefficient of the lagged dependent variable called scalars, β_{ij} are the k x 1 coefficient vectors, φ_i is the unit-specific fixed effects, *p*

and *q* are the optimal lag orders, and ε_{it} is the error term. Thus the re-parameterized ARDL (p, q, q,…q) Error Correction Model is specified as:

$$\Delta y_{it} = \theta_i\left[y_{i,t-1} - \lambda'_i X_{i,t}\right] + \sum_{j=1}^{p-1} \xi_{ij}\, \Delta y_{i,t-j} + \sum_{j=0}^{q-1} \beta'_{ij}\, \Delta X_{i,t-j} + \varphi_i + \varepsilon_{it} \quad (2)$$

where θ_i is the group-specific speed of adjustment coefficient and expected to be less than zero, λ'_i is a vector of long-run relationships, ECT is the error correction term specified as $\left[y_{i,t-1} - \lambda'_i X_{i,t}\right]$, ξ_{ij} and β'_{ij} are the short-run dynamic coefficients, and ε_{it} is the error term. Therefore, this general specification can be adapted to estimate the empirical model as follow:

$$\Delta GDP_{it} = \theta_i\left[GDP_{i,t-1} - \lambda'_i X_{i,t}\right] + \sum_{j=1}^{p-1} \xi_{ij}\, \Delta GDP_{i,t-j} + \sum_{j=0}^{q-1} \beta'_{ij}\, \Delta X_{i,t-j} + \varphi_i + \varepsilon_{it} \quad (3)$$

where GDP_{it} denotes GDP per capita growth (annual percent) in *i* country at time *t*, X_{it} indicates the set of control variables in *i* country at time *t*: trade openness, foreign direct investment, net official development assistance, and inflation, θ_i is the group-specific speed of adjustment coefficient, λ'_i is a vector of long-run relationships, $\left[GDP_{i,t-1} - \lambda'_i X_{i,t}\right]$ is the error correction term (ECT), ξ_{ij} and β'_{ij} are the short-run dynamic coefficients, and ε_{it} is the error term.

3.2 Panel Unit Root Test

We conduct a unit root test to ascertain the order of integration of the variables prior to selecting the type of estimator (MG, PMG, or DFE) to analyze the relationship between tax revenue and economic growth. We use Im, Pesaran, and Shin (IPS) (2003) panel unit root test to assume heterogeneous slopes. Also, the IPS test deals well with gaps in data series compared with Levin and Lin's (1992, 1993) test, which assumes that the panel data comprises homogeneous cross-sections when conducting a test on the pooled data series.

Im, Pesaran, and Shin (2003) stated that to conduct the IPS test in panel data, the average of the Augmented Dickey-Fuller (ADF) tests assume that the μ_{it} is serially correlated, and the correlation properties vary across sections. Thus, when the iid assumption is relaxed for μ_{it}, $\mu_{it} = \sum_{j=1}^{p_i} \varphi_{ij}\, \mu_{it-j} + \varepsilon_{it}$, the following model for the panel unit root test is:

$$y_{it} = \rho_i y_{i,t-1} + \sum_{j=1}^{p_i} \varphi_{ij}\, \Delta y_{it-j} + z_{it}\gamma + \varepsilon_{it} \quad (4)$$

the null hypothesis is $H_0 = \rho_i = 1$ for all *i,* and the alternative hypothesis is $H_a = |\rho_i| < 1$, for at least one *i*. This test depends on the autoregressive properties of each cross-section, which is the average of the individual ADF statistics. Finally, the Bayesian Information Criterion (BIC) or the Akaike Information Criterion (AIC) is used to select the augmentation order for the ADF test in each cross-section.

3.3 Optimal Lags Selection and Hausman Test

After performing the unit root test to ensure that no variable integrates at order 2, the next step is to determine the optimal lags using the unrestricted model and an information criterion, either BIC or AIC, to decide the choice lags for each unit or group per variable. Thus, we chose the most common lag for each variable for the model. The cointegration results are determined from the statistical significance of the long-run coefficients due to the assumption of long-run homogeneity. Thus, the cointegration is the joint significance of the level's equation. Furthermore, we conduct a Hausman test to determine the best estimator (MG, PMG, or DFE) for the model. Therefore, the null hypothesis of homogeneity is tested based on a Hausman-type test by comparing MG, PMG, and DFE. The null and alternative hypotheses along with the decision criterion are as follows: under the null hypothesis, PMG is efficient than MG and DFE. Thus, the null hypothesis is selected if PMG ($p>0.05$), while the alternative hypothesis is selected if MG and DFE ($p<0.05$).

4.0 DATA AND ESTIMATION METHOD

4.1 Data

The data are annual observations for 12 West African countries for the period 2005-2020. The period reflects the post-global food and financial crisis, changes in government administration, and the health crisis (e.g., the Ebola outbreak and COVID-19 pandemic), among others. Three countries, namely Guinea Bissau, Niger, and Nigeria, were not included in the study because of limited data observations or different tax revenue classifications. The variables in this analysis include GDP per capita growth (annual percent), tax revenue as a percent of GDP, taxes on income, profits, and capital gains as a percent of GDP, taxes on goods and services as percent of GDP, taxes on international trade as percent of GDP, trade as percent of GDP, foreign direct investment net inflows as a percent of GDP, and gross capital formation as a percent of GDP. The variables in this study are from the World Bank (*World Development Indicators Dataset*) and the International Monetary Fund (*Government Finance Statistics*).

This study used the dependent variable, GDP per capita growth (annual percent) at constant prices, as an efficient measure of economic growth. GDP per capita growth (annual percent) adjusts for inflation, and it provided a meaningful interpretation in terms of the country's average living standards and economic well-being. We used tax revenue as our primary independent variable. The government's tax revenue generation finances its expenditures and other operations and redistributes wealth through development initiatives (Ola 2001; Jhingan 2004; Bhartia 2009). To further understand the impact of tax revenue on economic growth, we categorized tax

revenue into three main components: taxes on income, profits, and capital gains as a percent of GDP, taxes on goods and services as a percent of GDP, and taxes on international trade as percent as a percent of GDP. Thus, tax revenue has a macro effect on output, employment, prices, and growth (Mascagni, Moore, and McCluskey, 2014). In addition, we included control variables that may affect GDP per capita growth (annual percent), such as trade as a percent of GDP (trade openness), foreign direct investment, net inflows as a percent of GDP, and gross capital formation as a percent of GDP.

Empirical evidence suggests that trade openness positively impacts economic growth through various channels, resulting in increased human capital for leading industries and a spillover effect of transmitting knowledge across countries (Rivera-Batiz, 1995). Wacziarg (2001) and Ynikkaya (2003) concluded that trade openness is positively associated with economic growth. Furthermore, Asfaw (2014) revealed that trade openness stimulates both economic growth and investment.
Foreign direct investment is recognized in several studies to positively impact economic growth and welfare for the host country through increased financial resources, innovation and technology, skill development, and job creation (Borensztein et al. 1998; De Mello, 1999; Herzer et al., 2008; Esso 2010; Umoh et al., 2012; and Dihn et al., 2019). Hence, foreign direct investment is linked to an increase in total investment and, by extension, increased total output and growth rate.

Gross capital formation is a proxy for capital stock, which several studies indicated positively affects economic growth (Adhikary, 2011; Uneze, 2013; Taraki and Arslan, 2019; Pasara and Garidzirai, 2020).

Table 1 shows the summary statistics of variables use in the study. It indicates that there is enough variation across West African countries, as evidenced by the standard deviation.

Table 1: Summary Statistics

Variables	Obs	Mean	Std. Dev.	Min	Max
GDP per capita growth	192	1.720	4.017	-22.312	18.053
Tax revenue	189	14.389	3.496	6.800	22.100
Taxes_income, profits & capital gains	184	4.033	1.594	1.500	11.940
Taxes_goods & services	184	6.051	2.487	1.410	11.600
Taxes_international trade	179	3.679	1.852	1.260	9.900
Trade openness	188	73.111	37.163	33.780	311.354
Foreign direct investment	180	5.858	12.815	-2.545	103.337
Gross capital formation	186	20.891	8.384	4.704	50.797

Source: Authors Computation

Table 2 presents the correlation coefficients. The correlation coefficient shows a negative (-0.088) correlation between GDP per capita growth and tax revenue. Also, the correlation coefficient indicates a negative (-0.129) correlation between GDP per capita growth and taxes on income, profits, and capital gains. In addition, GDP per capita growth negatively correlates amongst taxes on goods and services and taxes on international trade as -0.012 and -0.091, respectively. However, there exists a positive correlation (0.079) between GDP per capita growth and trade, as well as foreign direct investment (0.134) and gross capital formation (0.060). The correlation analysis shows that the regressors do not have a perfect or exact linear representation of one another, as evidence by the benchmark of less than 0.80 to avoid multicollinearity.

Table 2: Correlation Analysis

Variables	GDP per Capita growth	Tax revenue	Taxes_income, profits & capital gains	Taxes_goods & services	Taxes_international trade	Trade openness	Foreign direct investment	Gross capital formation
GDP per capita growth	1.000							
Tax revenue	-0.088	1.000						
Taxes_income, profits & capital gains	-0.129	0.429	1.000					
Taxes_goods & services	-0.012	0.614	0.120	1.000				
Taxes_international trade	-0.091	0.376	0.145	-0.308	1.000			
Trade openness	0.079	0.079	0.210	-0.198	0.299	1.000		
Foreign direct investment	0.134	0.186	0.338	-0.184	0.321	0.314	1.000	
Gross capital formation	0.060	0.365	0.377	0.449	-0.078	0.221	0.092	1.000

Source: Authors Computation

4.2 Estimation Method

4.2.1 Panel ARDL Estimator

We investigate the relationship between tax revenue and economic growth using panel data from 12 West African countries for 2005-2020. This analysis involves a combination of cross-section (*N*) and time-series (*T*) observations in which *N* and *T* represent countries and the number of years, respectively. Baltagi (1995) and Baltagi and Li (1995) noted that in a panel estimation, neither the Generalized Least Squared (GLS) estimator nor Fixed Effect (FE) would produce consistent estimates in the presence of dynamics and endogenous regressors. Thus, Instrumental Variables (IV) are needed to produce consistent estimates, particularly in the presence of dynamics.

To produce a consistent estimate in the presence of dynamics and endogenous regressors, Arellano and Bond (1991) proposed a dynamic panel Generalized Method of Moments (GMM) estimator. The dynamics GMM panel estimator is an IV estimator which considers both current and past values of endogenous regressors and uses them as instruments. However, Roodman (2009) stated that the GMM estimator would produce spurious results in large T and N. As *T* becomes larger, the instruments increase,

affecting the Sargan test's validity over-identifying restriction. Also, small *N* may lead to unreliable autocorrelation test results. Thus, we can use panel ARDL estimators such as Mean Group (MG), Pooled Mean Group (PMG), or Dynamic Fixed Effect (DFE) to overcome the problems associated with the GMM estimator.

4.2.2 MG, PMG, DFE Estimators

Pesaran and Smith (1995) proposed that the MG estimator produces consistent average parameter estimates for large *N* and *T*. However, this estimator may not account for the similarity of parameters across the same groups. On the other hand, the PMG estimator takes into account both pooling and averaging. Furthermore, this estimator allows the intercepts, short-run coefficients, and error variances to differ without restriction across groups while keeping the long-run coefficients homogeneous (Pesaran, Shin, and Smith, 1999). Finally, the DFE estimator keeps the coefficients of the co-integrating vector to be the same across all panels with an equal speed of adjustment coefficient and short-run coefficients (Blackburne and Frank, 2007). But, there is an inherent bias to the simultaneous equation for small samples due to the endogeneity between the lagged dependent variable and error term (Baltagi et al., 2000). Therefore, to select the best estimator for the model, we conduct a Hausman test.

5.0 Results and Discussions

Given the time of the large (16 years) dataset, the macroeconomic variables are likely to be characterized by the unit root process (Nelson and Plosser, 1982). Therefore, we use the IPS test to determine the order of integration. After that, the optimal lags using the unrestricted model and the BIC information criterion determine lags for each unit or group per variable and choose the most common lag for each variable to represent the lags for the model. Following the choice of the optimal lags, we conduct the Hausman test to determine the best estimator (MG, PMG, or DFE) for the model. Finally, equation (3) is estimated to ascertain the short and long-run relationship between tax revenue and economic growth.

5.1 Results of the Unit Root Test

Table 3 presents the unit root test results. The results indicate that GDP per capita growth, trade, and foreign direct investment are stationary at a level. While tax revenue, taxes on income, profits, and gain capital, taxes on goods and services, taxes on international trade, and gross capital formation are stationary after the first difference. Therefore, this mixture of I(0) and I(1) recommends using a panel ARDL model that produces accurate results.

Table 3: Im-Pesaran-Shin Unit Root Test

Variables	Levels	First Difference	Integration Order
GDP per capita growth	-3.275***		I(0)
Tax revenue	0.122	-4.771***	I(1)
Taxes_income, profits & capital gains	1.422	-4.173***	I(1)
Taxes_goods & services	1.209	-4.790***	I(1)
Taxes_international trade	-1.030	-5.191***	I(1)
Trade openness	-2.133***		I(0)
Foreign direct investment	-1.761**		I(0)
Gross capital formation	-1.120	-5.596***	I(1)

Notes: Parameter estimates are statistically different from zero at *** 1%, ** 5% and * 10% significance levels.

5.2 Results of Optimal Lags and Hausman Test

The optimal lags for the panel ARDL models in Table 5 columns (1) to (4) are ARDL (1 0 0 0 0), ARDL (1 1 0 0 1), ARDL (1 0 1 0 1) and ARDL (1 0 0 0 1), respectively. Table 4 presents the Hausman test results. The Hausman tests indicate that the PMG is more efficient than MG and DFE under the alternative hypothesis because the results are statistically insignificant at the 5% level. Therefore, these results support the panel short-run heterogeneous and the long-run homogeneity presented in the PMG estimator. Therefore, the empirical model in equation (3) is estimated using the PMG estimator.

Table 4: Hausman Test

Estimator	Chi-square Statistic	Prob>chi2
H_0: PMG vs. H_1: MG	0.71	0.9505
H_0: PMG vs. H_1: DFE	2.39	0.6638

Notes: H_0: Select PMG if ($p>0.05$) vs. H_1: Select MG if ($p<0.05$);

H0: Select PMG if ($p>0.05$) vs. H_1: Select DFE if ($p<0.05$).

5.3 Results from Error Correction-based ARDL Model

Table 5 presents the PMG estimator results on the effect of tax revenue on economic growth. Columns (1) illustrate the effect of tax revenue on economic growth, while columns (2) to (4) present the effect of taxes on income, profits, and capital gains; taxes on goods and services; and taxes on international trade on economic growth, respectively. In a panel ARDL model, the existence of a long-run relationship is a premise for a valid, consistent, and efficient relationship among the variables of

interest. Therefore, for this condition to hold, the error correction term must be negative and not lower than -2 (Sohag, Nabilah, Begum, 2015). The results of the error correction term in Table 5 indicate that the term is negative and not lower than -2. Also, it is statistically significant at the 1% level in columns (1, 2, 3, 4). Thus, the adjustment coefficient illustrations how fast short-term disturbances return to the long-run equilibrium. For example, in column (1), the value of -0.756 indicates that economic growth short-term disturbances would adjust in the long run by 75.6% each year.

Columns (1) provides the effect of tax revenue on economic growth. The result indicates that tax revenue has a positive relationship with economic growth only in the long run and is statistically significant at the 10% level. For example, in the long run (columns 1), increasing tax revenue by 1% will boost economic growth by 14.5%. Also, the coefficients for trade openness, foreign direct investment, and gross capital formation have a positive relationship with economic growth. Again, these variables are statistically significant at 1% and 10%.

Columns (2) provides the effect of taxes on income, profits, and capital gains on economic growth. The result shows that taxes on income, profits, and capital gains have a positive relationship with economic growth only in the long run and are statistically significant at the 1% level. For example, in the long run (columns 1), increasing taxes on income, profits, and capital gain by 1% will boost economic growth by 60.3%. Also, the coefficients for trade openness and foreign direct investment positively correlate with economic growth and are statistically significant at 1%. Gross capital formation positively correlates with economic growth in the short run at the 5% significant level.

Columns (3) and (4) indicates that in the short run, taxes on goods and services and taxes on international trade are negatively correlated with economic growth while positively correlated in the long run. Also, these variables are not statistically significant; therefore, taxes on income, profit, capital gains, and taxes on international trade affect economic growth can not be ascertained. However, the controlling variables, namely trade openness, foreign direct investment, and gross capital formation, are positively correlated and statistically significant on economic growth in the long run.

The main focus of this study is the relationship between tax revenue and economic growth. First, we note a significant positive relationship between tax revenue and economic growth in the long run. Second, the existence of a long-run and positive relationship between tax revenue and economic growth indicates an adjustment process regarding tax revenue and its lag effect on economic growth in the economy.

Third, that amongst the sub-classification of tax revenue, taxes on income, profits, and capital gains are positively correlated and statistically significant to economic growth in the long run. Fourth, the results obtained from the PMG estimator support previous studies that there is a positive effect of tax revenue on economic growth.

Table 5: Estimation Results of the Pooled Mean Group

Dependent variable: GDP per Capita growth								
Variable	(1)		(2)		(3)		(4)	
	Coefficient	Std. Error	Coefficient	Std. Error	Coefficient	Std. Error	Coefficient	Std. Error
Long-run coefficients								
Tax revenue	0.145*	0.087						
Taxes_income, profits & capital gains			0.603***	0.174				
Taxes_goods & services					0.256	0.170		
Taxes_international trade							0.236	0.227
Trade openness	0.037***	0.004	0.035***	0.002	0.051***	0.006	0.035***	0.004
Foreign direct investment	0.072***	0.011	0.047***	0.008	0.083***	0.013	0.057***	0.011
Gross capital formation	0.092*	0.049	0.065	0.070	0.130**	0.064	0.098	0.062
Error-correction coeff.	-0.756***	0.090	-0.747***	0.107	-0.707***	0.071	-0.714***	0.089
Short-run coefficients								
Δ Tax revenue	-0.183	0.371						
Δ Taxes_income, profits & capital gains			-0.342	0.496				
Δ Taxes_goods & services					-0.485	0.495		
Δ Taxes_international trade							-0.003	1.153
Δ Trade openness	-0.021	0.061	0.022	0.060	-0.004	0.063	-0.008	0.066

Δ Foreign direct investment	-0.196	0.130	-0.120	0.210	-0.095	0.206	-0.125	0.214
Δ Gross capital formation	0.132	0.085	0.203**	0.091	0.151	0.097	0.116	0.101
Constant	-4.212***	1.114	-3.819***	1.177	-4.617	0.891	-2.989***	0.952
Country	12		12		12		12	
Observation	164		157		157		154	

Notes: Robust standard errors in parentheses. The parameter estimates are statistically different from zero at *10%, **5%, and ***1%
significance levels, respectively. Δ is the first difference operator. The first panel of the table presents the long-run estimation and speed of
adjustment, while the second panel reports the short-run
estimated coefficients.

6.0 CONCLUSION

Over the years, the debate about the link between tax revenue and economic growth and development has become critical. This concept has become essential, particularly for developing countries, to improve the economy and foster sustainable growth and development in recent years. For example, in West Africa, countries' revenue performance has been weak, with tax revenue as a percent of GDP averaging 14.4 percent, from 2005 to 2020.

This paper uses panel data from West African countries (2005-2020) with a panel ARDL estimator (PMG) technique to investigate the effects of tax revenue on economic growth. The result shows that tax revenue has a positive and statistically significant impact on economic growth in the long run. Also, there is a lag adjustment process in the tax revenue collection and economic growth. In addition, the results indicate that taxes on income, profits, and capital have positive and statistically significant effects on GDP per capita growth in the long run. The study also finds that taxes on international trade and on goods and services do not have positive and statistically significant effects on GDP per capita growth in the long run.

Based on the findings, the study recommends that governments of West African countries should strengthen efforts to enhance tax revenue generation. Specifically, efforts should be geared towards blocking leakages associated with tax revenue generation and reducing tax administration and compliance costs. The study also recommends that fiscal authorities should widen the tax base by formalizing the informal sectors, where a lot of earned incomes, profits and capital gains are untaxed. They should also increase broad-based consumption taxes regarding goods and services (GST) or value-added tax (VAT). Lastly, the study recommends that

governments in West Africa should minimize their over reliance on international trade taxes, since they do not positively influence GDP per capita growth.

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CREDIT, OUTPUT & EMPLOYMENT NEXUS IN NIGERIA, 1985-2019

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Abstract

This study investigates the relationship between credit, output and employment in Nigeria using the Dynamic OLS estimation procedure between 1985 and 2019. The substantive contribution of this study was the investigation of the differences between the oil and non-oil sectors of the economy, which was a unique feature in Nigeria. The findings buttressed our intuitions about the allocation of credit for economic growth in Nigeria. While the impact of non-oil credit on output and employment was positive and significant, oil credit had a significantly negative effect. Furthermore, the findings reinforced the assertion of the jobless growth phenomenon in Nigeria as output exerted a negative impact on employment. The impact of employment on non-oil GDP is insignificant and negative. This implied that growth is not induced by a change in employment. Thus, in order to foster growth in the economy, government policy should focus on improving the productivity of the workforce in the non-oil sector. Lastly, more credit should be prioritized for the non-oil sector in order to stimulate real growth in the economy.

Keywords: Credit allocation, Output, Employment, Dynamic OLS
JEL Classification: E23, E24, E51, C22

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1.0 INTRODUCTION

High unemployment rate is one of the greatest challenges of sub-Saharan economies. The rate of unemployment has maintained a rising trend in the region (Akeju and Olanipekun, 2014). Nigeria as a country in the region is not excluded from this unemployment problem. The level of unemployment is relatively high despite the high Gross Domestic Product (GDP) growth rate recorded in recent times (World Bank, 2020). Despite the growth in GDP, the rate of the increase in labour force exceeded the recorded economic growth. Thus, the increase in the number of workers employed subceeds the number of labour supplied into the labour market (Aiyedogbon and Ohwofasa, 2012). As argued in the literature, the growth rate of GDP should lead to lower unemployment and higher employment levels in an economy. However, contrary to this postulate, the relationship between employment level and output growth is not clear in Nigeria. It seems the jobless growth phenomenon exists in Nigeria. Since employment and output growth is a key element of the overall economy, the relationship between these variables is very important for the proper understanding of the workings of the Nigerian economy. In determing the workings of the economy, financial intermediation is key as banks play a crucial role in transferring resources from surplus sectors to the deficit sectors in the economy. This intermediatory function of the bank is argued in the literature to stimulate growth (Bencivenga and Smith, 1991; Chen, 2006; Levine et al., 1999). To this effect, the Central of Bank of Nigeria plays a leading role in the overall expansion of credit in the priority sectors such as agriculture, manufacturing and industry. Notwithstanding the effort of the Central bank, Nigeria's banks prefer to give loans to the oil sector because the yield of investment in the sector is very high, with a turnover of a very short period. However, the share of the oil sector in GDP is very low compared to the high contribution of non-oil to GDP in Nigeria. Yet, the growth of bank credit to the oil sector vis-à-vis the non-oil sector continued to increase. These facts reveal that the allocation of bank credit could inhibit growth in Nigeria. This is an important issue this study seeks to investigate.

This study is prompted by the need to examine the credit-output relation on one hand, and the relationship between output and employment on the other hand. A substantive contribution of this study is the investigation of the differences between the oil and non-oil economy which is a unique feature in Nigeria. The contribution of the oil sector to government revenue and exports is still very high in spite of several attempts to diversify the economy. About 85 per cent of its total exports are accounted for by the oil sector (CBN, 2020). This further informs the classification of Nigeria's economy into oil and non-oil. The rest of the paper is organised into the following sections. Following the introduction, the next section presents the stylized facts which is followed by the reviews of the various theoretical and empirical literature

on employment, growth and credit relations. While Section 4 focused on the methodology, section 5 is the discussion of results. Section 6 concluded the study.

2.0 STYLIZED FACTS ON NIGERIA'S MACROECONOMY

It is axiomatic that finance plays a fundamental role in the growth and development process of any economy. Evidence from Table 1 shows an increase in and deepening of the aggregate domestic credit to the private sector relative to the output of the economy. The credit/GDP ratio (financial deepening) has doubled over the period – particularly between 1981 to 2009 – reaching 19 % in 2019. Nevertheless, an observation of serious concern about the trajectory of the economy is that the growth rate of credit to the non-oil sectors of the economy, which provides the most growth, is falling compared to the unfavourably domineering oil sector, which is rapidly gaining in credit allocation. It is worth noting that the oil sector gained about 30% extra credit during the last recession period (2015 to 2016), compared to the non-oil sector's gain of which was marginal.

Table 1: Selected Macroeconomic Aggregates for Nigeria

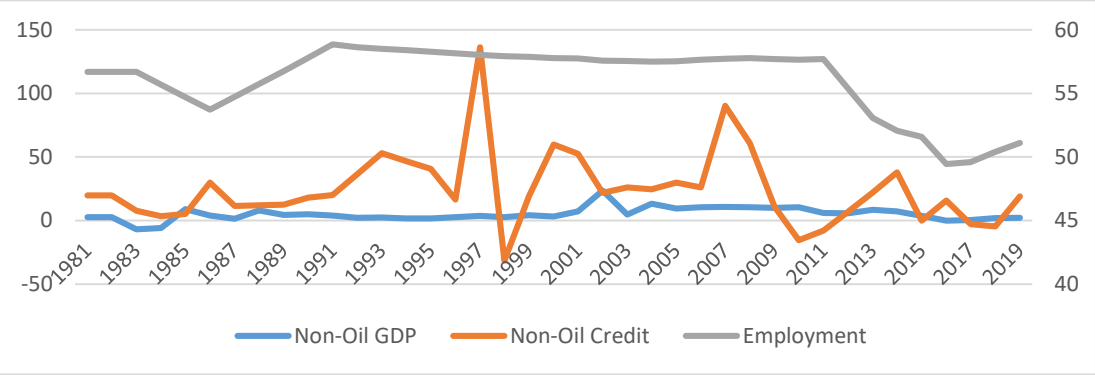
Period	1985-1989	1990-1994	1995-1999	2000-2004	2005-2009	2010-2015	2015-2019
GDP growth	3.69	2.58	2.05	8.57	6.78	6.10	1.19
Non-oil GDP	5.30	2.98	2.95	10.39	10.19	7.51	1.62
Oil GDP	3.54	3.46	1.14	7.57	-2.80	-2.20	-1.91
CPS/GDP	7.71	7.65	7.20	8.35	13.12	18.97	18.99
Oil credit	12.19	42.12	165.64	44.39	57.14	12.63	12.70
Non-oil credit	14.19	34.81	36.26	36.92	43.61	8.71	5.38
Employment	55.12	58.44	58.05	57.63	57.67	55.17	50.42

Source: Authors computation from NBS (various issues). Note: the value for each indicator is a five-year average.

Furthermore, the Real Gross Domestic Product (RGDP) shows positive growth rates that climax at the beginning of the century, initially depicting a healthy economy. However, on closer inspection on the sources of growth, it is clear to see that the non-oil economy has been the main driver of growth since 2005. The non-oil GDP has exhibited strong growth rates to keep the economy afloat, whereas oil GDP growth rate has been largely negative particularly during the last decade. Moreover, despite the positive RGDP growth rates, the employment rate in the economy has been hovering around average of 56.07 per cent as its value never reach 60 per cent. The falling employment rate in recent years can be interpreted as an increase in the unemployment rate as the two variables are practically opposites of each other. This

evidence portrays the 'jobless growth' phenomenon. Thus, it seems there is a low employment impact of credit growth and disproportionate distribution of credit across sectors in the country.

Figure 1: Trend of Non-oil GDP, Non-oil Credit and Employment in Nigeria

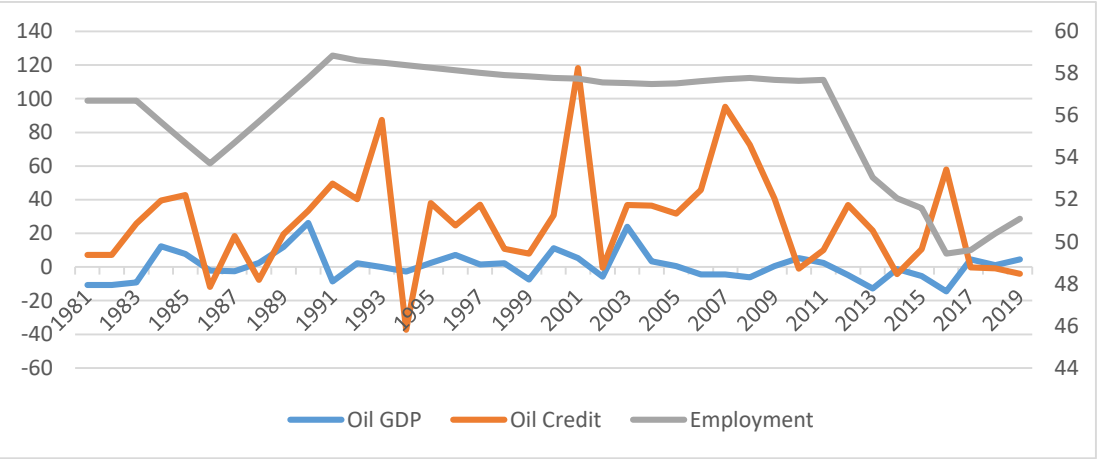


Source: Central Bank of Nigeria (CBN), (2020)

In addition, figure 1 displays the growth rate of non-oil GDP and non-oil credit (referenced on the left axis) as well as the level of employment (in N'Millions) (referenced on the right axis). At a first glance at the graph, it might seem that there is no clear relationship among the variables. However, a closer inspection shows that there exists some connection between non-oil credit and non-oil GDP. For instance, between 1981 and 1989, growth in both non-oil credit and non-oil GDP moved together before non-oil credit became unstable. A similar trend is noticed from 2013 to 2019. Thus, it can be deduced from the graph that non-oil credit tends to predict the change in non-oil GDP in certain periods.

However, a different relationship was observed in the chart of oil GDP and oil credit which was presented in figure 2. The connection between oil GDP and oil credit is more glaring. The period of fall in oil GDP coincides with that of oil credit. Thus, oil credit is an important determinant of growth in oil GDP in Nigeria. Comparing these trends with employment in both graphs, the level of employment seems to exhibit little correlation with other variables in the charts. This follows the narrative so far that GDP does not determine the level of employment in Nigeria's economy. There seems to have always been a case of jobless growth in the economy, particularly in recent years where the level of employment has plummeted.

Figure 2: Trend of Oil GDP, Oil Credit and Employment in Nigeria



Source: Central Bank of Nigeria (CBN), (2020)

3.0 LITERATURE REVIEW

3.1 Output to Employment Relations

Employment represents labour demand derived from the demand and supply of goods and services from the various sectors (primary, secondary and tertiary) of the economy. The theoretical anchor for the employment-output relations is the Okun's law. The law links two key macroeconomic variables together: output and unemployment. The theory proposes an inverse relationship between growth rate and unemployment rate (Okun, 1962). In other words, an increase in the growth rate of output should reduce the unemployment rate. In contrast to the theoretical discussions around the relationship between output and employment, Wilson (1960) asserted that modern employment theory assumes a close positive relationship between changes in output and employment that may be rather erratic and ambiguous. The ambiguity is observed more clearly in the short-run, wherein changes in aggregate demand may determine only output, due to various short-run constraints. This could limit the use of public policy seeking to influence within-the-year fluctuations in employment.

There are several empirical studies in Nigeria and other developing countries on the relations between employment and output. Many seek to examine the jobless growth phenomenon. Garba & Garba (2014) showed that the evidence from the data between 2006 and 2011, which were high growth periods, did not support Okun's law. They found a rather discontinuous relationship. Nonetheless, the study focused on the case of the jobless poor amongst youths in areas of the country where growth was not

inclusive. More so, small sample size was used, so might not be useful for a medium and long-term view, which was part of what this work seeks to address.

Similarly, others adopted the elasticity of employment to growth approach, which was useful when time-series data points were adequate. Using an Ordinary Least Squares (OLS) estimation technique, Sodipe & Ogunrinola (2011) showed that the negative relationship did not exist between employment and growth during the period between 1981 and 2006 in Nigeria. This finding followed theoretical expectations but did not follow the stylised facts of the economy.To shed some light on this perceived discrepancy, the authors explained that the persistence of rising unemployment in the data had to do with low employment intensity. In other words, employment was generated during the period, but not enough to offset the rising unemployment.

Furthermore, Ogunyiola & Garba (2014) estimated the elasticities for key sectors (agriculture, mining and quarrying, manufacturing and services) in Nigeria. Their result indicated that the secondary and tertiary sectors generated up to quadruple job creation elasticities than the primary sectors. This finding had implications for structural change policy which promoted competitiveness in that direction. Ajakaiye et al (2015) sought to further understand the relationship between growth and employment in relations to poverty and inequality, using Shapley decomposition approach. They found similar evidence of positive but low employment elasticities of growth, indicating poor employment generation in high-productive sectors.

Beyond the Nigerian context, employment elasticities had been estimated for Botswana (Leshoro, 2014) and India (Misra & Suresh, 2014 and Basu & Das, 2015). Using an Error Correction Model (ECM) which gives short and long-run dynamics, the total employment elasticity of GDP growth was negative in Botswana between 1980 and 2011. In other words, total employment declined in response to an increase in total output. However, sectoral employment elasticity was positive and lower than that of the aggregate. These results inferred that output growth was labour-productivity driven, not labour-employment driven. The authors recommend labour-intensive job creation policies across sectors.

In India, Misra & Suresh (2014), using point and arc elasticities, found elasticities for both aggregate and sectoral level before, during and after labour market reforms. The key findings showed that elasticities varied across all sectors and periods. While employment elasticity of output in agriculture was negative, that of manufacturing and services were average, while that of construction and utilities were intensively positive with elasticities over 1. Furthermore, Basu & Das (2015) analysed the effects of

sectoral elasticities on aggregate elasticities between India and the United States of America (USA). In India, a change in elasticities in agriculture was the most important factor in changing the aggregate level of employment. In the USA, however, a change in the manufacturing sector was the dominant factor in aggregate employment levels.

3.2 Credit to Output Relations

From a monetary perspective, output reaches full employment, without the influence of monetary policy in the long-run (Friedman, 2000). In this view, price stability is the objective of monetary policy (Meyer, 1997). However, Keynesian theory showed that monetary policy mechanism exists, through which output and employment are determined, via interest rate influence over investment (Romer & Romer, 1989). And importantly, "looking into the black box of monetary policy transmission", the credit channel (balance sheet and bank lending) plays important roles in quantitatively successful analyses of monetary policy transmission (Akerlof, 2007).

Moreover, the role of finance in development was postulated by Schumpeter (1911) who advocated for a finance-led growth through the allocation of savings which enhanced investment and productivity. More so, future capital accumulation, technological change and economic growth could be well predicted by the level of financial development (Levine, 1997). In addition, the theoretical literature also established that monetary policy could have an effect on real economic performance through the supply and demand of credit, namely the "the credit channel" (Dobrinsky & Markov, 2003). In the "supply effects" view, real economic activity was affected by monetary shocks through shifts in the supply of credit by financial intermediaries. This view is an advance from the more traditional "demand effects" view, which examined the monetary shocks through the interest rate (cost of credit) transmission mechanism.

The evidence of the strength and direction of credit and output relations is mixed. Korkmaz (2015) analysed the effect of bank credit on economic growth for 10 European countries between 2006 and 2016, using panel analysis. The results were positive, but not without caveats: economic growth increased only if a majority of the credit created was channeled to the real sector; and secondly, credit supply of banks, contracted, if the country's domestic debt requirement was provided by the banks, indicating low development levels. In addition, Singh et al (2016) investigated the interdependence (co-integration) between credit and growth across various sectors in India, and they found a strong relationship, particularly for the manufacturing sector. For Brazil, Tecles & Tabak (2008) estimated the credit-GDP elasticity using a Vector Error

Correction (VEC) Model, which showed that there was a significant impact of credit on future incomes and vice versa.

Furthermore, many studies have investigated the credit-output relationship in Nigeria with varying approaches and results. On an aggregate level, Akpansung & Babalola (2011), using a Two-Stage Least Squares estimation technique, found a positive relationship between Private Sector Credit and GDP. In contrast, Judith et al (2014) found a negative and significant effect of credit on growth, arguing that bank credit was not in favour of the most active sector (informal economy) and that high interest rates played their part in eroding the returns to investment. By examining the impact of credit allocation across sectors in Nigeria, Itaman and Awopegba (2021) showed that a disproportionate flow of credit, particularly to the oil and gas sectors, had a significant negative impact on the country's manufacturing sector. A study by Akujuobi & Nwezeaku (2015) showed that although commerce and productive sectors had a positive and significant relationship, there was a negative and insignificant effect of bank lending activities on the service sector.

Other studies, which showed a positive relationship, emphasized the need for taking structural breaks in the data into account which could underestimate credit effects (Olowofeso et al, 2017). To examine monetary policy shocks and their short- and long-run effects, Asaleye et al (2018) explored the implication of the credit channel of monetary policy on output and employment, using Structural Vector Autoregressive (SVAR) and Autoregressive Distributed Lags (ARDL) methodologies. Their findings showed that the impact of monetary policy shocks was felt more on output than employment over time. Also, most monetary variables, particularly money supply and interest rate, were economically and statistically significant in both the short and long run.

Overall, this study seeks to model the credit, output and employment relations, with particular emphasis on re-examining the role of credit in driving output and employment in Nigeria. This is an issue already well established in the empirical literature, nevertheless, this paper aims to model the relations based on the character of the Nigerian economy. The Nigerian economy remains an oil sector-dependent economy. Given that policy thrust has shifted from oil toward promoting non-oil output growth, this study disaggregates total credit into oil and non-oil channels. This permits the study to investigate the allocative effects of credit on output and employment. The findings can hence be used to guide policy in tackling the "jobless growth" problem.

4.0 METHODOLOGY

4.1 Data

The data used for estimation are from secondary sources. These include the National Bureau of Statistics (NBS), Central Bank of Nigeria (CBN), and World Development Indicators (WDI). Due to the unavailability of employment data, we limit the analysis to cover the years 1985 to 2019 which span 33 observations. The variables used in the analysis are total output, represented by real gross domestic product (GDP); sectoral outputs are non-oil GDP (GDPN) and oil GDP (GDPO); sectoral credit, represented by the credit by deposit money banks allocated to non-oil sector (CRN) and oil sector (CRO); maximum lending rate (INT) denotes the interest rate; gross capital formation (GCF) denotes investment; official exchange rate (OEX) represents the exchange rate; and total employment (EMP) denotes labour employed. All series, except INT and OEX, are in millions. A Log-log specification is used for our variables of interest to render the interpretation of results as elasticities (Kapsos, S. 2005; Leshoro, 2014).

4.2 Theoretical Framework

To model the relations between credit, output and employment in Nigeria, this study adopts Okun's law hypothesis as the theoretical frameworks, given the variables under consideration. Following Okun's law, a positive relationship exists between output and employment. The basic linear function is given:

$$E = f(Y) \quad (1)$$

where E and Y are full employment and the natural rate of output. In order to capture the short-run effects and show the long-run cointegrating relationship among the variables, we employed Dynamic Ordinary Least Squares (DOLS) estimation technique. Likewise, the relationship between employment and output is further outlined through the production function as follows:

$$Y = f(L,K) \quad (2)$$

where the L and K represent labour and capital respectively. As noted in the theoretical review, Keynesian theory shows that monetary policy mechanism exists, via interest rate influence over investment (Romer & Romer, 1989). This in turn influences the real economy through the supply and demand of credit (Dobrinsky & Markov, 2003). In a small open economy like that of Nigeria, the effect of the exchange rate on the economy cannot be over-emphasised (Mishkin, 1995; Bhuiyan 2008). Therefore, the implicit forms of the models to be estimated are as follows:

$$GDP = f(CRN, CRO, INT, GCF, OEX, EMP) \quad (3)$$
$$GDPN = f(CRN, INT, GCF, OEX, EMP) \quad (4)$$
$$GDPO = f(CRO, INT, GCF, OEX, EMP) \quad (5)$$
$$EMP = f(CRN, CRO, INT, GCF, OEX, GDP) \quad (6)$$

where GDP is a proxy for output, EMP is total employment, CRN and CRO represent sectoral allocation of credit to non-oil and oil sectors, GDPN and GDPO represent non-oil and oil output, GCF is a proxy for capital, while INT represents the interest rate and OEX denotes the exchange rate. Given the unique nature of the Nigerian economy, we reclassify the GDP accounts into oil and non-oil. And based on the thrust of this study, it is important to examine the credit, output and employment relations through those two channels, hence the disaggregation of total credit into the sectoral levels as portrayed in equations 3 to 6.

4.3 Estimation Procedure and Technique

In line with standard practice in the empirical literature, the study carries out pre-estimation tests to avoid misspecification errors and spurious regression. First, all the series (in millions) are transformed into logs to correct for heteroscedasticity. Then we conduct unit root tests to ascertain the stationarity of the series. Both Augmented Dickey-Fuller (ADF) and Kwiatkowski-Phillips-Schmidt-Shin (KPSS) unit root tests were employed. Further, the possibility of multicollinearity was tested using pairwise correlation analysis, after which the models were estimated using the dynamic OLS (DOLS) by Stock and Watson (1993). We used DOLS since all the series were integrated of order one I(1). The estimation technique has the benefit of correcting for potential endogeneity bias among regressors commonly associated with the basic OLS procedure. It also improves on OLS by eliminating the small sample bias. Following the DOLS results, residual-based Engle-Granger cointegration technique was employed to show if a long-run relationship exists among the variables. Four DOLS models were estimated in the study were specified below:

$$GDP = \beta_0 + \beta_1 CRN + \beta_2 CRO + \beta_3 OEX + \beta_4 INT + \beta_5 GCF + \beta_6 EMP + \sum_{i=-j}^{i=j} \partial \Delta CRN_{t-i} +$$

$$\sum_{i=-k}^{i=k} \mu \Delta CRO_{t-i} + \sum_{i=-l}^{i=l} \lambda \Delta OEX_{t-i} + \sum_{i=-m}^{i=m} \gamma \Delta INT_{t-i} + \sum_{i=-n}^{i=n} \phi \Delta GCF_{t-i} + \sum_{i=-o}^{i=o} \tau \Delta EMP_{t-i} + \varepsilon_t$$

(DOLS 1)

$$GDPN = \beta_0 + \beta_1 CRN + \beta_2 OEX + \beta_3 INT + \beta_4 GCF + \beta_5 EMP + \sum_{i=-j}^{i=j} \partial \Delta CRN_{t-i} +$$

$$\sum_{i=-l}^{i=l} \lambda \Delta OEX_{t-i} + \sum_{i=-m}^{i=m} \gamma \Delta INT_{t-i} + \sum_{i=-n}^{i=n} \phi \Delta GCF_{t-i} + \sum_{i=-o}^{i=o} \tau \Delta EMP_{t-i} + \varepsilon_t$$

(DOLS 2)

$$GDPO = \beta_0 + \beta_1 CRO + \beta_2 OEX + \beta_3 INT + \beta_4 GCF + \beta_5 EMP + \sum_{i=-k}^{i=k} \mu \Delta CRO_{t-i} + \sum_{i=-l}^{i=l} \lambda \Delta OEX_{t-i} + \sum_{i=-m}^{i=m} \gamma \Delta INT_{t-i} + \sum_{i=-n}^{i=n} \phi \Delta GCF_{t-i} + \sum_{i=-o}^{i=o} \tau \Delta EMP_{t-i} + \varepsilon_t$$

(DOLS 3)

$$EMP = \beta_0 + \beta_1 CRN + \beta_2 CRO + \beta_3 OEX + \beta_4 INT + \beta_5 GCF + \beta_6 GDP + \sum_{i=-j}^{i=j} \partial \Delta CRN_{t-i} + \sum_{i=-k}^{i=k} \mu \Delta CRO_{t-i} + \sum_{i=-l}^{i=l} \lambda \Delta OEX_{t-i} + \sum_{i=-m}^{i=m} \gamma \Delta INT_{t-i} + \sum_{i=-n}^{i=n} \phi \Delta GCF_{t-i} + \sum_{i=-o}^{i=o} \tau \Delta GDP_{t-i} + \varepsilon_t$$

(DOLS 4)

where all the variables are as defined in the theoretical framework, ε_t is the error term and j, k, l, m, n, o are the length of the leads and lags of the regressors.

5.0 RESULTS

5.1 Unit Root Test

To test for the stationarity of the series, Augmented Dickey-Fuller (ADF) and Kwiatkowski-Phillips-Schmidt-Shin (KPSS) unit root tests were employed. The null hypothesis of ADF is that the variable exhibits a unit root, while the alternative hypothesis is that the variable is stationary. If the ADF statistic at levels yields a significant result, then the null hypothesis is rejected and we conclude that the series has no unit root. In contrast, KPSS tests the null hypothesis that the variable is stationary against the alternative hypothesis of the presence of a unit root. If the KPSS statistic at levels yields a significant result, then the null hypothesis is rejected and we conclude that the series is not stationary, thus I(1). The results were displayed in Table 2. The reported results for ADF showed that apart from employment and interest rate that were stationary at levels, all other variables were stationary at first difference. However, KPSS test showed that all the series were integrated of order one I(1). The contradictory results between ADF and KPSS could be due to the lower power of ADF test when the root is very close to the unity circle and thus decreases when the deterministic factors are added (Choong and Lim, 2009). Given that KPSS is more powerful than ADF, especially in small sample size, the study relied on KPSS for reaching a conclusion that all the series were integrated of order one I(1).

Table 2: Unit root Tests

Variables	ADF		Conclusion	KPSS		Conclusion
	Levels	1st Diff		Levels	1st Diff	
LOG(CRN)	-0.7381	-5.4713***	I(1)	0.7418***	0.2088	I(1)
LOG(CRO)	-0.8897	-7.4768***	I(1)	0.7413***	0.1537	I(1)
LOG(EMP)	-4.0014***	-2.0574	I(0)	0.7466***	0.1727	I(1)
LOG(GCF)	-1.8067	-4.8292***	I(1)	0.3583*	0.3312	I(1)
LOG(GDP)	-0.0968	-3.4341**	I(1)	0.7298**	0.2691	I(1)
LOG(GDPN)	-0.3542	-2.9886**	I(1)	0.7227**	0.2846	I(1)
LOG(GDPO)	-1.4788	-5.6989***	I(1)	0.4509*	0.2092	I(1)
LOG(GDPC)	-0.945	-3.8745***	I(1)	0.6087**	0.336	I(1)
LOG(GDPCO)	-0.0976	-5.68***	I(1)	0.4607*	0.2149	I(1)
LOG(GDPCN)	-0.6058	-2.9958**	I(1)	0.6663**	0.282	I(1)
INT	-2.6704*	-6.87***	I(0)	0.4224*	0.0944	I(1)
OEX	-2.0617	-4.222***	I(1)	0.3682*	0.1185	I(1)

Source: Author's computation. Note: ***,** and * indicate 1 per cent, 5 per cent and 10 per cent significant level respectively. Where the abbreviations are CRN (Credit to non-oil), CRO (Oil credit), EMP (Employment), GCF (Investment), GDP (Real Gross domestic product), GDPN (Non-oil GDP), GDPO (Oil GDP), GDPC (Per capita GDP), GDPCO (Per capita oil GDP), GDPCN (Per capita non-oil GDP), INT (Maximum lending rate) and OEX (Official exchange rate). We used unit root with constant and trend for OEX given the significant trend exhibited by the series.

5.2 Descriptive Statistics

As stated earlier, Nigeria's economy is an oil-dependent one and there is a significant amount of credit channeled to the sector. This is evidenced in Table 3 as about N0.73 trillion on average were allocated to oil sector while N3.27 trillion went to non-oil. While GDP recorded the largest deviation from the mean, the lowest standard deviation was GDPCO. Most of the series were positively skewed apart from EMP and INT that

had a negative skewness. All the series had the values of kurtosis greater than zero, so they were heavy tails and could be said to be leptokurtic.

Table 3: Descriptive

Variable	Mean	Std. Dev.	Skewness	Kurtosis
CRN	3.274	4.486	1.091	2.679
CRO	0.729	1.177	1.503	3.886
EMP	39.760	10.515	-0.047	1.667
GCF	8.764	2.101	1.077	4.563
GDP	34.691	20.238	0.674	1.881
GDPN	27.946	19.689	0.793	2.039
GDPO	6.745	1.435	0.044	2.129
GDPC	0.267	0.067	0.579	1.706
GDPCO	0.055	0.011	-0.969	3.161
GDPCN	0.196	0.084	0.681	1.758
INT	22.107	6.184	-0.064	2.694
OEX	148.709	118.585	1.867	5.664

Source: Author's computation. Note: The abbreviations represent CRN (Credit to non-oil), CRO (Oil credit), EMP (Employment), GCF (Investment), GDP (Real Gross domestic product), GDPN (Non-oil GDP), GDPO (Oil GDP), GDPC (Per capita GDP), GDPCO (Per capita oil GDP), GDPCN (Per capita non-oil GDP), INT (Maximum lending rate) and OEX (Official exchange rate).

5.3 Correlation Analyses

Table 4 presented pairwise correlation between the variables of interest in the study. In empirical studies, correlation analysis is usually carried out to determine the degree of association between two or more variables. Besides. The analysis is also done to detect the existence of collinearity or multicollinearity among the explanatory variables. Based on the relationship between output, employment and credit, some intuitive insights were derived. It would be observed that both the control variables and the key variables correlated highly with the measure of output and employment. Though oil GDP correlated weakly with both Oil credit and non-oil credit, non-oil GDP had high correlation. Majority of negative correlation coefficient were found in real effective exchange rate and oil GDP per capita. Based on this correlation results, it can be said that relevant variables were incorporated into the model.

Table 4: Correlation Matrix Results

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
(1)CRN	1.00											
(2)CRO	0.97	1.00										
(3)EMP	0.84	0.77	1.00									
(4)GDP	0.96	0.91	0.93	1.00								
(5)GDPN	0.97	0.94	0.91	1.00	1.00							
(6)GDPO	0.20	0.06	0.66	0.41	0.35	1.00						
(7)GDPC	0.93	0.87	0.86	0.97	0.97	0.38	1.00					
(8)INT	0.45	0.49	0.56	0.49	0.48	0.29	0.37	1.00				
(9)OEX	-0.25	-0.21	-0.51	-0.36	-0.33	-0.56	-0.30	-0.67	1.00			
(10)GCF	0.49	0.48	0.34	0.46	0.48	0.01	0.56	0.00	0.10	1.00		
(11)GDPCO	-0.88	-0.91	-0.60	-0.78	-0.81	-0.20	-0.71	-0.37	-0.06	-0.38	1.00	
(12)GDPCN	0.96	0.90	0.90	0.99	0.99	0.38	0.99	0.42	-0.32	0.49	-0.77	1.00

Source: Author's computation. Note: The abbreviations represent CRN (Credit to non-oil), CRO (Oil credit), EMP (Employment), GCF (Investment), GDP (Real Gross domestic product), GDPN (Non-oil GDP), GDPO (Oil GDP), GDPC (Per capita GDP), GDPCO (Per capita oil GDP), GDPCN (Per capita non-oil GDP), INT (Maximum lending rate) and OEX (Official exchange rate)

5.4 Discussion of Results

The relationship among output, employment and credit were estimated using DOLS. Based on the estimated results, the four DOLS models considered in this study are presented in Tables 5 to 8. The first model to be considered is the GDP model where real GDP in aggregate terms was employed as the dependent variable. This is displayed in table 5. The estimation showed that most of the explanatory variables were significant and had the expected signs. Credit to non-oil impacted GDP positively by 0.54 per cent. However, both oil credit and interest rate had negative effects on growth. The negative impact of oil is expected as oil was an enclave sector in Nigeria and was not considered as the major driver of growth in the country. Also, the negative effect of interest rate is understood as it influenced growth through its impact on money supply. Real exchange rate, employment and investment had positive effects on growth. The positive effects of these variables are in alliance with theory.

Table 5: DOLS Result for Aggregate GDP

Dependent variable: GDP			
Variable	Coefficient	t-statistic	Std. Error
LOG(CRN)	0.539***	0.139	3.873
LOG(CRO)	-0.374***	0.062	-6.078
OEX	0.003**	0.001	2.961
INT	-0.009	0.010	-0.919
LOG(GCF)	0.148	0.137	1.084
LOG(EMP)	0.855	1.323	0.646
C	8.729**	3.062	2.851
Adjusted R-squared	0.992	Jarque-Bera (Prob.)	0.480
Wald test (F-Stat)	226.37***	Engle-Granger (Z-stat)	-54.54***

Source: Author's computation. Note: ***,** and * indicate 1 per cent, 5 per cent and 10 per cent significant levels respectively. Where the abbreviations represent CRN (Credit to non-oil), CRO (Oil credit), EMP (Employment), GCF (Investment), GDP (Real Gross domestic product), INT (Maximum lending rate) and OEX (Official exchange rate).

Disaggregating the GDP into oil and non-oil GDP showed, more directly, the impact of credit on each sector. The results of the sectoral disaggregation are presented in Tables 6 and 7. While the impact of bank credit on non-oil GDP was positive and significant, employment had a negative effect on non-oil GDP. The positive impact of non-oil credit buttresses the point that channeling credit to non-oil GDP would bolster Nigeria's economic growth. However, a possible explanation for the negative effect of employment on non-oil GDP could be due to low productivity of labour where an increase in employment did not generate a proportionate rise in the growth of the sector. Also, exchange rate had a negative but not significant effect on non-oil GDP. This is not without support in the literature. For instance, Alagidede and Ibrahim (2017) argued for the slow-down of economic growth by exchange rate appreciation.

Table 6: DOLS Result for Non-oil GDP

Dependent variable: GDPN			
Variable	Coefficient	t-statistic	Std. Error
LOG(CRN)	0.897**	0.362	2.478
OEX	-0.001	0.002	-0.248
INT	0.049*	0.023	2.126
LOG(GCF)	0.378	0.435	0.867
LOG(EMP)	-6.686*	3.273	-2.042
C	22.795**	8.414	2.709
Adjusted R-squared	0.968	Jarque-Bera (Prob.)	0.667
Wald test (F-Stat)	7566.86***	Engle-Granger (Z-stat)	-35.16***

Source: Author's computation. Note: ***,** and * indicate 1 per cent, 5 per cent and 10 per cent significant levels respectively. Where the abbreviations represent CRN (Credit to non-oil), EMP (Employment), GCF (Investment), GDPN (Non-oil GDP), INT (Maximum lending rate) and OEX (Official exchange rate)

For oil GDP, oil credit contributed marginally to the growth of the sector. However, employment had a positive and significant effect on oil GDP. A positive explanation for the positive impact of employment on oil GDP could be that marginal productivity of labour in the oil sector was high as evidenced by the lower share of Nigeria's labour force that was gainfully employed in the sector. Investment, interest rate and exchange rate had negative effects on oil GDP. A negative effect of investment on oil GDP could be counterintuitive at first glance, but a closer examination showed clearly that investment in the oil sector in Nigeria is huge and labour requirement is low. This led to low marginal productivity of capital relative to labour in the sector.

Table 7: DOLS result for Oil GDP

Dependent variable: GDPO			
Variable	Coefficient	t-statistic	Std. Error
LOG(CRO)	-0.217*	0.110	-1.976
OEX	-0.001	0.001	-0.569
INT	-0.022	0.014	-1.660
LOG(GCF)	-0.497	0.293	-1.698
LOG(EMP)	4.172**	1.435	2.906
C	11.237*	5.871	1.914
Adjusted R-squared	0.817	Jarque-Bera (Prob.)	0.023
Wald test (F-Stat)	12906.90***	Engle-Granger (Z-stat)	-81.27***

Source: Author's computation. Note: ***,** and * indicate 1 per cent, 5 per cent and 10 per cent significant levels respectively. Where the abbreviations represent CRO (Oil credit), EMP (Employment), GCF (Investment), GDPO (Oil GDP), INT (Maximum lending rate) and OEX (Official exchange rate)

The last model to be examined was the employment model which is presented in table 8. Most of the variables were significant and had the expected sign. While credit to non-oil had a significant positive effect on employment, oil credit had a negative effect on employment. As regards the relationship between employment and output, the results of the DOLS did not align with Okun's Law which is the theoretical anchor of this study. In the employment model, negative relation was found between real GDP and employment. When GDP increased by one per cent, employment fell by 0.16 per cent. Though this is counter-intuitive, this aligned with the studies of Leshoro (2014) and Misra & Suresh (2014). The two studies argued that growth in output tends to be labour-productivity driven rather than labour-employment driven. Furthermore, exchange rate, interest rate and investment had a positive effect on employment. Thus, more investment created more jobs in the economy.

Table 8: DOLS result for Total Employment

Dependent variable: EMP			
Variable	Coefficient	t-statistic	Std. Error
LOG(CRN)	0.160***	0.034	4.714
LOG(CRO)	-0.016	0.019	-0.840
OEX	0.000**	0.000	-2.402
INT	0.008***	0.001	7.232
LOG(GCF)	0.080*	0.042	1.905
LOG(GDP)	-0.161***	0.047	-3.418
C	3.113***	0.930	3.348
Adjusted R-squared	0.996	Jarque-Bera (Prob.)	0.666
Wald test (F-Stat)	808.70***	Engle-Granger (Z-stat)	-36.57**

Source: Author's computation. Note: ***,** and * indicate 1 per cent, 5 per cent and 10 per cent significant levels respectively. Where the abbreviations represent CRN (Credit to non-oil), CRO (Oil credit), EMP (Employment), GCF (Investment), GDP (Real Gross domestic product), INT (Maximum lending rate) and OEX (Official exchange rate)

For robustness, the results of Engle-Granger residual-based cointegration using the Z-statistics showed that all the models were cointegrated. Also, the R-squares were very high which confirmed the fitness of the models. This was also corroborated by the significant value of the Wald test. In view of the foregoing, it was evidenced that credit stimulated growth in the overall economy and non-oil credit was more impactful on economic growth than oil credit in Nigeria. This was buttressed by the negative effect of oil credit on oil GDP and the positive impact of non-oil credit on non-oil GDP. It was also clear from the analysis that output was not driven by labour employment as suggested by the negative relationship between employment and GDP. This, therefore, created enquiry for further research to see whether labour productivity could be the driver of GDP as suggested by Leshoro (2014) and Misra & Suresh (2014). Also, similar results were found when the aggregate GDP, both oil and non-oil GDP together with employment were expressed in per capita terms (see appendix).

6.0 CONCLUSION AND RECOMMENDATION

Dynamic OLS was employed to examine the relationship among credit, output and employment between 1985 and 2019. The substantive contribution of the study was the disaggregation of the economy into oil and non-oil sectors. Unit root tests using ADF and KPSS; and correlation analyses were performed as pre-estimation tests. The results of the unit root showed that the series were integrated of order one I(1). The findings showed that only non-oil credit was positive and significant for output and employment. Oil credit had a significant negative effect on output and employment. This broadened our intuition about the allocation of credit for economic growth in Nigeria. In addition, while aggregate GDP had a negative and significant effect on employment, the impact of employment on non-oil GDP was negative but insignificant. This implies that growth is not induced by changes in employment. The existence of long-run relationship among the variables was confirmed by the cointegration results based on the values of z-statistics.

The policy implication is that more credit should be prioritized for the non-oil sector in order to drive real growth in the economy. Government policy should focus on either promoting direct employment or removing barriers that limit output's potential to induce employment. This can be achieved by intensifying efforts on the provision of an enabling environment for small and medium-scale businesses. Furthermore, since weak currency implies a weak economy, the government can adopt macroeconomic policies that help to protect the value of the Naira from further depreciation. Finally, policy should focus on improving the productivity of the workforce in the non-oil sector, since the oil sector is not labour absorbing. This can be

achieved by incentivizing training and re-skilling of labour in the non-oil sector with huge output potential.

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APPENDIX

Table A1: DOLS result for Aggregate GDPC

Dependent variable: GDPC			
Variable	Coefficient	t-statistic	Std. Error
LOG(CRN)	0.437***	0.085	5.149
LOG(CRO)	-0.362***	0.038	-9.640
(OEX)	0.002***	0.001	3.460
(INT)	-0.011*	0.006	-1.806
LOG(GCF)	0.141	0.083	1.687
LOG(EMP)	0.800	0.807	0.992
C	-8.232***	1.866	-4.410
Adjusted R-squared	0.975408	Jarque-Bera (Prob.)	0.590548
Wald test (F-Stat)	146.7855***	Engle-Granger (Z-stat)	-54.90297***

Source: Author's computation. Note: ***,** and * indicate 1 per cent, 5 per cent and 10 per cent significant levels respectively. Where the abbreviations represent CRN (Credit to non-oil), CRO (Oil credit), EMP (Employment), GCF (Investment), GDPC (Per capita GDP), INT (Maximum lending rate) and OEX (Official exchange rate).

Table A2: DOLS result for Non-Oil GDPCN

Dependent variable: GDPCN			
Variable	Coefficient	t-statistic	Std. Error
LOG(CRN)	0.750**	0.336	2.232
(OEX)	-0.001	0.002	-0.429
(INT)	0.041*	0.021	1.893
LOG(GCF)	0.311	0.404	0.770
LOG(EMP)	-6.022*	3.039	-1.981
C	4.900	7.812	0.627
Adjusted R-squared	0.926224	Jarque-Bera (Prob.)	0.517374
Wald test (F-Stat)	52.14522***	Engle-Granger (Z-stat)	-81.1695***

Source: Author's computation. Note: ***,** and * indicate 1 per cent, 5 per cent and 10 per cent significant levels respectively. Where the abbreviations represent CRN (Credit to non-oil), EMP (Employment), GCF (Investment), GDPCN (Per capita non-oil GDP), INT (Maximum lending rate) and OEX (Official exchange rate).

Table A3: DOLS result for Oil GDPCN

Dependent variable: GDPCO			
Variable	Coefficient	t-statistic	Std. Error
LOG(CRO)	-0.250*	0.139	-1.792
(OEX)	-0.002	0.001	-1.213
(INT)	-0.024	0.017	-1.416
LOG(GCF)	-0.545	0.372	-1.464
LOG(EMP)	4.020**	1.824	2.204
C	-5.627	7.461	-0.754
Adjusted R-squared	0.751568	Jarque-Bera (Prob.)	0.009651
Wald test (F-Stat)	288.0730***	Engle-Granger (Z-stat)	-58.28569***

Source: Author's computation. Note: ***,** and * indicate 1 per cent, 5 per cent and 10 per cent significant levels respectively. Where the abbreviations represent CRO (Oil credit), EMP (Employment), GCF (Investment), GDPCO (Per capita oil GDP), INT (Maximum lending rate) and OEX (Official exchange rate).

ESTIMATING DYNAMIC STOCHASTIC GENERAL EQUILIBRIUM MODELS FOR MONETARY POLICY ANALYSIS IN LIBERIA

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Abstract

The need to have a structural model which analyzes the dynamic responses of macroeconomic variables to unexpected shocks and provides an idea of what policy reaction should be is of critical importance to policy makers, especially central bankers in their design and implementation of monetary policy. In this regard, this paper estimates a structural model, the Dynamic Stochastic General Equilibrium model, to analyze monetary policy, productivity, and exchange rate shocks on inflation and output gap in Liberia. The findings reveal that monetary policy shock has a transient negative impact on output gap, productivity shock has a persistent positive impact on inflation, while exchange rate shock has a transient negative impact on output gap but a persistent positive impact on inflation. These findings provide evidence that the monetary authority should exert effort in stabilizing the exchange rate and implement monetary policy to support productivity at a level that does not cause the economy to overheat and lead to undesirable inflation.

Keywords: Inflation, DSGE, Monetary Policy, Forecasting, Output gap, Shock.
JEL Codes: C53, E31, E52

Acknowledgement: The authors extend appreciation to the West African Institute for Financial and Economic Management (WAIFEM) for affording them the opportunity to attend the course on Dynamic Stochastic General Equilibrium Modeling. Most importantly, the authors would like to acknowledge the course facilitator, Prof. Afees Salisu Adebare, for his invaluable contribution and guidance, admitting that his selfless services and inputs played a key role in the production of this paper. Furthermore, the authors appreciate the Central Bank of Liberia for affording them the opportunity to attend the course

Disclaimer: The views and opinions herein expressed are those of the authors and do not necessarily represent the views of the Management of the Central Bank of Liberia.

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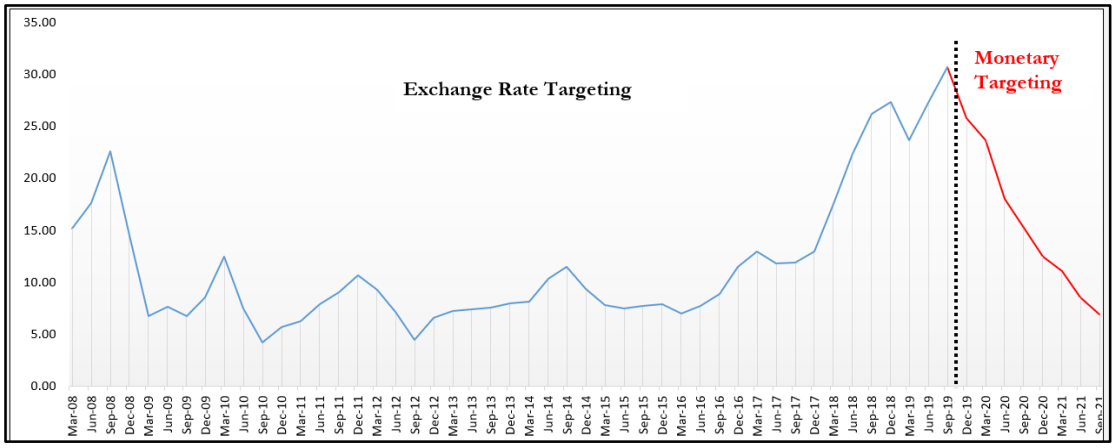
1.0 INTRODUCTION

Given the vital role that monetary policy plays in the macroeconomic development of countries, monetary authorities around the world have significantly improved the formulation and implementation of monetary policy as well as communication to their audience.

Over the past years, prior to November 2019, the Central of Liberia (CBL) employed an exchange rate targeting framework and largely relied on foreign exchange intervention as the major tool in implementing its monetary policy. This monetary policy tool allowed the CBL to directly mop up excess Liberian dollar liquidity from the foreign exchange market by auctioning hard currency, the United States (US) dollar, to importers and major vendors with the anticipation of restoring equilibrium to smooth out volatility in the exchange rate and narrow the exchange rate pass-through to inflation since Liberia is a highly dollarized economy as the US dollar is also used as a transaction currency.

To some extent, this approach provided short-term benefits in smoothing out volatility in the exchange rate and lowering inflation. However, the regular intervention by the Bank to sell hard currency exerted significant pressure on Liberia's gross international reserves and exposed the economy to greater risk in responding to external shocks, thereby putting significant pressure on the exchange rate and inflation.

Figure 1: Inflation Trend Under Exchange Rate Targeting and Monetary Targeting Regimes (in percent)



Source: Authors' calculation using Central Bank of Liberia's data

The limited availability of foreign exchange combined with the high cost associated with the implementation of the exchange rate targeting compelled the monetary authority to abandon this framework in favor of the monetary targeting framework which was adopted in November 2019 with the establishment of the Monetary Policy Advisory Committee (MPAC). The current framework has shown some effectiveness as evidenced by the decline in inflation from higher double digit to mid-single digit (from 30.55 percent in October 2019 to 4.42 in October 2021, Figure 1). However, the Liberian economy is still susceptible to shocks that significantly impact the conduct of monetary policy, and one of such unexpected shocks is the exchange rate shock.

The adoption of any monetary policy framework requires continuous improvements in monetary policy formulation and implementation as well as communication to the public. Like many central banks, the CBL provides an overview of Liberia's macroeconomic outlook and policy strategy to the public. Behind the scenes, this process involves the conduct of advanced macroeconomic analyses, informed by macroeocnometric models (such as Autoregressive Integrated Moving Average and Vector autoregressive models) and analytical tools to forecast and simulate policy responses. However, traditional macroeocnometric models have received strong criticisms, due to the lack of an optimization-based approach to the development of these models, as their parameters are not invariant to policy changes and other structural changes (Lucas, 1976 and Sargent, 1981).

Given this criticism, several structural models have been developed to address this shortcoming of relying on just traditional macroeconometric models for policy analysis and forecasting. This development has ensured that central banks have a suite of models at their disposal for policy analysis and forecasting. One of such structural models is the Dynamic Stochastic General Equilibrium (DSGE) model which has been mainly popularized in two strands of the literature: the Real Business Cycle framework which assumes flexible prices (Kydland and Prescott, 1982 and 1990) and the New-Keynesian framework which assumes price rigidities (Rotemberg and Woodford, 1997) and provides microeconomic foundations for Keynesian concepts (Gali and Gertler, 2007).

DSGE models are backed by fundamental macroeconomic and microeconomic theories, emphasizing the intertemporal choice for economic agents. In DSGE models, current choices are dependent on future uncertainties. The outcome of this dependence renders the models dynamic, thereby, assigning a key role to agents' expectations in determining current macroeconomic outcomes. The general equilibrium nature of DSGE models captures the interaction between agents' behavior

and policy actions. The potential and robustness of DSGE models in analyzing policy make them appealing to policymakers (Sbordone et al. 2010). According to Coletti and Murchison (2002), DSGE models are useful for monetary policy practices in that they can help to identify sources of fluctuations, answer questions about structural changes, generate forecasts, predict the effects of policy changes, and perform counterfactual experiments. DSGE models offer a concise framework for policy analysis and forecasting. Additionally, the models can be used to effectively conduct business cycle analysis, and they help to identify sources of variations while forecasting the impact of policy changes.

Considering the plausible features of DSGE models and the additional benefits they offer in terms of accounting for shocks in policy analysis and forecasting, this paper estimates New Keynesian DSGE models for Liberia to inform monetary policy formulation and implementation by the CBL. In the baseline model, the impacts of monetary policy and productivity shocks on key macroeconomic variables are analyzed. In order to analyze the impacts of exchange rate shock on the macroeconomy and how the CBL should respond, another model is estimated considering exchange rate shock in addition to the two shocks previously mentioned. Quarterly data on output, consumer price index, monetary policy rate and exchange rate for the period 2007Q1 to 2021Q2 are used.

The rest of the paper is structured as follows: section two provides the methodology and data used; section three presents the empirical results and analysis; while section four concludes the papers and presents policy recommendations.

2.0 METHODOLOGY AND DATA

2.1 Model

To assess the impacts of monetary policy and productivity shocks on inflation and output gap, this paper utilizes, as its theoretical foundation, the linearized version of the DSGE model presented by Woodford (2003, Chapter 4). The DSGE model consists of a suite of equations derived from economic theories, and therefore, has directly interpretable parameters. The model utilized in this paper consists of three equations that describe the behavior of households, firms, and central bank as specified in equations 1, 2 and 3, respectively. Details on the nonlinear DSGE model and the derivation of the equations are reported in the Appendix.

Equation 1 presents a Phillips Curve generated from optimization by firms (linearized form of eq. A1 in the appendix). The equation is in fact referred to as the New Keynesian Phillips Curve (NKPC) based on the Calvo (1983) and Taylor (1980)

staggered-contracts models (see Roberts, 1995). The equation specifies inflation (p_t) as a linear combination of future inflation (p_{t+1}) and the output gap (x_t). The parameter kappa (k) measures how responsive inflation is to excess demand in the economy and should have a positive sign. The parameter β captures inflation expectations.

$$p_t = \beta E_t p_{t+1} + k x_t \quad (1)$$

Household optimization gives rise to the Euler equation in 2 (linearized form of eq. A2 in the Appendix) which specifies output gap as a linear combination of future output gap (x_{t+1}), nominal interest rate (r_t), and a state variable (g_t) which captures changes in the natural level of output (see Appendix for derivation of g_t)

$$x_t = E_{t+1} x_{t+1} - (r_t - E_t p_{t+1} - g_t) \quad (2)$$

The central bank's monetary policy rule is presented in equation (3) (linearized form of eq. A3 in the Appendix) which specifies interest rate as a linear combination of inflation and a state variable (u_t) that captures movements in the interest rate that are not driven by inflation. The parameter $\frac{1}{\beta}$ captures the degree to which the central bank responds to movements in inflation.

$$r_t = \frac{1}{\beta} p + u_t \quad (3)$$

To complete the model, both state variables, u_t and g_t are modeled as first-order autoregressive processes in equations 4 and 5, respectively

$$\mu_{t+1} = \rho_u \mu_t + \epsilon_{t+1} \quad (4)$$

$$g_{t+1} = \rho_g g_t + \varepsilon_{t+1} \quad (5)$$

where ϵ_{t+1} is the shock to the state variable u_t (monetary policy shock); and ε_{t+1} is the shock to the state variable g_t (productivity shock).

To estimate the model specified above, a Maximum Likelihood estimator is employed using Stata 16.

2.2 Data

The paper utilizes quarterly data on monetary policy rate, inflation, and exchange rates for the period 2007Q1 to 2021Q2. Inflation is measured by the change in consumer price index (CPI). The exchange rate variable is measured as units of local currency per a unit of foreign currency, the US dollars, thus, a negative rate of change would imply an appreciation of the domestic currency. Data on these variables were obtained from the Central Bank of Liberia.

3.0 EMPIRICAL RESULTS AND ANALYSIS

This section presents the empirical results and analyzes the dynamic responses of macroeconomic variables to unexpected shocks to monetary policy, productivity, and exchange rate. It also provides suggestions on what should be the appropriate responses by policymakers at the central bank. Additionally, the section reports short-term forecasts for both inflation and monetary policy rates.

As a preliminary exercise, two models (one unrestricted and the other restricted) are estimated to select the best fit model for the data. In the restricted model, the value for the parameter beta is constrained at 0.5, implying that about 50 percent of agents set prices considering future prices. The preferred model is chosen based on the root mean squares error (RMSE) and forecast performance. Based on these criteria, the unrestricted model is chosen as the preferred model because it has lower RMSE and better projections for the forecast period. Hence, the analysis that follows is based on results from the unrestricted model.

In the structural matrix reported in Table 1, beta is statistically significant and has a value of 0.55, implying that about 55 percent of the economic agents in the Liberian economy set their prices considering future inflation. Thus, it is possible for the CBL to reduce the inflation rate by an appropriate monetary policy stance. The inverse of beta shows that for a percent increase in inflation, the CBL should adjust its policy rate by about 1.8 percentage points.

The policy matrix of the unrestricted model reports the initial impulse responses and is presented in Table 2 column 2. The result shows no significant impact of a unit shock to the state variable u_t (monetary policy shock) on inflation. This finding is in line with Leeper et al. (1996) assumption that price is not affected in the impact period of monetary policy shock. However, a unit shock to the state variable u_t increases monetary policy rate (MPR) by about 0.92 percent. These findings possibly imply a weak transmission mechanism that is likely due to the underdeveloped nature of the financial markets in Liberia. The results also show that a unit shock to the state variable g_t (productivity shock) has no significant impact on output gap and inflation in the initial period.

Additionally, the findings show an inverse and significant relationship between monetary policy shock and output gap. That is, a unit shock to the state variable (u_t) reduces output gap by an estimated 2.29 percent. This inverse relationship aligns with arguments in the macroeconomic literature that an increase in the rate of interest resulting from the monetary policy shock as discussed earlier reduces output (see for

example, Christiano, Eichenbaum and Evans, 1999). It is important to note that monetary policy shock significantly impacts output and not inflation, thus, suggesting the structural nature of inflation in Liberia.

The results of the impulse response functions (IRFs) further reveal that the response of output gap to monetary policy shock is transient, thus, indicating that the effect of unexpected changes in monetary policy on output is short-lived. Conversely, the impact of productivity shock on inflation seems to be persistent over time, highlighting the structural nature of inflation in Liberia.

The forecast values for inflation and monetary policy rate are reported in Table 3. The forecasts are realistic and supported by previous univariate time series models forecast produced. According to the forecast, inflation is expected to remain in single digit up to the last half of 2021 but is expected to marginally rise to about 8.9 percent in the fourth quarter of 2021. In contrast, the forecast for the monetary policy rate shows a downward trend but remains in double-digit.

Table 1: Structural Matrices

Variables	Unrestricted	Restricted
beta	0.551***	0.500
	(0.0788)	(0)
kappa	0.0133	0.0358
	(0.0403)	(0.0337)
rhou	0.587***	0.601***
	(0.115)	(0.113)
rhog	0.897***	0.895***
	(0.0535)	(0.0538)
1/beta	1.8143***	
	(0.2593)	
sd (e.u)	3.847***	3.919***
	(0.373)	(0.377)
sd (e.g)	11.86	6.542
	(28.35)	(4.294)
Obs.	54	54

Source: Authors' calculation using Central Bank of Liberia's data

Note: a) *** indicates that parameter estimates are statistically significant at 10%, 5% and 1% level of significance. b) The structural matrix presents results of the estimated structural model which specifies the theoretical relationship among the set of variables.

Table 2: Policy Matrices

Variables		Unrestricted	Restricted
Inflation			
	u	-0.0449	-0.1090
		(0.1248)	(0.0794)
	g	0.2058	0.3678
		(0.4896)	(0.2379)
Output Gap			
	u	-2.2890***	-2.1265***
		(0.7673)	(0.6944)
	g	7.8436	5.6679***
		(5.7448)	(2.83118
MPR			
	u	0.9185***	0.7820***
		(0.2353)	(0.1589)
	g	0.3734	0.7355
		(0.9272)	(0.4758)
Obs.		**54**	**54**

Source: Authors' calculation using Central Bank of Liberia's data
Note: a) *** indicates that parameter estimates are statistically significant at 1% level of significance.
b) The policy matrix is part of the state-space form of the DSGE model. It specifies the model's control variables as a function of the model's state variables.

Table 3: Two-Period Ahead Quarterly Forecast for Monetary Policy Rate and Inflation

	2021Q3	2021Q4	Confidence Interval
MPR	21.76	20.04	[16.0160 28.5192]
Inflation	8.55	8.92	

Source: Authors' calculation using CBL's data
Note: Inflation does not have confidence interval for its forecast because of zero standard deviation

3.1 Additional Analysis

This section provides additional analysis to support the findings from the baseline estimation by incorporating exchange rate shock in the unrestricted model. To do this, the Phillips curve in Equation 1 is modified as follows:

$$p_t = \beta E_t p_{t+1} + kx_t + \psi es_t \quad (6)$$

where es_t is a state variable capturing movements in inflation not driven by the exchange rate. To ensure that the model is solvable, another equation is specified linking the unobserved state variable es_t to the growth rate of the exchange rate, e_t, which is an observed exogenous variable:

$$e_t = es_t \quad (7)$$

To complete the model, a first-order autoregressive process for the unobserved state variable es_t is specified:

$$es_{t+1} = \rho_e es_t + \eta_{t+1} \quad (8)$$

where η_{t+1} is the shock to state variable es_t (exchange rate shock).

The results of the structural and policy matrices of the estimated model are reported below in Tables 4 & 5, respectively. The results of the structural matrix of this model with exchange rate shock is similar to those of the baseline unrestricted model in terms of the sign and magnitude of the estimated parameters, excluding the estimates of the new parameter and standard deviation characterizing the exchange rate shock.

The results of the policy matrix in Table 5 show that the impacts of monetary policy and productivity shocks on inflation are not significant in the initial period. However, a unit shock to the state variable es_t (exchange rate shock) is found to increase inflation by 0.27 percent, thus, implying that es_t has greater passthrough to inflation compared to shocks to u_t and g_t. This result of exchange rate shock increasing inflation corroborates the findings of Billmeier and Bonato (2004) on the impact of exchange rate shock on inflation in Croatia.

Additionally, all the state variables (u_t, g_t & es_t) are found to have significant impacts on output gap. While a unit shock to the state variables u_t reduces output by 2.44 percent, a unit shock to state variable g_t increases output gap by about 7.5 percent. A shock to state variable es_t reduces output by 3.35 percent. Interestingly, it is worth highlighting that the significant negative impact of exchange rate shock on output gap signals the high degree of import dependence of the Liberian economy. Depreciation of the Liberian dollars as a result of the exchange rate shock makes imports expensive for individuals and businesses mainly transacting in Liberian dollars

in the economy. The negative impact of depreciation on output gap is consistent with findings from previous studies (see, for example, Ahmed, 2003; Kandil, 2004).

In terms of the impacts of shocks on the monetary policy rate, exchange rate shock is found to positively impact monetary policy rate in the initial period, implying that exchange rate depreciation occasions monetary tightness by increasing policy rate. A unit shock to state variable es_t causes a 0.47 percent increase in the monetary policy rate. Also, the impact of monetary shock on the monetary policy rate is higher (at about 0.99 percent for a one-unit monetary policy shock).

Table 4: **Structural Matrix with Exchange Rate Shock**

Variables	**Coefficients (Standard Errors)**
beta	0.5735***
	(0.0564)
kappa	0.0000
	(0.0001)
psi	0.1245***
	(0.0369)
rhou	0.5907***
	(0.1147)
rhog	0.8663***
	(0.0637)
rho_e	0.9353***
	(0.0492)
$1/beta$	1.7438***
	(0.2593)
sd (e.u)	3.8406***
	(0.3696)
sd (e.g)	5954.22
	(32713.59)
sd(e.es)	4.0964
	(0.3952)
Obs.	54

Source: Authors' calculation using Central Bank of Liberia's data
Note: a) *** indicates that parameter estimates are statistically significant at 10%, 5% and 1% level of significance. b) The structural matrix presents results of the estimated

structural model which specifies the theoretical relationship among the set of variables.

Table 5: **Policy Matrix with Exchange Rate Shock**

Variables		Coefficients (Standard Errors)
Inflation		
	u	-0.0001
		(0.0005)
	g	0.0004
		(0.0020)
	es	0.2684***
		(0.0715)
Output Gap		
	u	-2.4429***
		(0.6848)
	g	7.4768**
		(3.5602)
	es	-3.3554**
		(2.6104)
MPR		
	u	0.9998***
		(0.0009)
	g	0.0006
		(0.0035)
	es	0.4681***
		(0.1330)
Obs.		**54**

Source: Authors' calculation using Central Bank of Liberia's data

Note: a) *** indicates that parameter estimates are statistically significant at 1% level of significance.

b) The policy matrix is part of the state-space form of the DSGE model. It specifies the model's control variables as a function of the model's state variables.

Results of the impulse response functions show that the impact of monetary policy shock on output gap is transient and significant up to three quarters whereas the impact of monetary policy shock on monetary policy rate persists up to the fifth quarter. The impacts of productivity shock on inflation and monetary policy rate are positive and persistent over the 8-quarter horizon. Exchange rate shock has persistent

positive impacts on price and monetary policy rate over the 8-quarter horizon but negative impact on output gap up to the fifth quarter.

4.0 CONCLUSION AND POLICY RECOMMENDATIONS

This paper is focused on estimating DSGE models for analyzing the impacts of monetary policy, productivity, and exchange rate shocks on key macroeconomic variables: inflation, output, and monetary policy rate. In the baseline model, the impacts of monetary policy and productivity shocks are analyzed. The findings show that, in the initial period, monetary policy shock impacts monetary policy rate but does not impact inflation and output gap. However, over the horizon (eight quarters), monetary policy shock is found to have a short-lived negative impact on output gap (up to the third quarter). Also, productivity shock is found to have a persistent positive impact on inflation over the full horizon, implying the structural nature of inflation in Liberia.

In the extended model which incorporates exchange rate shock, in the initial period, a shock to exchange rate is found to have a positive impact on inflation, whereas monetary policy and productivity shocks have no impact on inflation. However, results from impulse response functions show that the positive impact of productivity shock on inflation is permanent and lasts over the eight quarters. In terms of the impacts of shocks on output gap in the initial period, both monetary policy and exchange rate shocks have negative impacts while productivity shock has a positive impact. Over the horizon, monetary policy and exchange rate shocks have short-lived negative impacts on output gap (three quarters and four quarters, respectively). Additionally, monetary policy and exchange rate shocks positively impact MPR in the initial period whereas productivity shock has no impact. Over the horizon, productivity and exchange rate shocks have positive impacts on MPR for the entire eight quarters, while monetary policy shock positively impacts MPR up to the fifth quarter.

The finding that monetary policy shock induces monetary policy tightness through increase in the policy rate but does not impact inflation implies a weak monetary policy transmission mechanism possibly resulting from underdeveloped financial markets in Liberia. Thus, this paper recommends that that CBL works with relevant stakeholders (mainly the national government through the Ministry of Finance and Development Planning) to develop the financial markets which will enhance the monetary policy transmission mechanism.

In addition, given the finding that exchange rate shock negatively impacts output gap while productivity shock increases the gap, the paper recommends that the CBL

should endeavor to stabilize the exchange rate in a tolerable range and implement conducive monetary policy to support productivity (development finance) at a level that does not cause the economy to overheat and lead to undesirable inflation which undermines its main objective (price stability).

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Appendix

Derivation of Non-Linear DSGE Model

The following non-linear DSGE model capturing the behaviors of firms, households and the central bank is based on the work by Woodford (2003).

Optimization by firms generates equation (A1) linking current deviation of inflation from its steady state, $\pi_t - \pi$, to the expected value of the deviation of inflation from its steady state in the future, $E_t(\pi_{t+1} - \pi)$, and to the ratio of actual output, Y_t, to the natural level of output, Z_t.

$$(\pi_t - \pi) + \frac{1}{\phi} = \phi\left(\frac{Y_t}{Z_t}\right) + \beta E_t(\pi_{t+1} - \pi) \qquad \text{(A1)}$$

Optimization by households results into equation (A2) which links current output Y_t to future output, Y_{t+1}, expected inflation π_{t+1} and current nominal interest rate R_t.

$$\frac{1}{Y_t} = \beta E_t\left(\frac{1}{Y_{t+1}}\frac{R_t}{\pi_{t+1}}\right) \qquad \text{(A2)}$$

Equation (A3) describes the *central bank monetary policy rule* which shows how the central bank adjusts the interest rate in response to inflation and other factors not modeled.

$$\frac{R_t}{R} = \left(\frac{\pi_t}{\pi}\right)^{1/\beta} U_t \qquad \text{(A3)}$$

The state variables U_t captures all movements in interest rate not occasioned by inflation, while R is the steady-state value of interest rate.

Following Woodford (2003), the model in (A1) to (A3) is respecified by defining $X_t = Y_t/Z_t$ as the output gap.

$$(\pi_t - \pi) + \frac{1}{\phi} = \phi(X_t) + \beta E_t(\pi_{t+1} - \pi) \qquad \text{(A4)}$$

$$1 = \beta E_t\left(\frac{X_t}{X_{t+1}}\frac{1}{G_t}\frac{R_t}{\pi_{t+1}}\right) \qquad \text{(A5)}$$

$$\frac{R_t}{R} = \left(\frac{\pi_t}{\pi}\right)^{1/\beta} U_t \qquad \text{(A6)}$$

where $G_t = Z_{t+1}/Z_t$ is a state variable capturing changes in the natural level of output, Z_t.

Table A1. Impulse Response Function

	1			2		
Step	**irf**	**Lower**	**Upper**	**irf**	**Lower**	**Upper**
0	-8.8056	-11.8048	-5.8064	-0.1728	-0.6519	0.3063
1	-5.1708	-7.8275	-2.5140	-0.1015	-0.3830	0.1800
2	-3.0363	-5.1560	-0.9166	-0.0596	-0.2258	0.1066
3	-1.7830	-3.3638	-0.2022	-0.0350	-0.1336	0.0636
4	-1.0470	-2.1747	0.0807	-0.0205	-0.0793	0.0382
5	-0.6148	-1.3948	0.1652	-0.0121	-0.0472	0.0231
6	-0.3610	-0.8884	0.1664	-0.0071	-0.0282	0.0140
7	-0.2120	-0.5626	0.1386	-0.0042	-0.0169	0.0085
8	-0.1245	-0.3544	0.1054	-0.0024	-0.0101	0.0052
	3			**4**		
Step	**irf**	**Lower**	**Upper**	**irf**	**Lower**	**Upper**
0	93.0163	-178.9620	364.9940	2.4407	2.2052	2.6762
1	83.3972	-160.4720	327.2670	2.1883	1.9455	2.4311
2	74.7729	-143.9830	293.5290	1.9620	1.6686	2.2554
3	67.0405	-129.2690	263.3500	1.7591	1.4097	2.1085
4	60.1077	-116.1300	236.3460	1.5772	1.1794	1.9750
5	53.8918	-104.3910	212.1750	1.4141	0.9787	1.8495
6	48.3187	-93.8953	190.5330	1.2679	0.8054	1.7303
7	43.3219	-84.5052	171.1490	1.1367	0.6567	1.6168
8	38.8419	-76.0985	153.7820	1.0192	0.5297	1.5087

68% lower and upper bounds reported

(1) irfname = model1, impulse = u, and response = x

(2) irfname = model1, impulse = u, and response = p

(3) irfname = model1, impulse = g, and response = x

(4) irfname = model1, impulse = g, and response = p

Source: Authors' calculation using CBL's data

Table A2: Robustness Check for Interval Estimate for MPR. One-Sample t-test

	Obs.	Mean	Std. Err	Std. Dev	[68% Conf. Interval]	
X	3	22.26762	1.452966	2.516611	16.01601	28.51923

Mean = mean (x) t = 4.3027

Ho: mean = 16.01601		degrees of freedom = 2
Ha: mean < 16.01601	Ha: mean! = 16.01601	Ha: mean > 16.01601
Pr (T<t) = 0.9750	Pr (|T| >|t|) = 0.0500	Pr (T>t) = 0.0250

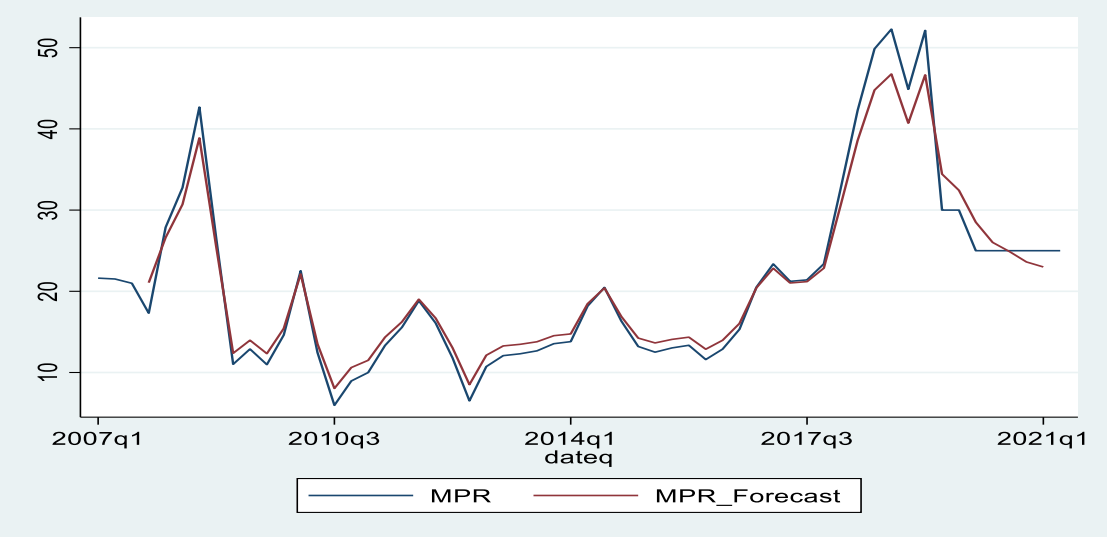
Source: Authors' calculation using Central Bank of Liberia's data

Table A3: Quarterly Forecast for Monetary Policy Rate, Inflation & Exchange Rate of Change

	2021Q3	2021 Q4	Confidence Interval
MPR	21.08	18.86	
Inflation	8.11	8.16	
Rate of Change in Exchange Rate appreciation (-)/depreciation (+)	- 13.0096	- 11.7237	

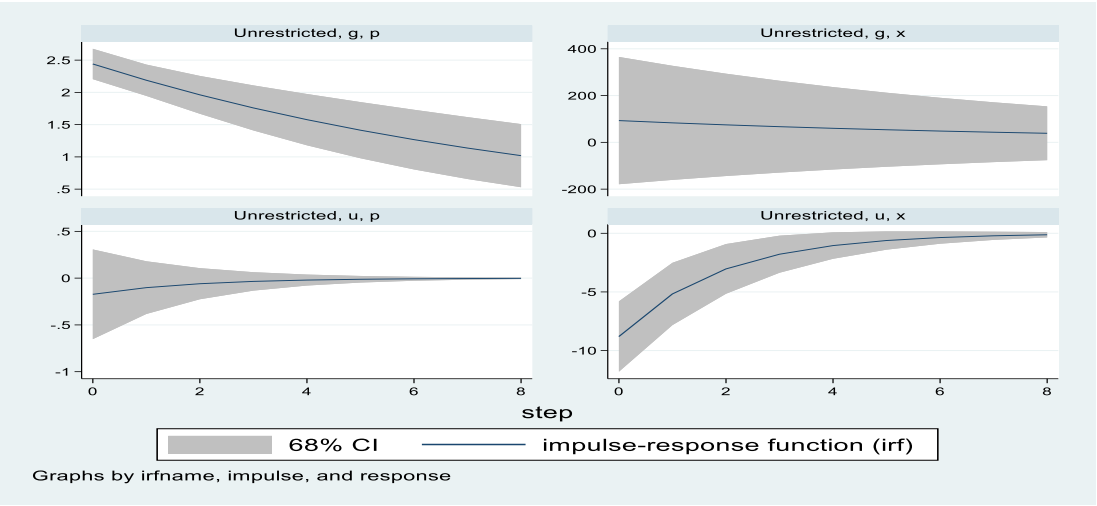
Source: Authors' calculation using Central Bank of Liberia's data

Figure A1: MPR and MPR Forecast



Source: Authors' construction using CBL's data

Figure A2: Impulse Response Functions



Source: Authors' construction using CBL's data

Table A4: Impulse Response Functions

	1			2		
Step	**irf**	**Lower**	**Upper**	**irf**	**Lower**	**Upper**
0	-9.3821	-12.1303	-6.6339	-0.0004	-0.0023	0.0016
1	-5.5419	-8.2003	-2.8836	-0.0002	-0.0013	0.0009
2	-3.2736	-5.4672	-1.0800	-0.0001	-0.0008	0.0006
3	-1.9337	-3.6000	-0.2674	-0.0001	-0.0005	0.0003
4	-1.1422	-2.3460	0.0616	0.0000	-0.0003	0.0002
5	-0.6747	-1.5157	0.1663	0.0000	-0.0002	0.0001
6	-0.3985	-0.9721	0.1750	0.0000	-0.0001	0.0001
7	-0.2354	-0.6196	0.1488	0.0000	-0.0001	0.0000
8	-0.1391	-0.3928	0.1147	0.0000	0.0000	0.0000
	3			**4**		
Step	**irf**	**Lower**	**Upper**	**irf**	**Lower**	**Upper**
0	3.8400	3.4724	4.2075	44518.3000	-198640.0000	287676.0000
1	2.2682	1.7833	2.7532	38566.0000	-172201.0000	249333.0000
2	1.3398	0.8091	1.8706	33409.5000	-149313.0000	216132.0000
3	0.7914	0.3281	1.2548	28942.5000	-129496.0000	187381.0000
4	0.4675	0.1044	0.8306	25072.8000	-112333.0000	162479.0000
5	0.2761	0.0086	0.5436	21720.4000	-97465.6000	140906.0000
6	0.1631	-0.0263	0.3525	18816.3000	-84583.9000	122216.0000

7	0.0964	-0.0341	0.2268	16300.5000	-73420.1000	106021.0000
8	0.0569	-0.0311	0.1449	14121.0000	-63742.9000	91985.0000

	5			6		
Step	**irf**	**Lower**	**Upper**	**irf**	**Lower**	**Upper**
0	2.1878	1.9783	2.3973	3.8151	3.2927	4.3374
1	1.8953	1.6716	2.1189	3.3050	2.7984	3.8116
2	1.6418	1.3605	1.9232	2.8631	2.2981	3.4281
3	1.4223	1.0873	1.7574	2.4803	1.8476	3.1129
4	1.2322	0.8578	1.6065	2.1487	1.4629	2.8345
5	1.0674	0.6683	1.4665	1.8614	1.1420	2.5808
6	0.9247	0.5133	1.3361	1.6125	0.8779	2.3471
7	0.8011	0.3873	1.2149	1.3969	0.6625	2.1313
8	0.6940	0.2855	1.1024	1.2101	0.4881	1.9321

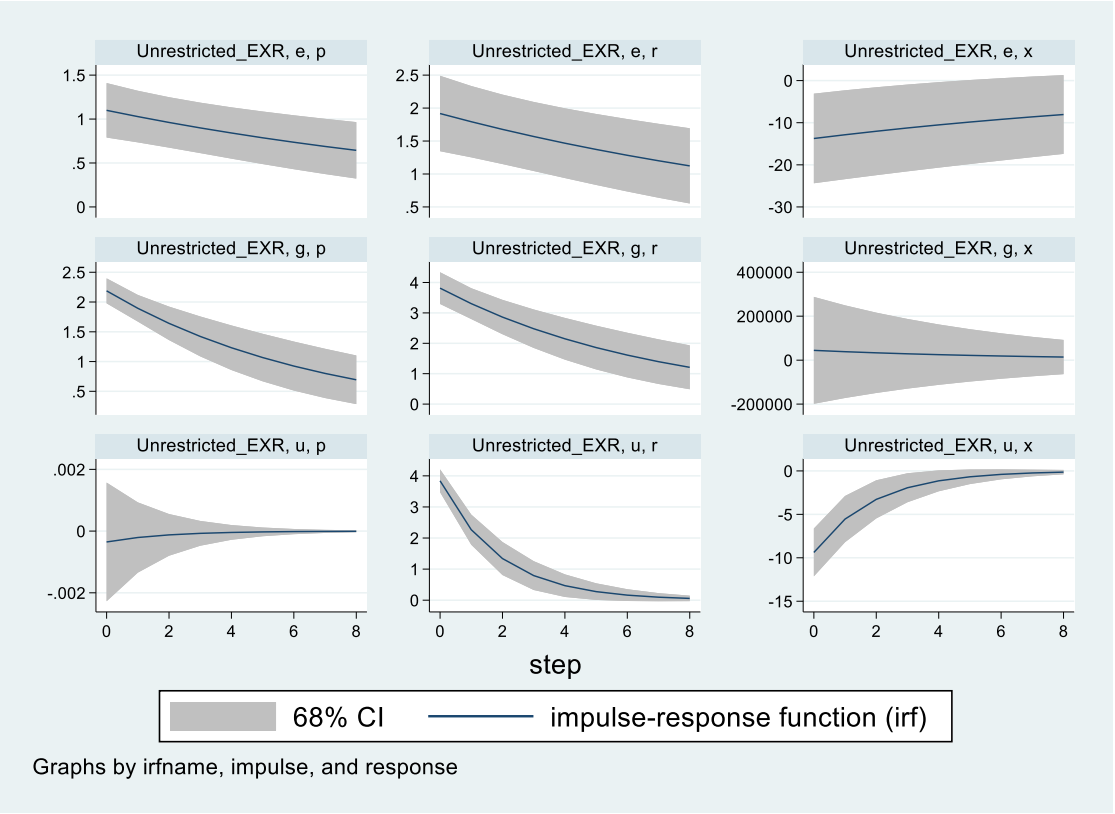
	7			8		
Step	**irf**	**Lower**	**Upper**	**irf**	**Lower**	**Upper**
0	-13.7452	-24.3773	-3.1132	1.0995	0.7896	1.4094
1	-12.8563	-23.4036	-2.3090	1.0284	0.7349	1.3219
2	-12.0248	-22.4613	-1.5884	0.9619	0.6750	1.2488
3	-11.2472	-21.5488	-0.9456	0.8997	0.6125	1.1869
4	-10.5198	-20.6650	-0.3746	0.8415	0.5496	1.1334
5	-9.8394	-19.8091	0.1303	0.7871	0.4882	1.0860
6	-9.2031	-18.9806	0.5744	0.7362	0.4295	1.0429
7	-8.6079	-18.1787	0.9629	0.6886	0.3743	1.0029
8	-8.0512	-17.4032	1.3008	0.6440	0.3229	0.9652

	9		
Step	**irf**	**Lower**	**Upper**
0	1.9173	1.3453	2.4894
1	1.7933	1.2523	2.3344
2	1.6774	1.1509	2.2039
3	1.5689	1.0451	2.0927
4	1.4674	0.9385	1.9963
5	1.3725	0.8343	1.9107
6	1.2838	0.7344	1.8331
7	1.2007	0.6402	1.7613
8	1.1231	0.5524	1.6938

68% lower and upper bounds reported

(1) irfname = model2, impulse = u, and response = x
(2) irfname = model2, impulse = u, and response = p
(3) irfname = model2, impulse = u, and response = r
(4) irfname = model2, impulse = g, and response = x
(5) irfname = model2, impulse = g, and response = p
(6) irfname = model2, impulse = g, and response = r
(7) irfname = model2, impulse = e, and response = x
(8) irfname = model2, impulse = e, and response = p
(9) irfname = model2, impulse = e, and response = r

Figure A3: Impulse Response Functions (Model with Exchange Rate Shock)



AN ANALYSIS OF MONETARY POLICY AND PRODUCTIVITY SHOCKS ON KEY POLICY INDICATORS FOR NIGERIA: A DSGE APPROACH

Joseph O.B. Tawose, Emmanuel O. James, Temitope J. Laniran, Olufunmilayo S. Tajudeen*[1], John O. Obeta

Abstract

This study investigates the impacts of monetary policy and productivity shocks on selected macroeconomic variables in Nigeria. Drawing from theoretical foundations and literature, we adopt the Dynamic Stochastic General Equilibrium (DSGE) model to analyse and forecast the impact of monetary policy and productivity shocks. The study employs quarterly data from 2002:M1 to 2020:M2. This study contributes to the literature by exploring the analysis of in-sample and out-of-sample forecasts. Results from the study suggest that monetary policy shocks have transient effects, while productivity shocks have lasting effects on monetary policy rate and inflation. The study concludes that maintaining a relatively stable interest rate is crucial for Nigeria.

Keywords: Monetary Policy Shocks, Productivity Shocks, DSGE Models, Forecast

JEL Classification Codes: E52 E58

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1.0 INTRODUCTION

Economies are often faced with shocks that distort real business cycles and often warrants a response from the economic managers in this case the monetary authorities/central banks mitigating distortion to monetary policy. Investigating the relationship among monetary policy, output and other key macroeconomic variables has therefore attracted a large volume of literature.

Models highlighting the interaction between the financial and real sectors can be broadly grouped into two. On the one hand, the New-Keynesians have argued that financial frictions alongside nominal frictions cause default risk, hence, the need for collateral and this is the basis for the margin between borrowing and lending rates. For instance, a study carried out by (Lacoviello, 2005) opines that changes to this margin are linked to movements in the underlying default risk and collateral value which end up having substantial effects on productivity. On the other end, the Real Business Cycle Economists focused on analysing the reverse causation between money and productivity. They posit that changes to monetary policy are linked to developments in monetary variables (Freeman and Kydland, 2000). Dia and Menna (2016) extended this position by highlighting a significant relationship among changes to monetary policy, other macroeconomic variables, and the real business cycle. They further argued that this explains why central banks emphasize interest rate, as it is a crucial channel for the transmission of monetary impulses.

The need for authorities to understand the stabilizing effect of policy on the fluctuations in the business cycle and other macroeconomic fundamentals have incited a lot of study in recent times. While, the use of monetary policy for macroeconomic stabilisation has been largely successful and well researched in the advanced economies, same cannot be said for developing economies, particularly those of Sub-Saharan Africa (SSA). According to Peiris, and Saxegaard, (2007) the vast literature on "the Science of Monetary Policy" is focused on industrial countries and advanced emerging markets, as such limiting the intuitions to the conduct of monetary policy in SSA, where the economic and policy settings are quite different.

Furthermore, attempts at understanding the relationship between monetary policy shocks and output in SSA and particularly in Nigeria have largely relied on testing for long-run relationships using some form of co-integration tests among others (Olayiwola, 2019 and Hammed, 2020). Adediran et.al, (2017) opined that many of the macroeconomic models that have been used for measuring the effect of monetary policy on the Nigerian economy lack the analytical specificity to account for the importance of shocks on output. Using a VAR model, they concluded that monetary

policy is capable of stabilizing output shocks in Nigeria. Uzoma et.al, (2017) using an SVAR model concluded that monetary policy in Nigeria has implications for manufacturing sector output. Similarly, Hammed (2020) found that shock to broad money supply would bring about a positive and significant impact on the manufacturing output, while the impact of a shock to interest rate was found to be negative and insignificant.

However, understanding the theoretical consensus that suggests a short-run influence of monetary policy on productivity warrants the need for a more precise understanding of the relationship. Moreover, the fact that productivity shocks in a given sector caused either by fluctuations in demand or supply may spill over to other sectors of the economy through input-output linkages as suggested by Acemoglu et al. (2012). It is therefore important to understand the dynamics between monetary policy and productivity shocks. It is notable, however, that in understanding these dynamics, methodological issues do exist. For instance, there is the issue of the somewhat overreliance on testing for long-run relationships using some form of co-integration tests among others as earlier pointed out. This path grapples with the challenge of lacking the analytical specificity to account for the importance of shocks on output. The adoption of the DSGE model in our study is remarkably an attempt at addressing the observed drawback. In the light of the foregoing, this study attempts to investigate the relationship between monetary policy and productivity shocks in Nigeria using the Dynamic Stochastic General Equilibrium (DSGE) approach.

This, we did, based on many attractions to the DSGE models, particularly for macroeconomic policy analysis. The fact that they are structural in nature and as such there are economic interpretations to each equation thereby making it easy to identify policy interventions and transmission channels, as well as the ability to optimize behaviours of economic agents, makes it very useful for policy analysis (Dotsey, 2013). In addition, their stochastic nature which enables the analysis of shocks and their percolation process, as well as their forward-looking capacity which allows to forecast future behaviours of economic agents, makes them very attractive.

In this paper, we develop a macroeconomic model to analyse monetary policy and productivity shocks using data from Nigeria. As compared to most previous studies, we situate our analysis within the context of the new Keynesian DSGE model. We attempt to answer three fundamental questions. First, we investigate the nature of the relationship between monetary policy and productivity in the Nigerian economy. Second, we analyse the interactions (including the shocks) amongst monetary policy actions of the Central Bank (i.e., the price level against the backdrop of the existence

of double-digit inflation in the economy, interest rate and output gap. Third, we attempt to design a policy matrix and model for forecasting the trajectory of inflation using the DSGE model.

The result of our analysis shows a transient effect of monetary policy shocks on monetary policy rate (MPR) and Inflation while productivity shocks have lasting effects and feed into the output gap which is an indicator of economic performance.

The rest of the study is presented as follows: Section two presents stylised facts, section three outlines our model in detail, while section four presents results, and section five concludes the study.

2.0 STYLISED FACTS

The Nigerian economy, like all other emerging economies, reacts to monetary policy actions of the relevant authorities in various ways. While investigations continue regarding the scale and nature of these reactions including the relationship types amongst many macroeconomic variables, however, monetary policy actions in Nigeria have certainly had significant effects over the years.

Two broad categories of tools - direct tools and indirect (market-based) tools are usually in use in most economies including Nigeria. The Central Bank of Nigeria (CBN) adopted direct tools to regulate the interest rate and bank credit. Deployment of these direct tools appears to give expression to the earlier mentioned Real Business cycle economic thinkers in respect of the relationship among changes to monetary policy, other macroeconomic variables, and the real business cycle. The CBN evidently recognizes the role of interest rate as a crucial channel for transmitting monetary impulses to the entire economy.

Given a typical free-market economy, the interaction between the forces of demand and supply gives rise to both price determination and resources allocation. Direct instruments of monetary control as identified by the CBN include credit ceilings, secretarial credit allocation, interest rate controls, imposition of special deposits, moral suasion, movement of government deposits, stabilization securities and exchange controls, etc. (CBN, 2007). Equally, the indirect or market–based tools of monetary policy are open market operations (OMO), variation of reserve requirements and discount window operations.

Nigeria had for a long time relied almost entirely on the use of direct instruments of monetary control in the conduct of monetary policy. The identified direct tools have

at different time intervals been applied in varying combinations. In Ibeabuchi, (2007), it was noted that the economic conditions that influenced monetary policy before 1986 were mainly dominated by the oil sector, and the increasing role of the public sector in the economy. Specifically, to achieve price stability, amongst other macroeconomic objectives, the monetary authority relied on direct monetary instruments which included: credit ceilings, selective credit and interest rate controls, exchange rate regimes and cash reserve requirements. Also, Ajayi (1999) observes that the use of market-based instruments prior to the 1986/7 reforms was not viable due to the underdeveloped nature of the financial markets and the deliberate restraint on interest rates.

Soludo (2008) noted that the conduct of monetary policy, prior to the reforms, resulted into low nominal interest rate, high inflation and as such yielded negative real return which discouraged savings, investment, and growth. However, following fundamental reforms which started largely in the 1980s, (the introduction of the Structural Adjustment Programme (SAP), the Financial Sector Reforms in 1987 etc), the CBN began a gradual shift from the use of direct instruments to market-based instruments. In June 1993, Open Market Operation (OMO) was introduced by the CBN as a bold step toward the adoption of market based monetary policy stance. Other market-based tools that came into operation include reserve requirements, discount window operations, forex sales and standing facility. It is deducible from the foregoing that Nigeria's financial sector, by virtue of some fundamental and structural reforms, has acquired enormous capacity and resilience in the use of indirect policy tools in achieving policy objectives.

3.0 METHODOLOGY AND DATA DESCRIPTION

3.1 Brief Description of the Model

Drawing from theoretical foundations, we analyse the impacts of monetary policy and productivity shocks on inflation and interest rate for Nigeria, using the Dynamic Stochastic General Equilibrium (DSGE) model. Models of this type are popular in describing monetary policy in both academic and policy settings (Salisu and Yaya, 2021) and its suitability in estimating shocks is well established in existing studies (e.g., see Nam and Wang, 2017; Christiano, Eichenbaum and Evans, 2005 & Peiris and Saxegaard, 2007). The DSGE model is a system of equations that are relatable to economic theories and normally used for policy analysis and forecasting. As stated in Sbordone, Tambalotti, Rao, and Walsh, (2010), "One of the fundamental features of DSGE models is the dynamic interaction between three interrelated blocks[4]—in the

[4] According to Sbordone, Tambalotti, Rao, and Walsh, 2010, the DSGE model is structured around three blocks: the demand block, supply block and the rate.

sense that expectations about the future are a crucial determinant of today's outcomes". In this regard, we employ the DSGE model to analyse the impact of monetary policy and productivity shocks on inflation, interest rate and more subtly, the output gap in Nigeria as well as provide a realistic forecast of the variables.

3.2 Model Specification

Following Woodford (2003), a general nonlinear DSGE model with equations that capture households', firms', and central banks' behaviour is specified as follows:

Household Optimization Equation:

$$\frac{1}{Y_t} = \beta E_t \left(\frac{1}{Y_{t+1}} \frac{R_t}{\Pi_{t+1}}\right) \quad (1)$$

where β is the household's willingness to delay consumption; Eq. (1) states that current output Y_t is a function of expected output Y_{t+1}, expected inflation Π_{t+1} and current nominal interest rate (i.e., the monetary policy rate) R_t.

Firm Optimization Equation:

$$(\Pi_t - \Pi) + \frac{1}{\phi} = \phi \left(\frac{Y_t}{Z_t}\right) + \beta E_t (\Pi_{t+1} - \Pi) \quad (2)$$

where ϕ is a parameter for the pricing decision of firms; Eq. (2) presents the relationship between the ratio of actual output Y_t to the natural level of output Z_t and also current deviation of inflation from its steady-state $(\Pi_t - \Pi)$ to the expected value of the deviation of inflation from its steady-state in the future $E_t (\Pi_{t+1} - \Pi)$

Central Bank Optimization Equation:

$$\frac{R_t}{R} = \left(\frac{\Pi_t}{\Pi}\right)^{1/\beta} U_t \quad (3)$$

where R is the steady-state value of the interest rate and U_t is a state variable that captures all movements in the interest rate not driven by inflation. The central bank adjusts the interest rate in response to inflation and other factors not incorporated.

As stated in Woodford (2003), we further rewrite Eqs. 1-3 in Eqs. 4-6 such that $X_t = Y_t/Z_t$ defines the output gap:

$$1 = \beta E_t \left(\frac{X_t}{X_{t+1}} \frac{1}{G_t} \frac{R_t}{\Pi_{t+1}}\right) \quad (4)$$

$$(\Pi_t - \Pi) + \frac{1}{\phi} = \phi X_t + \beta E_t (\Pi_{t+1} - \Pi) \quad (5)$$

$$\frac{R_t}{R} = \left(\frac{\Pi_t}{\Pi}\right)^{1/\beta} U_t \quad (6)$$

Where $G_t = Z_{t+1}/Z_t$ is a state variable that captures Z_t.

Finally, equations for the state variables are stated in logarithms as follows:

$$ln(G_{t+1)} = \rho_g ln(G_t) + \xi_{t+1} \quad (7)$$

$$ln(U_{t+1)} = \rho_g ln(U_t) + e_{t+1} \quad (8)$$

A more concise system of nonlinear DSGE equations tailored to our study is presented in appendix A.

3.3 Estimation Procedure

This study adopts the Maximum Likelihood (ML) procedure to estimate the non-linear DSGE model. Empirically estimated DSGE models using non-linear Maximum Likelihood technique capture the effect of big shocks and the role of risk for economic behaviour which other methods may not have captured (Kollmann, 2017).

Before our estimations, we compute the annualized inflation rate using the quarterly time series. In addition to this, our parameter estimates are obtained by imposing restrictions on selected parameters in the computation of inflation. Introducing restrictions are known to make unidentified parameters in a model identified (See Salisu & Yaya, 2021). In other words, prior restriction of parameters attempts to overcome identification issues in DSGE models. Therefore, we define constraints that best suits our model by setting the parameters thus:

$\beta = 0.5,\ \psi = 1.5$

While theoretical monetary policy rules assume a beta (β) of 0.5 and Psi (ψ) of 2, various rich studies have adopted several values within this range. For example, Kollmann, (2017) set beta (β) at 0.99 which is consistent with Ratto, Roeger & Veld, (2008) where it was set as 0.996.

3.3.1 Post - Estimation Analysis

Having carried out an estimation of our parameters, we conduct some post estimation analysis. These do not only provide robustness for our estimated model(s); it also seeks to achieve the objectives of this study. These include the policy matrix of parameters which provides an intuition as to the effect of a unit of monetary policy and productivity shock on the control variables i.e., inflation rate and the monetary policy rate; the impulse response analysis (graphs and tables) and in-sample and out of sample forecasts using forecast estimates. The Interval estimates were conducted using confidence intervals of 95%, 90% and 68%.

Finally, we conducted a sensitivity analysis to ascertain the optimal fit of the structural parameters. All estimations are carried out using STATA 16 statistical package.

3.4 Data: Sources, Description and Summary Statistics

For the estimations of our DSGE model, we employ quarterly data covering the period 2002Q1-2020Q2. The study considers two (2) main variables: inflation (inf) and monetary policy rate (mpr) as proxies for inflation rate and interest rate, respectively.

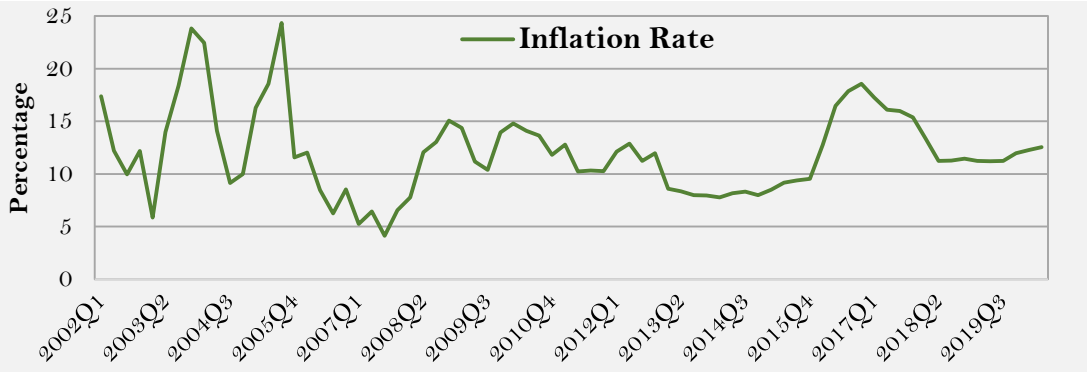
The data are sourced from the Central Bank of Nigeria (CBN) Statistics Department, as well as the statistical database. Table 1 and Figure 1 are summary statistics and the graphical representation of trends of the variables over the period, respectively.

Table 1: Summary Statistics

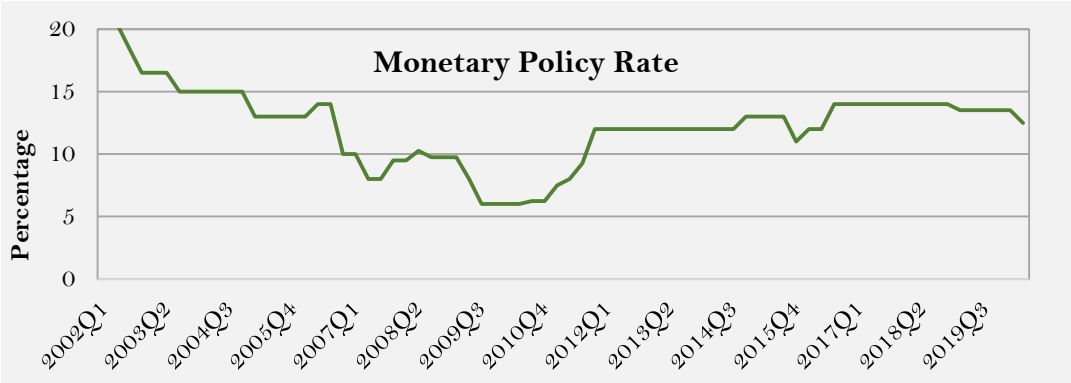
Variable	Label	Obs.	Mean	SD	Min.	Max.
Inflation Rate (%)	*Inf*	74	12.0523	4.0770	4.1200	24.3200
Monetary Policy Rate (%)	*Mpr*	74	12.2534	3.1119	6.0000	20.5000

Source: Compiled by Authors

Figure 1: Trends of the Selected Variables



Source: CBN Statistical Database



Source: CBN Statistical Data

4.0 RESULTS AND DISCUSSIONS

Table 2 presents the estimated structural parameters of the model. Our parameter estimates are obtained by imposing restrictions on selected parameters (specifically with beta and psi restricted to 0.5 and 1.5, respectively). Introducing these restrictions are known to make unidentified parameters in a model identified (See Salisu & Yaya, 2021). In other words, prior restriction of parameters attempts to overcome identification issues in DSGE models. Furthermore, our decision for choosing the above restrictions of the parameters is drawn from the theoretical monetary policy assumptions of setting beta (β) equal to 0.5 and Psi (ψ) of 2, as well as probing further into arguments by studies such as Kollmann, (2017) and Ratto, Roeger & Veld, (2008).

More so, the Kappa parameter in Table 2 below is the coefficient of output gap derived from the Philips equation stated in the methodology specification. The Kappa parameter tells how much output gap (which can also be redefined in terms of employment level) responds to changes in inflation level in the economy. The inclusion of the parameter in the model is vital to establish the relationship between inflation, output, and interest rates in the model. The Rhou and Rhog parameters represent the level of persistence in monetary and productivity shocks respectively.

4.1 Results

4.1.1 Structural Parameters

From the results in Table 2, the coefficients of monetary policy shocks (u: 0.697) and productivity shocks (g: 0.976) are statistically significant with productivity shocks showing more persistence. Thus, monetary policy plays a transient role in terms of impact on inflation and interest rates (the monetary policy rate in this case), compared to the productivity shocks. This is, however, not unexpected as the monetary policy instrument here is a short-term instrument. However, we do not make an early conclusion at this point, but to probe further by reporting the policy matrix to explain more broadly, the transmissions of these shocks. The Kappa coefficient is also positive and statistically significant. We interpret the kappa parameter here (coefficient of output gap) with caution as the policy matrix below will provide the reason for this result and which shock triggers a positive effect on the output gap.

Table 2: Structural Parameters

Variables	(1)	(2)
Beta	0.500	
Kappa	0.253**	
Psi	1.500	
Rhou	0.696***	
Rhog	0.976***	
sd (e.u)		4.399***
sd (e.g)		0.353***
Observations	74	74

Notes:

1. Beta and Psi are restricted to 0.5 and 1.5 respectively following economic theory as provided in the methodology section
2. Standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1
3. The sd(e.u) and sd(e.g) are the responses of own shocks

4.1.2 Policy Matrix

The policy Matrix in Table 3 shows that monetary policy shocks that propel the monetary authorities to increase the MPR by 0.05 per cent will in turn cause inflation to fall by 0.63 per cent. Consequently, the contractionary monetary policy triggers a decline in the output gap by 1.6 per cent suggesting that actual economic output is below the economy's full capacity. The result is not farfetched from apiori expectation and economic theory as the target of every monetary authority is to maintain price stability by curtailing inflationary trends. However, there is an acceptable level of inflation to which productivity/output and economic growth thrive and below this level, the economy operates below its full capacity. This comes into bear in the result shown in Table 3 below as it provides suggestions as to why the output gap falls when the monetary authorities adjust the monetary policy rate to control inflation. While the target of checking inflationary trends may be met, it might have its consequent effect on the economy's output growth. Hence, there is need for policy sequencing by monetary policy authorities to meet several targets, to avoid incurring negative costs/externalities in the process of implementing one policy over another.

On the other hand, productivity shocks cause the output gap to increase by 3.52 per cent meaning that the economy is outperforming expectations. This causes aggregate demand to increase and hence inflation to about 1.74 per cent. The monetary policy authorities thus respond to this by increasing interest rates to 2.61 per

cent to mop-up inflation. However, it is important to view the productivity shocks here as being a positive one as these will drive investors to invest more which could trigger inflationary trends.

The result from the policy matrix shows that both productivity shocks and monetary policy shocks have opposing effects on the output gap. While productivity shocks will improve economic conditions through their positive effect on the output gap, however, not without the cost of increasing inflation, monetary policy shocks on the other hand in an attempt to reduce inflation affects the output gap negatively. Thus, the need for policy sequencing by the monetary authorities cannot be overemphasized.

Table 3: Policy Matrix

Coefficient	Standard Error	Z	P-Value	[95% Confidence	Interval]
			INF		
u -0.630***	0.015	-41.440	0.000	-0.660	-0.601
g 1.743***	0.247	7.060	0.000	1.259	2.227
			X		
u -1.623***	0.602	-2.700	0.007	-2.802	-0.444
g 3.526**	1.454	2.420	0.015	0.676	6.377
			MPR		
u 0.054**	0.023	2.380	0.017	0.010	0.099
g 2.614***	0.370	7.060	0.000	1.888	3.340

Notes:

1. u denotes the effect of monetary policy shocks on the various variables of interest, while g denotes the effect of productivity shocks to the various variables
2. 95 per cent confidence interval was also reported. *** p<0.01, ** p<0.05, * p<0.1.
3. INF, X and MPR denotes Inflation, Output gap and Monetary policy rate respectively

4.1.3 Impulse Response Functions (IRFs)

Tables 4 and 5 present the impulse responses of the variables (monetary policy rate and inflation) to monetary and productivity shocks at different periods at 95 per cent confidence interval. Table 4 shows that MPR responds to monetary policy shocks for only periods 0 to 2 meaning that the effect of monetary policy shock on MPR is temporary. However, this is not the case for productivity shocks as productivity shock on MPR as shown in table 5. The effect of productivity shock is permanent on MPR

which follows expectation. However, the effect of monetary policy shocks on inflation persists until the 3rd period, while productivity shocks have a lasting effect on inflation.

Table 4: Response of MPR and INF to Monetary Policy Shocks

Step	Model 1	Impulse=u	Response=mpr	Model 2	Impulse=u	Response=inf
	IRF	Lower	Upper	IRF	Lower	Upper
0	0.239	0.039	0.440	-2.773	-3.239	-2.307
1	0.167	0.022	0.311	-1.930	-2.472	-1.389
2	0.116	0.005	0.226	-1.344	-1.993	-0.695
3	0.081	-0.006	0.168	-0.936	-1.591	-0.280
4	0.056	-0.013	0.126	-0.651	-1.253	-0.050
5	0.039	-0.016	0.094	-0.453	-0.974	0.067
6	0.027	-0.016	0.071	-0.316	-0.749	0.118
7	0.019	-0.015	0.053	-0.220	-0.571	0.132
8	0.013	-0.013	0.040	-0.153	-0.432	0.127

Notes:

1. Table 4 presents the response of monetary policy rate and inflation to monetary policy shocks. Impulse=u denotes the impulse of the monetary policy shocks while response=mpr and response=inf denote the response of both monetary policy rate and inflation to the shocks u, respectively.
2. An interval of period zero to 8 is included, while IRF denotes the impulse response function. The intervals included are the 95 per cent confidence interval.

Table 5: Response of MPR and INF to Productivity Shocks

Step	Model 3	Impulse=g	Response=mpr	Model 4	Impulse=g	Response=inf
	IRF	Lower	Upper	IRF	Lower	Upper
0	0.924	0.775	1.073	0.616	0.516	0.716
1	0.901	0.752	1.050	0.601	0.502	0.700
2	0.879	0.718	1.041	0.586	0.478	0.694
3	0.858	0.675	1.041	0.572	0.450	0.694
4	0.837	0.628	1.046	0.558	0.418	0.698
5	0.817	0.579	1.054	0.544	0.386	0.703
6	0.797	0.530	1.064	0.531	0.353	0.709
7	0.777	0.481	1.073	0.518	0.321	0.716
8	0.758	0.434	1.083	0.506	0.289	0.722

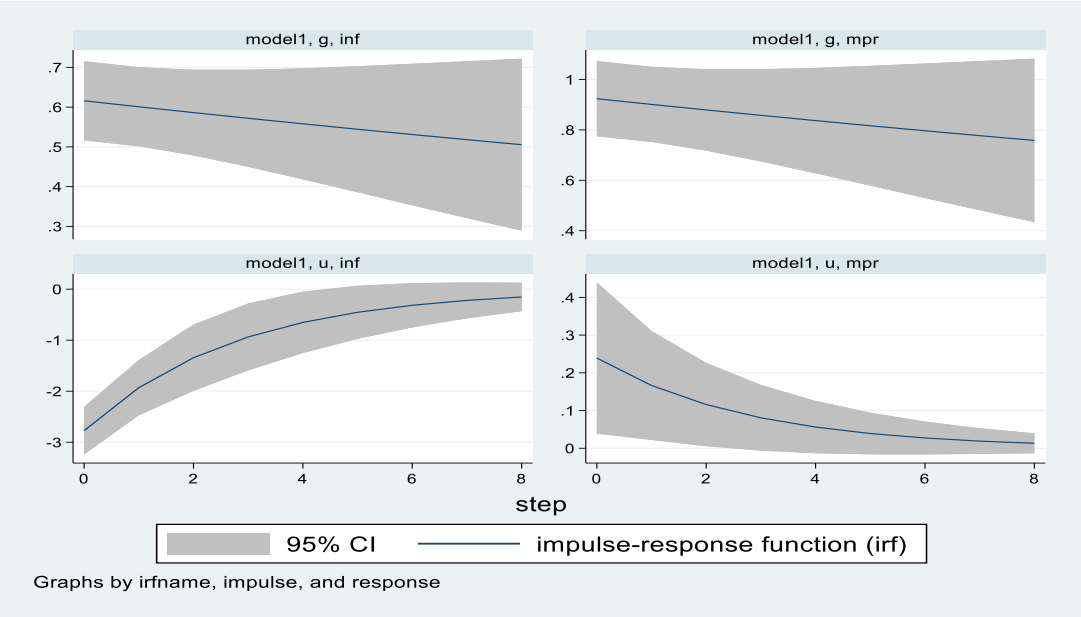
Notes:

1. Table 5 presents the response of monetary policy rate and inflation to productivity shocks
2. Impulse=u denotes the impulse of the monetary policy shocks while response=mpr and response=inf denotes the response of both monetary policy rate and inflation to the shocks u, respectively.

3. An interval of period zero to 8 is included, while IRF denotes the impulse response function. The intervals included are the 95 per cent confidence interval.

Figure 2 presents the graph of the impulse response function of the effects of monetary policy and productivity shocks on inflation and monetary policy rate. The results again confirm the discussion above from the policy matrix that while the effect of monetary policy shock is transient on monetary policy rate, productivity shock persists more on the monetary policy rate. Similarly, the effect of monetary policy shock on inflation is temporary (although extends for 3 periods), while that of productivity shock on inflation is long-lasting.

Figure 2: Impulse Response Graph at 95 Per cent Confidence Interval



Notes:

1. Figure 2 is the impulse response function of the response of inflation and mpr to both monetary policy and productivity shocks at a 95% confidence interval

Impulse Response Function at 90 per cent Confidence Interval

Probing further, we also carry out the same estimation at a different confidence interval to see if similar results as that of the 95 per cent confidence interval suffice. At 90 per cent, however, mpr responds to monetary policy shocks until the third period, while productivity shocks still show lasting effects. Inflation on the other hand responds to monetary policy shocks until the 5th period, while productivity shocks have a permanent effect on inflation. These are presented in Tables 6 and 7, respectively.

Table 6: Response of MPR and INF to Monetary Shocks

Step	Model 1	Impulse=u	Response=mpr	Model 2	Impulse=u	Response=inf
	IRF	Lower	Upper	IRF	Lower	Upper
0	0.239	0.071	0.407	-2.773	-3.164	-2.382
1	0.167	0.045	0.288	-1.930	-2.385	-1.476
2	0.116	0.023	0.209	-1.344	-1.888	-0.799
3	0.081	0.008	0.154	-0.936	-1.486	-0.385
4	0.056	-0.002	0.114	-0.651	-1.156	-0.146
5	0.039	-0.007	0.085	-0.453	-0.890	-0.016
6	0.027	-0.009	0.064	-0.316	-0.680	0.048
7	0.019	-0.010	0.048	-0.220	-0.515	0.075
8	0.013	-0.009	0.035	-0.153	-0.388	0.082

Notes:

1. Table 6 presents the response of monetary policy rate and inflation to monetary policy shocks. Impulse=u denotes the impulse of the monetary policy shocks while response=mpr and response=inf denotes the response of both monetary policy rate and inflation to the shocks u, respectively.
2. An interval of period 0 to 8 is included, while IRF denotes the impulse response function. The intervals included are the 90 per cent confidence interval.

Table 7: Response of MPR and INF to Productivity Shocks

Step	Model 3	Impulse=g	Response=mpr	Model 4	Impulse=g	Response=inf
	IRF	Lower	Upper	IRF	Lower	Upper
0	0.924	0.799	1.049	0.616	0.532	0.700
1	0.901	0.776	1.027	0.601	0.517	0.684
2	0.879	0.744	1.015	0.586	0.496	0.677
3	0.858	0.704	1.012	0.572	0.469	0.674
4	0.837	0.661	1.013	0.558	0.441	0.675
5	0.817	0.617	1.016	0.544	0.411	0.677
6	0.797	0.573	1.021	0.531	0.382	0.681
7	0.777	0.529	1.026	0.518	0.353	0.684
8	0.758	0.486	1.031	0.506	0.324	0.687

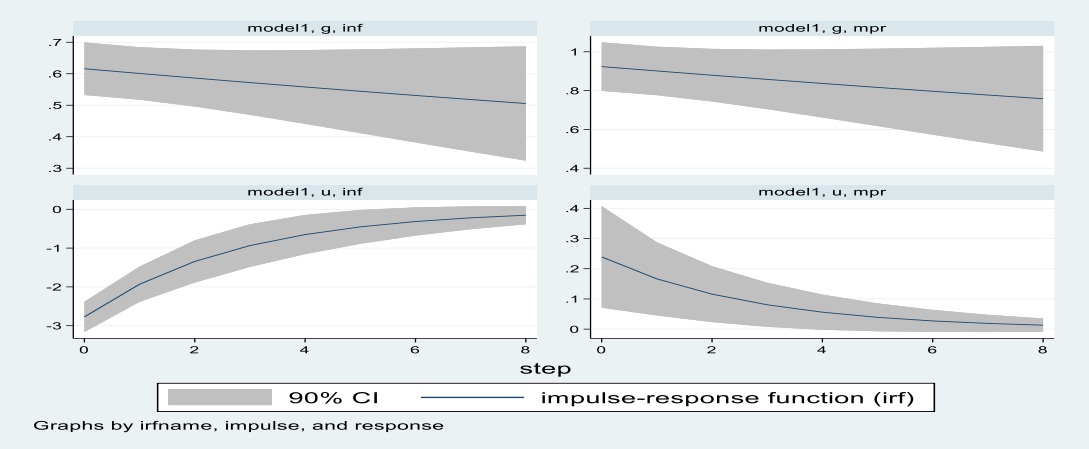
Notes:

1. Table 7 presents the response of monetary policy rate and inflation to productivity shocks. Impulse=u denotes the impulse of the monetary policy shocks while

response=mpr and response=inf denotes the response of both monetary policy rate and inflation to the shocks u respectively.

2. An interval of period zero to 8 is included, while IRF denotes the impulse response function. The intervals included are the 90 per cent confidence interval.

Figure 3: Impulse Response Function at 90 Per cent Confidence Interval



Notes:

1. Figure 3 shows the impulse response function of the response of inflation and mpr to both monetary policy and productivity shocks at 90% confidence interval

Impulse Response Function at 68 per cent Confidence Interval

At a 68 per cent confidence interval, however, both productivity and monetary policy shocks have lasting effects on MPR and inflation.

Table 8: Response of MPR and INF to Monetary Shocks

Step	Model 1	Impulse=u	Response=mpr	Model 2	Impulse=u	Response=inf
	IRF	Lower	Upper	IRF	Lower	Upper
0	0.239	0.137	0.341	-2.773	-3.009	-2.537
1	0.167	0.093	0.240	-1.930	-2.205	-1.656
2	0.116	0.060	0.172	-1.344	-1.673	-1.015
3	0.081	0.036	0.125	-0.936	-1.268	-0.603
4	0.056	0.021	0.091	-0.651	-0.957	-0.346
5	0.039	0.011	0.067	-0.453	-0.718	-0.189
6	0.027	0.005	0.049	-0.316	-0.536	-0.096
7	0.019	0.002	0.036	-0.220	-0.398	-0.041
8	0.013	-0.000	0.027	-0.153	-0.295	-0.011

Notes:

1. Table 8 presents the response of monetary policy rate and inflation to productivity shocks. Impulse=u denotes the impulse of the monetary policy

shocks, while response=mpr and response=inf denotes the response of both monetary policy rate and inflation to the shocks u respectively.

2. An interval of period 0 to 8 is included, while IRF denotes the impulse response function. The intervals included are the 68 per cent confidence interval

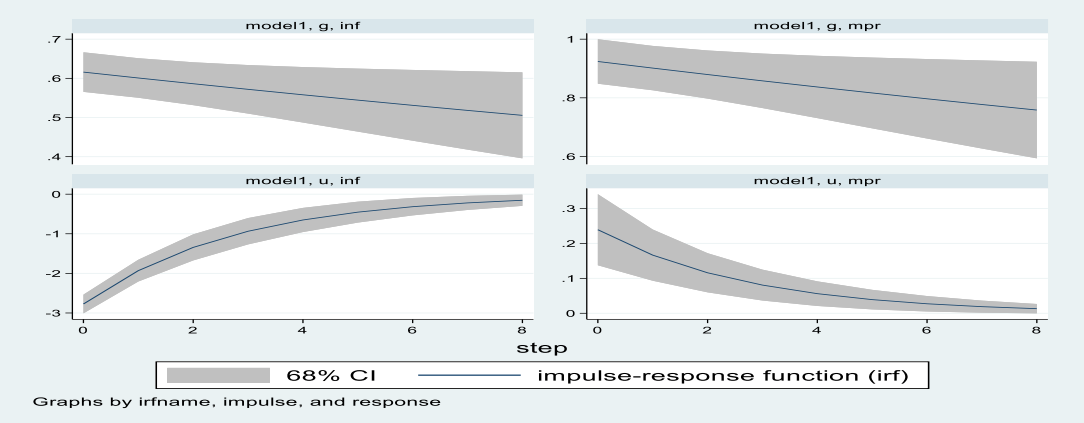
Table 9: Response of MPR and INF to Productivity Shocks

Ste	Model 3	Impulse= g	Response=mp r	Model 4	Impulse= g	Response=in f
0	0.924	0.848	1.000	0.616	0.565	0.666
1	0.901	0.826	0.977	0.601	0.550	0.651
2	0.879	0.797	0.961	0.586	0.532	0.641
3	0.858	0.765	0.951	0.572	0.510	0.634
4	0.837	0.731	0.943	0.558	0.487	0.629
5	0.817	0.696	0.937	0.544	0.464	0.625
6	0.797	0.661	0.932	0.531	0.441	0.621
7	0.777	0.627	0.927	0.518	0.418	0.618
8	0.758	0.594	0.923	0.506	0.396	0.615

Notes:

1. Table 9 presents the response of monetary policy rate and inflation to productivity shocks. Impulse=g denotes the impulse of the productivity policy shocks while response=mpr and response=inf denotes the response of both monetary policy rate and inflation to the shocks g, respectively.
2. An interval of period 0 to 8 is included, while IRF denotes the impulse response function. The intervals included are the 68 per cent confidence interval

Figure 4: Impulse Response Graph at 68 Per cent Confidence Interval



Notes:

1. Figure 4 the impulse response function of the response of inflation and mpr to both monetary policy and productivity shocks at 68% confidence interval

4.1.4 Dynamic Forecasts (Point and Density Forecasts)

Forecast for MPR and Inflation

Table 10 presents the out-of-sample forecasts for the monetary policy rate and inflation from 2021Q1 to 2021Q4. The result shows that for 2021Q1, the MPR is projected to lie between 11.7048 per cent and 11.7069 per cent, which depicts the lower and upper bounds of the 95 per cent confidence interval, respectively. On the other hand, inflation is expected to lie between 11.7625 per cent and 11.7640 per cent of the 95 per cent confidence interval in the same period. For 2021Q2, MPR is projected to increase marginally and lie within 11.7019 per cent and 11.7087 per cent of the bound, while inflation is projected to fall marginally to around 11.7605 per cent and 11.7654 per cent of the bound (a mean of 11.62 per cent, compared to 11.63 per cent in the first quarter). This follows expectation as a contractionary monetary policy (stemming from an increase in MPR, tends to reduce inflation, ceteris paribus).

For 2021Q3, however, the MPR is projected to decline marginally to lie between 11.7043 per cent and 11.7069 per cent which allows inflation to rise as a response to 11.7622 per cent and 11.7640 per cent with a mean forecast of 11.7631 per cent. Finally, the fourth quarter projections show that the MPR is expected to lie at 11.70556 per cent and 11.7077 per cent (the highest rise in the MPR, compared to other quarters with a mean of 11.7066 per cent), however, inflation is not expected to decline by much as inflation is projected to lie within 11.7631 per cent and 11.7646 per cent. This is not unconventional as the fourth quarter or year ending periods for low-middle income countries like Nigeria is characterised by many trade activities and hike in prices by suppliers of goods and services.

The forecast presented above typifies the operation of a low-income country or a developing economy. While an objective of the monetary authorities is to ensure price stability and control inflationary trends, there are, however, acceptable levels of inflation within which such economy is expected to attract investment, produce, employ and thrive in growth.

As reported from the forecast above, the monetary policy authorities can use various contractionary monetary policy instruments such as increasing the monetary policy rate which translates to an increase in the cost of borrowing and reduction in investment activities to check rising inflationary trends. In other words, a contractionary monetary policy through the increase in the monetary policy rate can be used to mop-up excess money in circulation to moderate inflation. Inflation, on the other hand, could dampen economic activities, lead to excess money in circulation and even translate to foreign exchange rate volatility, thereby depleting foreign reserves.

However, acceptable levels of inflation persist in which an economy is expected to thrive, hence the prevalence of inflation targeting by many countries of the world (both developed and developing) recently include the United Kingdom, Ghana, etc. It is also important to note that an economy can also thrive in the presence of negative inflation as in the case of Japan, however, these are for instances of self-sustaining economies and other factors outside the scope of this study.

Consequently, for a low-income country, there will be a continuous attempt by the monetary authorities to constantly monitor and control inflationary trends bearing in mind the acceptable level of growth in which such an economy can thrive under a targeted inflation level.

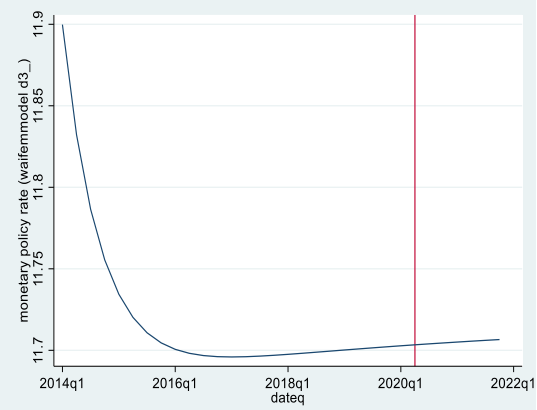
Table 10: Out of Sample Forecasts Tables for MPR and Inflation

Variable	Date	Mean Forecast (%)	Lower Bounds (95%)	Upper Bounds (95%)
MPR	2021Q1	11.7058	11.7048	11.7069
Inflation	2021Q1	11.7633	11.7625	11.7640
MPR	2021Q2	11.7053	11.7019	11.7087
Inflation	2021Q2	11.7629	11.7605	11.7654
MPR	2021Q3	11.7056	11.7043	11.7069
Inflation	2021Q3	11.7631	11.7622	11.7640
MPR	2021Q4	11.7066	11.7056	11.7077
Inflation	2021Q4	11.7638	11.7631	11.7646

Notes:

1. Table 10 above shows the out of sample forecasts from 2021Q1 to 2021Q4 for monetary policy rate and inflation. The third to fifth columns show the mean forecast, the lower and upper bounds of the 95% confidence intervals all in percentages

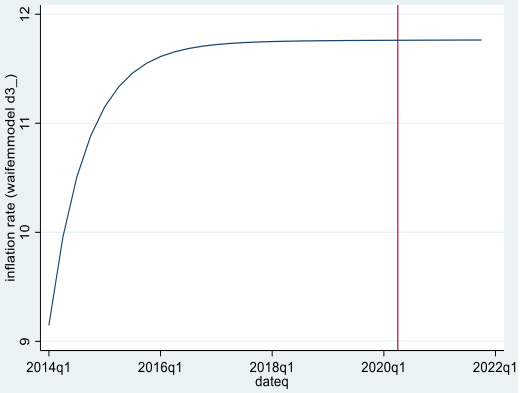
Figure 5: Forecast for Monetary Policy Rate



Notes:

1. Figure 5 presents the in-sample and out of sample forecast for Inflation
2. The partition of the red line after the 2020Q1 depicts the out of sample forecast, while the others are the, in-sample forecast

Figure 6: Forecast for Inflation



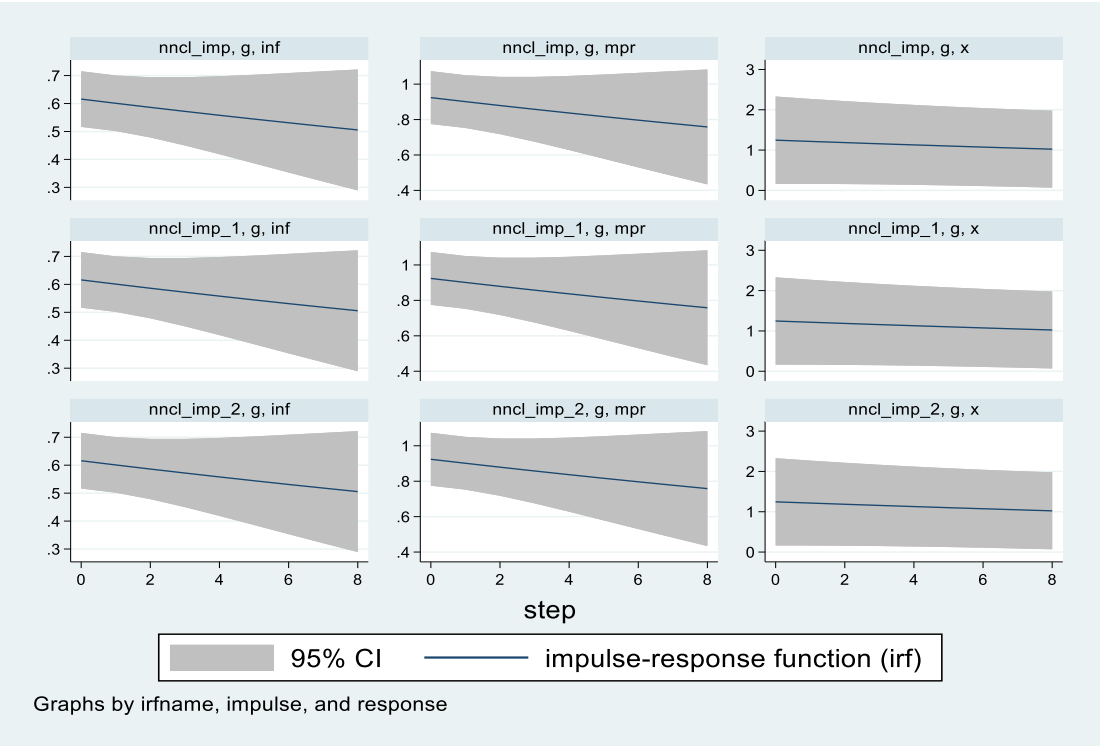
Notes:

1. Figure 6 presents the in-sample and out of sample forecast for the monetary policy rate
2. The partition of the red line after the 2020Q1 depicts the out of sample forecast while the others in-sample forecast

4.2 Sensitivity Analysis

We test for sensitivity of our results by re-estimating the model and constraining rho to 0.6 and 0.8 in comparison to the baseline model. While rhou measures the impact of a monetary policy shock on the macroeconomic variables included in the model, rhog on the other hand measures the impact of productivity shock on the same variables included in the model. We thus, constrain rho 0.6 and 0.8 to cover both the monetary policy shock and the productivity shock. The idea is to show whether the macro variables of interest would respond differently to higher values of "rho" and by extension higher persistence levels of a particular shock. This will make the conclusions from the study more robust. Figures 7 and 8 below presents the results of our impulse response functions.

Figure 7: Sensitivity Analysis on Impulse Responses for Productivity Shocks

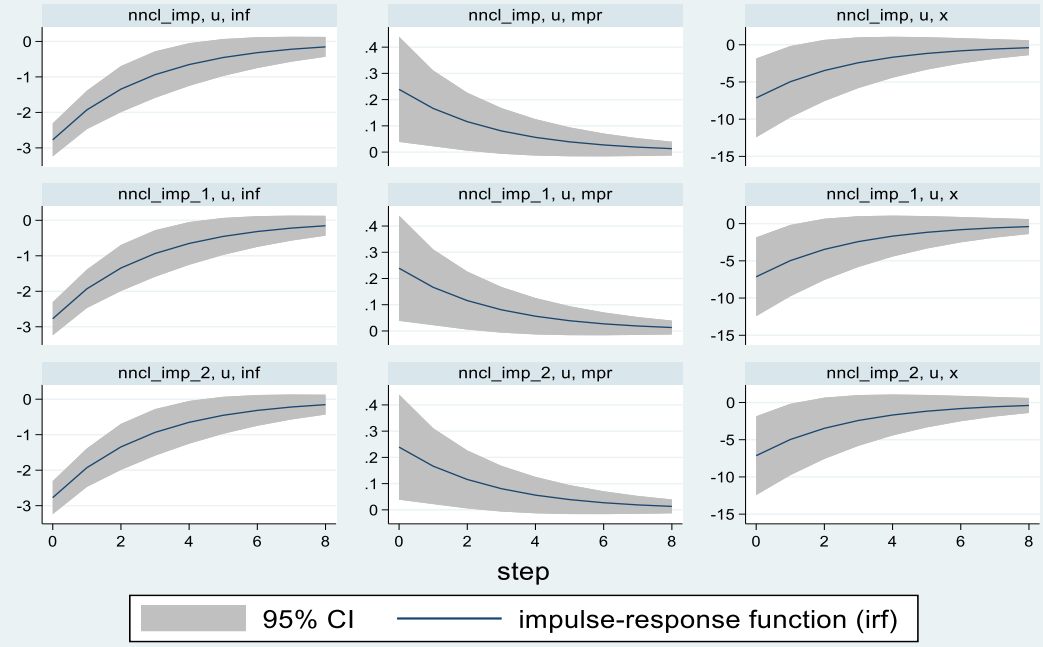


Notes:

1. Figure 7 presents the sensitivity analysis on impulse responses for productivity shocks (rhog). We denote the baseline model impulse response with nncl_imp, the restriction of rho to 0.6 impulse response with nncl_imp_1 and the restricted rho=0.8 impulse response function with nncl_imp_2
2. We denote the baseline model impulse response with nncl_imp, the restriction of rho to 0.6 impulse function to nncl_imp_1 and the restricted rho=0.8 impulse response graphs to nncl_imp_2.

Surprisingly, we find from the result of our sensitivity analysis as shown in figure 7 above that increasing rho (to 0.6 and 0.8) does not trigger any difference in the effects of productivity shocks on the output gap, MPR and inflation as compared to the baseline model. Thus, in sum, although productivity shocks incur lasting effects on MPR, inflation and output gap with the most persistent effect on output gap, raising rho will in no way increase the persistence. We hypothesize that this result may be unique to the Nigerian Economy.

Figure 8: Sensitivity Analysis on Impulse Responses for Monetary Policy Shocks



Notes:

1. Figure 8 presents the sensitivity analysis on impulse responses for monetary policy shocks (rhou). We denote the baseline model impulse response with nncl_imp, the restriction of rho to 0.6 impulse response with nncl_imp_1 and the restricted rho=0.8 impulse response function with nncl_imp_2

We find the case of the effects of monetary policy shocks on the output gap, mpr and inflation to be similar for the three models, that is the baseline model and the models with rho restricted to both 0.6 and 0.8. Thus, the interpretation for the baseline model as contained in section 4.2 stands for the rho restricted models.

We verify the results of our sensitivity analysis by tabulating the impulse response tables for the rho restricted models to 0.6 and 0.8 in appendix B. These results can be verified that it is the same as the impulse response table for the baseline model.

5.0 SUMMARY, CONCLUSION AND POLICY IMPLICATIONS

In this paper, we estimated a new Keynesian DSGE macroeconomic model for Nigeria, to understand the implications of the monetary policy shocks and productivity shocks for the Nigerian economy. We analysed the interaction between monetary policy

actions and price level. We also designed a policy matrix and a model for forecasting the trajectory of inflation.

The result obtained in this study shows that coefficients of monetary policy shocks and productivity shocks are statistically significant, with the productivity shock showing more persistence. The IRF shows that monetary policy shocks tend to have transient effects on the interest rate and price levels, while productivity shocks tend to have a lasting effect on the interest rate and price levels. The policy matrix shows that monetary policy shocks will propel the monetary authority to increase the interest rate in a bid to dampen inflationary pressures. Similarly, it shows that productivity shocks cause output gap and as such the monetary authority will respond by increasing interest rate.

The result of our analysis shows that monetary policy shocks have transient effects on MPR and inflation, while productivity shocks have lasting effects. This relationship also feeds into the output gap which is an indicator of economic performance.

The result of our forecast also follows expectation as it shows that a contractionary monetary policy through the increase in the monetary policy rate can be used to mop-up excess money in circulation to moderate inflation. Inflation, on the other hand, could dampen economic activities, lead to excess liquidity in circulation and even translate to exchange rate volatility. However, acceptable levels of inflation persist in which an economy is expected to thrive, hence the prevalence of inflation targeting by many countries of the world.

Consequently, for a low-income country, there will be a continuous attempt by the monetary authorities to constantly monitor and control inflation noting the acceptable level of growth in which such an economy can thrive under a targeted inflation level. We, therefore, recommend that the monetary authorities maintain relatively stable interest rates to moderate inflation at a level conducive for economic growth.

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Appendices

Appendix A: Concise Model Specification

$$Philips\ curve: \quad p_t = \beta E_t(p_{t+1}) + kx_t \qquad (i)$$

$$Euler\ Equation \quad x_t = E_t(x_{t+1)} - \left(r_t - E_t(p_{t+1})\right) - g_t) \qquad (ii)$$

$$Taylor\ Rule \quad r_t = \psi p_t + U_t \qquad (iii)$$

$$Monetary\ Policy\ Shock \quad u_{t+1} = \rho_u u_t + \epsilon_{t+1} \qquad (iv)$$

$$Productivity\ Shock \quad g_{t+1} = \rho_g g_t + \mathcal{E}_{t+1} \qquad (v)$$

Appendix B: Impulse Response Tables for rho restricted to 0.6 and 0.8

Table 11: Response of MPR and INF to Productivity Shocks when rho =0.6

Ste	Model 3 IRF	Impulse= g Lower	Response=mp r Upper	Model 4 IRF	Impulse= g Lower	Response=in f Upper
0	0.924	0.775	1.073	0.616	0.516	0.716
1	0.901	0.752	1.050	0.601	0.502	0.700
2	0.879	0.718	1.041	0.586	0.478	0.694
3	0.858	0.675	1.041	0.572	0.450	0.694
4	0.837	0.628	1.046	0.558	0.418	0.698
5	0.817	0.579	1.054	0.544	0.386	0.703
6	0.797	0.530	1.064	0.531	0.353	0.709
7	0.777	0.481	1.073	0.616	0.321	0.716
8	0.758	0.434	1.083	0.601	0.289	0.722

Notes:

1. Table 11 presents the response of monetary policy rate and inflation to productivity shocks. Impulse=g denotes the impulse of the productivity shocks while response=mpr and response=inf denotes the response of both monetary policy rate and inflation to the shocks u respectively.
2. An interval of period 0 to 8 is included, while IRF denotes the impulse response function. The intervals included are the 95 per cent confidence interval.
3. Here, rho is restricted to 0.6

Table 12: Response of MPR and INF to Monetary Shocks when rho =0.6

Ste	Model 1 IRF	Impulse= u Lower	Response=mp r Upper	Model 2 IRF	Impulse= u Lower	Response=in f Upper
0	0.239	0.039	0.440	-2.773	-3.239	-2.307
1	0.167	0.022	0.311	-1.930	-2.472	-1.389
2	0.116	0.005	0.226	-1.344	-1.993	-0.695
3	0.081	-0.006	0.168	-0.936	-1.591	-0.280
4	0.056	-0.013	0.126	-0.651	-1.253	-0.050
5	0.039	-0.016	0.094	-0.453	-0.974	0.067
6	0.027	-0.016	0.071	-0.316	-0.749	0.118
7	0.019	-0.015	0.053	-0.220	-0.571	0.132
8	0.013	-0.013	0.040	-0.153	-0.432	0.127

Notes:

1. Table 12 presents the response of monetary policy rate and inflation to monetary policy shocks. Impulse=g denotes the impulse of the productivity shocks while response=mpr and response=inf denotes the response of both monetary policy rate and inflation to the shocks u respectively.
2. An interval of period 0 to 8 is included, while IRF denotes the impulse response function. The intervals included are the 95 per cent confidence interval.
3. Here, rho is restricted to 0.6

Table 13: Response of MPR and INF to Productivity Shocks when rho =0.8

Step	Model 3 IRF	Impulse=g Lower	Response=mpr Upper	Model 4 IRF	Impulse=g Lower	Response=inf Upper
0	0.924	0.775	1.073	0.616	0.516	0.716
1	0.901	0.752	1.050	0.601	0.502	0.700
2	0.879	0.718	1.041	0.586	0.478	0.694
3	0.858	0.675	1.041	0.572	0.450	0.694
4	0.837	0.628	1.046	0.558	0.418	0.698
5	0.817	0.579	1.054	0.544	0.386	0.703
6	0.797	0.530	1.064	0.531	0.353	0.709
7	0.777	0.481	1.073	0.518	0.321	0.716
8	0.758	0.434	1.083	0.506	0.289	0.722

Notes:

1. Table 13 presents the response of monetary policy rate and inflation to productivity shocks. Impulse=g denotes the impulse of the productivity shocks

while response=mpr and response=inf denotes the response of both monetary policy rate and inflation to the shocks u respectively.

2. An interval of period 0 to 8 is included, while IRF denotes the impulse response function. The intervals included are the 95 per cent confidence interval.
3. Here, rho is restricted to 0.8

Table 14: Response of MPR and INF to Monetary Shocks when rho =0.8

Ste	Model 1 IRF	Impulse= u Lower	Response=mp r Upper	Model 2 IRF	Impulse= u Lower	Response=in f Upper
0	0.239	0.039	0.440	-2.773	-3.239	-2.307
1	0.167	0.022	0.311	-1.930	-2.472	-1.389
2	0.116	0.005	0.226	-1.344	-1.993	-0.695
3	0.081	-0.006	0.168	-0.936	-1.591	-0.280
4	0.056	-0.013	0.126	-0.651	-1.253	-0.050
5	0.039	-0.016	0.094	-0.453	-0.974	0.067
6	0.027	-0.016	0.071	-0.316	-0.749	0.118
7	0.019	-0.015	0.053	-0.220	-0.571	0.132
8	0.013	-0.013	0.040	-0.153	-0.432	0.127

Notes:

1. Table 14 presents the response of monetary policy rate and inflation to monetary policy shocks when rho=0.8. Impulse=g denotes the impulse of the productivity shocks while response=mpr and response=inf denotes the response of both monetary policy rate and inflation to the shocks u respectively.
2. An interval of period 0 to 8 is included, while IRF denotes the impulse response function. The intervals included are the 95 per cent confidence interval.
3. Here, rho is restricted to 0.8

Table 15: Response of Output Gap (x) to Productivity Shocks for the 3 models (baseline, rho =0.6 and 0.8)

Step	Model 1 IRF	Impulse=g Lower	Response=x Upper	Model 2&3 IRF	Impulse=g Lower	Response=x Upper
0	1.246	0.163	2.329	1.246	0.163	2.329
1	1.216	0.162	2.270	1.216	0.162	2.270
2	1.186	0.157	2.215	1.186	0.157	2.215
3	1.157	0.149	2.166	1.157	0.149	2.166
4	1.129	0.137	2.120	1.129	0.137	2.120

5	1.101	0.123	2.079	1.101	0.123	2.079
6	1.075	0.107	2.042	1.075	0.107	2.042
7	1.048	0.088	2.008	1.048	0.088	2.008
8	1.023	0.068	1.977	1.023	0.068	1.977

Notes:

1. Table 15 presents the response of the Output gap to productivity shocks. Impulse=g denotes the impulse of the productivity shocks while response=x denotes the response of output gap to the shocks g respectively.
2. An interval of period 0 to 8 is included, while IRF denotes the impulse response function. The intervals included are the 95 per cent confidence interval.
3. Here, rho is restricted to 0.6 and 0.8

Table 16: Response of Output Gap (x) to Monetary Policy Shocks (u) for the 3 models (baseline, rho =0.6 and 0.8)

Step	Model 1 IRF	Impulse=u Lower	Response=x Upper	Model 2&3 IRF	Impulse=u Lower	Response=x Upper
0	-7.140	-12.432	-1.849	-7.140	-12.432	-1.849
1	-4.971	-9.764	-0.177	-4.971	-9.764	-0.177
2	-3.460	-7.576	0.655	-3.460	-7.576	0.655
3	-2.409	-5.818	1.000	-2.409	-5.818	1.000
4	-1.677	-4.430	1.076	-1.677	-4.430	1.076
5	-1.167	-3.349	1.014	-1.167	-3.349	1.014
6	-0.813	-2.516	0.890	-0.813	-2.516	0.890
7	-0.566	-1.880	0.748	-0.566	-1.880	0.748
8	-0.394	-1.398	0.610	-0.394	-1.398	0.610

Notes:

1. Table 16 presents the response of the output gap to monetary policy shocks. Impulse=u denotes the impulse of the monetary policy shocks while response=x denotes the response of output gap to the shocks u respectively.
2. An interval of period 0 to 8 is included, while IRF denotes the impulse response function. The intervals included are the 95 per cent confidence interval.
3. Here, rho is restricted to 0.6 and 0.8

ANALYSING MONETARY POLICY AND PRODUCTIVITY SHOCKS ON OUTPUT, INFLATION AND MONETARY POLICY RATE IN SIERRA LEONE: A DSGE APPROACH

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Abstract

The Sierra Leonean economy has been hit by a number of external and internal shocks over the years, causing the economy to fluctuate and most times operate away from its steady state. This situation has also made the prediction of macroeconomic variables in the country somehow difficult. In light of this, the paper attempted to analyse the effects of monetary policy and productivity shocks on key macroeconomic variables (output, inflation and monetary policy rate) in the country, using the DSGE modelling and maximum likelihood techniques with quarterly data from 2011Q1 – 2021Q2. Based on the preferred DSGE model results, both the monetary and productivity shocks appear to have permanent effect on output, inflation and interest rate in Sierra Leone, though the effect of productivity shock appears not to be statistically significant. The model was also used to make two period out of sample projections.

Keywords DSGE model. Likelihood estimation, forecast, Sierra Leone
JEL Classification C51 C52 C53 E30

This paper is a result of three weeks DSGE modelling training program organised by WAIFEM from July 12-30, 2021. Special thanks therefore go to the entire WAIFEM administration for their tremendous efforts in building capacity in the WAMZ over the years. We also extend our gratitude to the Bank of Sierra Leone for providing us the opportunity to be part of this training program. Finally, our sincere appreciation goes to the two facilitators in the program – Professor Afees A. Salisu and Professor OlaOluwa Yaya for their commitment to ensure that we gain maximum benefits from the program.

1.0 INTRODUCTION

Macroeconomic stability remains the most important singular factor for growth and development for economies around the world. It is desirable that economies should always operate at full employment level, with low and stable inflation. However, economies are rarely able to operate at their desired (equilibrium) level on account of shocks. Such shocks be linked to both internal and external circumstances; the former (internal) could be attributed to ineffective domestic policy measures (fiscal, monetary and exchange rate policy) and unpredictable changes in private sector behaviour, while the latter (external) is attributed to changes in the international economic environment (real, financial) and technological changes in the emergence of new discoveries (Montiel, 2011).

The Sierra Leone economy has been hit by a number of external and internal shocks over the years, thereby causing the economy to fluctuate and during most time deviating from its steady state. This situation has also made the prediction of macroeconomic variables in the country somehow difficult to determine. The motivation for this study therefore, has stemmed from the need to assess the effect of shocks on key macroeconomic variables using a standard structural DSGE model.
Specifically, the paper attempts to analyse the response of output, inflation and interest rate to monetary policy and productivity shocks in Sierra Leone using DSGE modelling and maximum likelihood techniques. The model also seeks to produce two out-of-sample quarterly forecasts and point density estimation. The study is considered to be a novelty as this is the first time such technique has been used specifically for the Sierra Leone economy. The study will undoubtedly contribute significantly to an existing body of literature, particularly in the area of shocks and their impacts on the macroeconomy of Sierra Leone. The use of a structural model like DSGE is a step forward in supporting effective formulation and the implementation of monetary and financial stability policies at the Bank of Sierra Leone.

Following the above introduction, section two examines the methodology and data used in the study. Section three presents the estimation results and discussion, while section four concludes the outcome, with proffered recommendations for action by authority at the Bank of Sierra Leone.

2.0 METHODOLOGY AND DATA

The study made use of the linear/linearized DSGE model and maximum likelihood technique. The specific model is illustrated below as derived by Woodford (2003).

$$x_t = E_t x_{t+1} - (r_t - E_t \pi_{t+1} - g_t) \quad \text{.....(1)}$$

$$\pi_t = \beta E_t \pi_{t+1} + k x_t \quad \text{.....(2)}$$

$r_t = \frac{1}{\beta}\pi_t = u_t$……(3)

$u_{t+1} = \rho_u u_t + \epsilon_{t+1}$……(4)

$g_{t+1} = \rho_g g_t + \xi_{t+1}$……(5)

Where:

$\boldsymbol{x_t}$= output gap,

$\boldsymbol{x_{t+1}}$ = tomorrow's output gap,

r_t = monetary policy rate,

π_t = inflation,

π_{t+1} = tomorrows inflation,

$\boldsymbol{g_t}$ = a state variable that captures changes in productivity.

$\boldsymbol{\beta}$ = a parameter that captures households' willingness to delay consumption,

$\boldsymbol{k}$ = a function of the underlying parameter that measures price adjustment,

$\boldsymbol{u_t}$= a state variable that captures all movements in the interest rate that are not driven by inflation,

$\epsilon_{\boldsymbol{t+1}}$ represent monetary policy shocks,

and $\boldsymbol{\xi_{t+1}}$ represents productivity shocks.

The model, being a general equilibrium structural model, captures the behavior of households, firms, and the central bank as the main economic agents in Sierra Leone. The model thus contains output, inflation, and interest rate to reflect these agents' interactions in the economy. Equation (1) sets output as a function of its future path less the gap between interest rate and future path of inflation – a version of Euler's equation. Here, the monetary policy rate is considered to capture the central bank's monetary policy actions. Theoretically, a positive relationship is expected between output today and output tomorrow. However, output is negatively related to the gap between interest rate and future inflation.

Equation (2) sets inflation as a function of tomorrow's inflation and today's output – a version of Phillips curve with a slope of kappa (**k)**. Theoretically, this relationship is expected to be positive.

Equation (3) sets interest rate as a function of inflation – a version of Taylor's monetary policy rule. The relationship is theoretically expected to be positive for nominal interest rate. $\boldsymbol{g_t}$ and $\boldsymbol{u_t}$ represent productivity and monetary policy shocks. That is sudden and unexpected sharp changes in monetary policy and productivity. $\boldsymbol{u_{t+1}}$ and $\boldsymbol{g_{t+1}}$ then measures how persistent the effect of such shocks is on output growth, inflation and interest rate.

Monetary Policy Rate and Consumer Price Indices data were sourced from the Bank of Sierra Leone data warehouse. The consumer price series was transformed into inflation, thereby expressing the two variables in percentage term. The Bank of Sierra Leone started publishing monetary policy rate in the first quarter of 2021. Data used in the study spanned from 2011Q1 to 2021Q2. Therefore, this short range of data has proven to be a major attraction for the use of the DSGE model and the maximum likelihood estimation techniques. The Stata 16 software was use as the statistical software in this study.

3.0 RESULTS AND DISCUSSION

For robustness, three linear DSGE models were estimated (**see table 1**). One with no constraint, the second with a beta constraint and the other with both beta and psi constraints. Based on comparisons, the third model happens to produce estimates with the lowest RMSEs, and was thus, utilized as the preferred model.

Based on expert knowledge of the structure of the Sierra Leone economy, the long run average of beta, which measures the discount factor in the inflation function and psi, which captures the degree of central bank's response to inflation in the interest rate function are set at 0.5 and 1.5 respectively in the preferred model. These values are also consistent with what is found in the literature, for example A Stata Publication (2021)[6], Woodford (2003) and Smets & Wouters (2003). Additionally, both the productivity and monetary policy shocks appear to be statistically significant implying that they are indeed present in the model.

Table 1: DSGE Model Results for Sierra Leone

Variables	Structural Eq without constraint	Structural Eq constraint beta	Structural Eq constraint beta & psi
beta	0.00310	0.500	0.500
	(0.0177)	(0)	(0)
kappa	0.0853	0.0312	0.0272
	(0.0631)	(0.0269)	(0.0244)
psi			1.500
			(0)
rhou	0.925***	0.933***	0.937***
	(0.0506)	(0.0510)	(0.0507)
rhog	0.951***	0.943***	0.940***

[6] Stata Dynamic Stochastic General Equilibrium Models Reference Manual release 17

	(0.0446)	(0.0459)	(0.0463)
sd(e.u)	548.1	3.533***	2.749***
	(3,140)	(0.407)	(0.317)
sd(e.g)	1.192***	1.160	1.273
	(0.138)	(0.715)	(1.093)
Observations	38	38	38
Standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1			

Source: Authors' estimation using Stata 16

The policy matrix of the preferred model is presented in **table 2**. It is observed that a unit shock to monetary policy reduces inflation by an estimated 0.555, and a unit shock to productivity raises inflation by an estimated 0.581. However, the effect of productivity shock on inflation does not appear to be statistically significant. A unit shock to monetary policy is shown to reduce output by an estimated 10.848 and a unit shock to productivity increases output by an estimated 11.295, but the effect of monetary policy shock on output was not statistically significant. Additionally, unit shock to monetary policy is observed to raise interest rate by an estimated 0.166, while the effect of productivity shock on interest rate was not observed to be statistically significant.

Table 2: The Initial Impulse Responses, i.e. IRFs at Period 0

Policy Matrix		Coefficient	Standard Error
Inflation (cpi_inf)	u	-0.5556***	0.0438
	g	0.5805	0.4897
Output (x)	u	-10.8482	9.1365
	g	11.2954*	6.8538
Interest rate (r)	u	0.16645**	0.0658
	g	0.8708	0.7346
*** p<0.01, ** p<0.05, * p<0.1			

Source: Authors' estimation using Stata 16

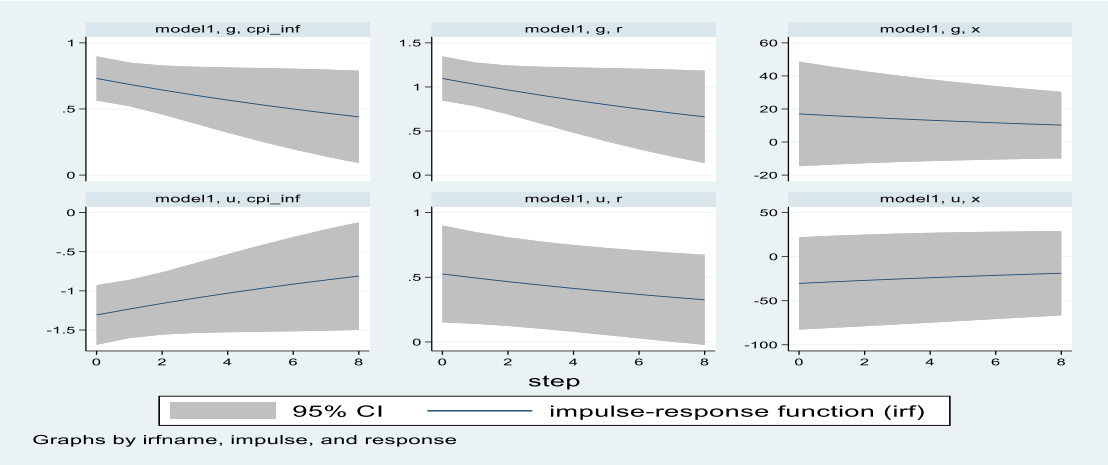
In addition, the transition matrix which captures the persistent of shocks over time appears to indicate that monetary policy shock has a persistent impact on future values of monetary policy rate, while the productivity shock seems to persistently affect future values of output (**see table 3**).

Table 3: Evaluating the response of state variables to u & g shocks

Transition matrix of state variables		Coefficient	Standard Error
F.u	u	0.9366***	0.0506
F.g	g	0.9402***	0.0463
*** p<0.01, ** p<0.05, * p<0.1			

Source: Authors' estimation using Stata 16

Figure 1: Impulse Responses for shocks due to u and g



Source: Authors' estimation using Stata 16

Table 4 presents both points and density forecasts for two out of sample quarters. The forecast results closely mimic the forecast of the other suit of models used by the Bank of Sierra Leone to forecast inflation and some other macroeconomic variable.

Table 4: Quarterly Forecasts for MPR and CPI Inflation using the estimated DSGE model

	2021Q3	2021Q4	[95% Conf. Interval]
Inflation	10.08	9.96	9.31 10.73
MPR	13.95	13.90	13.63 14.22

Source: Authors' estimation using Stata 16

The table in appendix A presents the one-sample t test as a form of robustness check for the density forecast of monetary policy rate.

Overall, the results appear to suggest that both monetary policy and productivity shocks affect the economy through interest rate and inflation. The interest rate and

inflation seems to respond strongly to monetary policy shocks, but their response to productivity shocks is not found to be statistically significant. Additionally, the response of output to monetary shock is also not found to be statistically significant.

4.0 CONCLUSION

The Sierra Leone economy has been hit by a number of external and internal shocks over the years causing the economy to fluctuate, while most times deviating from its steady state. This situation has also made the prediction of macroeconomic variables in the country somehow difficult to determine.

The motivation for the study was borne out of the need to assess the effect of certain types of shocks on key macroeconomic variables using a standard structural model. Specifically, the paper attempts to analyse the response of output, inflation and interest rate to monetary policy and productivity shocks in Sierra Leone using DSGE modelling and the maximum likelihood techniques. The estimated model was then used to make two-quarter point and density out-of-sample forecasts.

The study revealed that both monetary policy and productivity shocks affect the economy mainly through interest rate and inflation. Interest rate and inflation responded strongly to monetary policy shocks, but their response to productivity shock is not found to be statistically significant. Additionally, the response of output to both shocks is also not statistically significant. It is therefore recommended that policy makers, especially at the central bank should be cautious in setting the monetary policy rate so as to minimise or avoid high incidence of monetary policy shocks in the economy. The central bank should avoid taking rash decisions when responding to productivity shocks in the economy as the impact of such shocks appear to be relatively weak. Finally, the estimated model can be used as an aid to projecting inflation and interest rate, alongside with other traditional models currently utilised in the bank for forecasting macroeconomic outcomes.

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Appendix A: Table of Robustness Check for interval estimate of Inflation

One-sample t test

	Obs	Mean	Std. Err.	Std. Dev.	[95% Conf.	Interval]
x	2	10.01941	.0396558	.0560818	9.515535	10.52328

mean = mean(x) t = 17.9693
Ho: mean = 9.306824 degrees of freedom = 1

Ha: mean < 9.306824 Ha: mean != 9.306824 Ha: mean > 9.306824
Pr(T < t) = 0.9823 Pr(|T| > |t|) = 0.0354 Pr(T > t) = 0.0177

Appendix B: Table of Robustness Check for interval estimate of MPR

One-sample t test

	Obs	Mean	Std. Err.	Std. Dev.	[95% Conf.	Interval]
x	2	13.92465	.0166113	.0234919	13.71358	14.13572

mean = mean(x) t = 17.9691
Ho: mean = 13.62616 degrees of freedom = 1

Ha: mean < 13.62616 Ha: mean != 13.62616 Ha: mean > 13.62616
Pr(T < t) = 0.9823 Pr(|T| > |t|) = 0.0354 Pr(T > t) = 0.0177

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