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A Small Macroeconometric Model of Nigeria

Alarudeen Aminu[1]
Joshua Adeyemi Ogunjimi[2]

[1,2]*Department of Economics, University of Ibadan, Nigeria.*
[1]*Email: alarudeen@yahoo.com Tel: +2348034061234*
[2]*Email: joshuaogunjimi@gmail.com Tel: +2348064795124*


(✉ Corresponding Author)

Abstract

This study presents a small macroeconometric model to forecast and simulate policy options for the Nigerian economy. The model consists of ten behavioural equations and five identities made up of ten endogenous variables and thirteen exogenous variables. Autoregressive distribution lag (ARDL) framework is used to estimate the behavioural equations using annual time-series data for the period 1981-2014. The predictive ability of the model is evaluated and found to be satisfactory as the mean absolute error (MAE), root mean square error (RMSE) and Theil inequality coefficient are considerably small. Policy simulations to quantify the impact of shocks to government expenditure, exchange rate and crude-oil price on the economy are analysed. The results shows that a positive shock in government expenditure raises aggregate output, total exports, total import, gross fixed capital formation, exchange rate, consumption, and inflation rate while interest rate falls; a negative shock to exchange rate has a negative effect on gross fixed capital formation and a positive effect on aggregate national output, consumer price level, interest rate, consumption, total export and total imports; and a negative shock in oil prices results in an increase in total imports, total exports, consumption, exchange rate, gross fixed capital formation and aggregate national output. Hence, the study recommends that the monetary authorities employ a managed-floating exchange rate to address the volatility in exchange rate and government should formulate and implement policies aimed at diversifying the economy to cushion the shocks that result from oil price volatility in the international market.

Keywords: Behavioural equations, Shocks, Macroeconometric model, Autoregressive distributed lag (ARDL), Simulation, Nigeria.
JEL Classification: C32; C53; E27; N17.

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Contents

Contribution of this paper to the literature

This paper contributes to the existing literature by constructing an operational and up-to-date small macroeconometric model for the Nigerian economy wherein the impact of shocks to monetary policy, fiscal policy and oil price are examined so as to devise the appropriate policy with which to achieve desired outcomes in the Nigerian economy.

1. Introduction

Apparently, there are complexities in the real world and inter-relationships among economic variables thus, making it an uphill task to appropriately ascertain the effects (direct and indirect) of economic policies. Nevertheless, building macroeconomic models provides a plausible basis for inference making as regards the direction of impact of policy interventions. An economic model is a simplified representation of a system and abstraction of the real world. Thus, a model can be judged relevant by its ability to replicate real world features, the degree to which it explains the observed interactions among economic agents, the extent of its ability to accommodate indirect effects of policy interventions, and its ability to provide alternative policy directions through sensitivity analyses (Nwaobi, 2011). The Nigerian economy is plagued with structural inadequacies which are the primary roadblocks to the achievement of the developmental objectives in the country. From independence, various forms of macroeconomic instabilities constrained the performance of the economy. The country is faced with some fundamental issues which include: persistent fall in the crude oil price (our main export product) in the international market, inability of the Nigerian government (especially state governments) to pay the minimum wage, a persistent fall in the standard of living, incessant increase in the cost of living, high rate of unemployment, infrastructural and institutional decadence, high inflation rate and high level of corruption.

Nigerians place a high premium on imported products at the expense of locally produced goods, hence the reason for the high dependence on imports. Unfortunately, we also import foreign policies without taking cognizance of the peculiar nature of our economy. This has had devastating effects on the economy as a whole as policy makers are frustrated by the ineffectiveness of economic policies in the country. An economic policy that works perfectly well in an economy might fail in another due to the different institutional and economic frameworks, among other reasons, in the economies. Economic policies are contextual, hence the reason for their failure if taken out of context. Thus, it is highly imperative that government agencies and macroeconomic modelers understand the intricacies of their domestic economy.

For instance, the adoption of the structural adjustment programme (SAP) in 1986 had a debilitating effect on the Nigerian economy. This is because the World Bank and IMF, who instigated the programme, had a poor perception of the Nigerian economic problem. Thus, what was intended to serve as an economic panacea led to more devastating situations. One of the major effects of SAP is that it has eroded the value of the domestic currency overtime. Most economies undergoing adjustment have experienced a drastic fall in the value of their currency relative to other currencies. SAP, by its nature, is inflationary because it raises the amount of local currency used in buying units of local goods and import.

Another notable example is the recent issue on devaluation following the incessant fall in the value of naira which has brought representatives from the World Bank and IMF to persuade the Nigerian government to devalue her currency. The effects of devaluation on a country like Nigeria will be devastating for the following reasons: Nigeria is highly import-dependent, her export (mostly primary products) prices are quoted in foreign currencies and so is her import. Apparently, a devaluation of the domestic currency will further worsen the situation of the economy. This policy stance came due to a relatively good understanding of the structure of the Nigeria economy. A more comprehensive knowledge of the Nigerian situation will help policy makers formulate beneficial policies and not policies that will further worsen the economic situations of the country.

Hence, to tackle the existing and impending problems facing the Nigerian economy, an appropriate framework that will be an accurate representation of the domestic economy and also serve as a point of reference is imperative. It is also essential to study the nature of relationship between different macroeconomic variables in Nigeria in order to formulate well-informed policies. However, in building this model, it is also important that the modelers have a sound knowledge of the basic structure of the economy to aid the determination of the various sets of policy interventions that will correct the structural inadequacies in the economy. They should also be aware of the linkages among the various sectors of an economy and the impacts (direct and indirect) of policy coordination on individual sectors. This study identifies few research gaps. Several attempts have been made at building an operational and up-to-date macroeconometric model for Nigeria, the most recent being Central Bank of Nigeria (CBN) (2010); Olofin *et al.* (2014) and Nkoro and Uko (2018). However, there are a number of research gaps in these studies. For instance, CBN (2010) estimated only short-run equations for each of its stochastic equations in the model neglecting the long-run equations which should form the basis for simulation and forecast. Also, Olofin *et al.* (2014) developed a small-scale macroeconometric model which focused primarily on the response of key macroeconomic variables to changes in the monetary policy rate (MPR) in Nigeria neglecting the impact of fiscal policy and exchange rate movement on the performance of key macroeconomic variables in Nigeria. Moreover, Nkoro and Uko (2018) only focused on the impact of oil price shocks and monetary policy on macroeconomic performance without accounting for the impact of fiscal policy. Hence, this study fills these research gaps.

The novelty of this study lies in its contribution to the theoretical, methodological and empirical literature. Theoretically, this study contributes to the extant literature by adopting the standard Keynesian approach used by Asteriou *et al.* (2011) and Khan (2014) for Greece and India respectively. This approach is holistic in that it covers all sectors of the economy. To the best of our knowledge, this approach has not been used in developing a macroeconometric model in Nigeria. With respect to methodological contribution, many studies favour the choice of ordinary least square (for example the works of Olayide *et al.* (1981); CBN (2010); Hanif *et al.* (2011); and Egwaikhide *et al.* (2012) among others), the seemingly unrelated regression equations (see e.g. Akanbi and Du Toit (2011)) the two-stage least square technique (see e.g. Khan (2014)). Most of these studies did not take account of the stationarity properties of the macroeconomic variables, a practice which results in spurious regression. In addition, the long-run relationship, an important basis for forecast, of the macroeconomic variables was not

ascertained before estimation by several studies. These inadequacies render the findings from the model estimation unfit for policy analysis. However, to circumvent these inadequacies, this study adopts a relatively more robust model with inherent cointegration test technique: the autoregressive distributed lag (ARDL). Gurara (2013) have used same methodology for similar study in Rwanda. The empirical contribution of this study lies in the fact that most studies (CBN, 2010; Egwaikhide *et al*., 2012; Olofin *et al*., 2014) on macroeconometric model of Nigeria examined the effects of monetary and fiscal policy on the Nigerian economy. Since Nigeria doubles as a net oil exporter and importer, it is needful to evaluate the transmission mechanism through which changes in oil price in the international market filters into the aggregate economy, this analysis is missing in the literature. However, this study will fill this knowledge gap by examining the impact of changes in government expenditure (fiscal policy), oil price and exchange rate (monetary policy) on the overall performance of the Nigerian economy so as to devise the appropriate policy with which to achieve desired outcomes in the Nigerian economy.

This study aims at developing and estimating a model that explains the relationships between major macroeconomic variables and to operationalise the model by using it to forecast and simulate policy options for the economy. Friend and Taubman (1964) argued that small models are the best at explaining the economy more efficiently as against large models that make analysis of the economy more difficult and cumbersome due to the many equations in the model. Thus, they suggested that economic modellers should "Keep it Sophisticatedly Simple (KISS)". This principle forms the premise on which this study develops a small macroeconometric model of Nigeria.

The rest of this paper is structured as follows: Section two takes an overview of the Nigerian economy while Section three contains the review of relevant literatures. Section four presents the methodology and empirical results of this study and Section 5 concludes this study with policy recommendations.

2. The Nigerian Economy

Nigeria, with a population of over 170 million, is the most populous black nation with total land area of 923,773 square kilometres, covering five different vegetation zones. Nigeria's economy is second to none in Africa in terms of key macroeconomic indicators. Nigeria's gross domestic product (GDP) was estimated at ₦251.05 billion in 1981 and it grew to ₦328.61 billion, ₦412.33 billion, ₦776.33 billion and ₦950.11 billion in 1990, 2000, 2010 and 2013 respectively (see CBN (2014)). The Nigerian economy is dominated by agricultural and crude oil production which are both primary products. The oil and gas sector is the main driver of the economy, in terms of its share in government revenue, foreign exchange and foreign investments inflows. The contribution of the primary sector to GDP in 1981 was 33.6%, 38.5% for secondary sector and 27.9% for tertiary sector. In 1986, the year in which structural adjustment programme (SAP) was introduced, the share of primary sector to GDP stood at 41.4% and it rose to 42.1% in 2002 but fell to about 40% in 2014. However, the share of the secondary sector to GDP reached an unprecedented level of 40% in 1990 and further fell to 21.3% in 2014. This is because Nigeria is heavily dependent on imports at the expense of local production. The tertiary sector's share of GDP rose markedly from 29% in 2002 to 40.3% in 2012. This implies that the service sector grew markedly in the new millennium which was traceable to telecom investment by firms in the communication sector thereby leading to a rapid development of the sector.

Government expenditure has been changing and volatile overtime. Between 1981 and 1983, the capital expenditure was more than the recurrent expenditure. The reverse was the case between 1987 and 1996 as recurrent expenditure was greater than capital expenditure. This implies that capital projects were not adequately provided during those periods. Between 1996 and 1999, however, government spent more on capital expenditure than on recurrent expenditure. From the new millennium to 2014, recurrent expenditure outweighs capital expenditure as recurrent expenditure was ₦3417.58 billion while capital expenditure stood at ₦783.12 billion in 2014.

Nigeria's trade interaction with the rest of the world is categorized mainly into oil and non-oil due to the dual nature of the economy. A significant difference exists in the export of oil and non-oil products. The ratio of oil to non-oil export was ₦10.680.5 to ₦342.8 in 1981, ₦106626.5 to ₦3259.6 in 1990, ₦1920900.4 to ₦24822.9 in 2000 and ₦14326518.7 to ₦913708.4 in 2011. This clearly shows that the mainstay of the Nigerian economy is crude-oil; it is the major source of foreign exchange; and Nigeria depends heavily on the proceeds from oil which is a primary product susceptible to fluctuations in the international market.

Implicit price deflator rose from double-digit of 37.57 in 1981 to about 1108.76 in 1991, before declining to 1026.97 in 1998. The figure again jumped to about 1190.32 in 1999 and it continued to grow until it reached 3614.44 and 4561.28 in 2008 and 2012 respectively. It can be observed that the implicit price deflator grew steadily overtime. The increase in the implicit price deflator was attributed to increases in the domestic pump-price of petroleum products. Another notable reason for the increase in the implicit price deflator especially in 2008 and 2009 is the effects of the global financial crisis which led to naira depreciation and a reduction in general credit creation.

The monetary policy rate which substituted the minimum rediscount rate (MRR) in 2006 is the official interest rate of the Central Bank of Nigeria (CBN) and is the anchor rate for other interest rates in Nigeria. MRR was highly regulated in the period between 1970 and 1986. It was 4.5 percent between 1970 and 1975 before it experienced marginal increases in subsequent years and become stable again at 10 percent between 1984 and 1986. The CBN fixed the MRR and removed all controls on interest rate in 1987 to depict the direction it intends interest rate to go. MRR stood at 12.75 percent in 1987 and1988 and 18.5 percent in 1989 and 1990. It however plummeted to 13.5 percent from 1994 to 1997 and fluctuated till 2006 when MRR was change to MPR. This change had an almost immediate effect as interest rate fell from two-digits to one-digit between 2007 and 2011 before it rose to 12 percent in 2012 and 2013 and to 12.25 percent in 2014.

Nigeria is financially indebted to Paris Club, London Club, Multilateral creditors, promissory note creditors, bilateral and private sector creditors. Nigeria's external debt stock profile stood at ₦2.33 billion in 1981. The figure increased significantly to ₦100.79 billion and ₦633.02 billion in 1987 and 1998 respectively. It further increased markedly to ₦2577.37 billion, a 307% increase. This happened at a time when there was a change in government from military to democratic rule. External debt further rose tremendously to ₦4890.27 billion in 2004

but plummeted to ₦438.89 billion in 2007. However, the figure started increasing as there was a change of government and it stood at ₦1631.52 in 2014.

Nigeria's stock of external reserves depends largely on the world price of crude oil. The reserve derives from the excess of receipts on export of crude oil on import. The reserve grew persistently because of growing price of crude oil in the world market. Nigeria's external reserves trended downwards from US$4682.9 million in 1981 to US$456.6 million in 1984 before it rose gradually to US$981.8 million. Since then the figure has trended upwards till 1988 when it stood at US$6022.2 million and then declined marginally to US$3662 million in 1989. However, there was a persistent increase in the stock of external reserve from 1989 to 2008 when the stock reached an unprecedented US$58472.8 million before it started falling again until it reached US$37220.3 million in 2014.

The exchange rate in Nigeria has been fluctuating overtime. Between 1974 and 1980 the exchange rate of naira in relation to the US dollar stood between ₦0.54 and ₦0.71 with the naira appreciating against the dollar during this period, after 1980, the exchange rate started depreciating. However, the value of naira in relation to the US dollar has been rising over the years as a result of the various policies of the CBN. The rate was fixed by the then military government and it increased by about 300% from ₦21.89 in 1998 to ₦92.69 in 1999 with inflation rate rising by 6.6%. The exchange rate hit a triple digit in year 2000 with the rate at ₦102.11 and it has been increasing since then till it hit ₦150.31 to a dollar in year 2010 and ₦158.55 in 2014.

Stock/securities, debt/bonds and equities are the major financial instruments traded in the Nigeria stock exchange market. The stock exchange market has experienced tremendous growth overtime from ₦5 billion in 1980 to ₦10 billion in 1988. It later increased by about 162% from ₦180.4 billion in the 1995 to ₦472.3 billion in 2000. It later increased to four-digit of ₦1359.3 billion in 2003 and grew astronomically to ₦13181.7 billion in 2007, a 870% increase. However, the figure fell to ₦9563 billion and ₦7030.4 billion in 2008 and 2009 respectively. This decline can be attributable to the effects of the global financial crises of that period. However, the figure increase to reach an unprecedented level of ₦19077.4 billion in 2013 before it fell to ₦16875.1 billion in 2014.The persistent rise in the market capitalization depicts how the Nigerian stock exchange market evolved overtime. The recapitalization of commercial banks, regulation of the market, and improved confidence in the market, among other reasons, contributed immensely to rise in stock prices.

3. A Review of Macroeconometric Models

Efforts have been made by individuals and government institutions to develop a macroeconometric in order to understand the transmission mechanism through which policy changes affects different macroeconomic variables of interest. For instance, Gurara (2013) analysed the macroeconomic impact of different policy interventions by developing a macroeconometric model for Rwanda. The ARDL framework was employed to estimate the individual macroeconomic equations. The result showed that the model effectively tracked historical data given its low biasness and desirable Theil's inequality coefficient. The simulation results showed raising expenditure on infrastructure will lead to an increase in inflation and the scenario of cutting aid flows will have a devastating effect on growth.

With the purpose of analyzing the response of macroeconomic variables to changes in monetary policy in the Pakistan economy, Hanif *et al.* (2011) constructed a small macroeconometric model. The model contains 17 equations including 11 behavioural equations and 6 identities. Annual time-series data for the period 1973-2006 was estimated using the ordinary least squares method. The findings revealed that the most effective monetary policy transmission mechanism is the credit channel; government investment crowds-in private investment; and demand for narrow money is relatively stable.

Khan (2014) developed a macroeconometric model to forecast the supply and demand of food in India from 2012 to 2013. Six equations (3 structural equations and 3 identities) were specified and estimated using the two-stage least square (2SLS) method and the projection was based on compound average growth rate (CAGR). The results suggest an increase in both demand for and supply of food items by 2030 however, the government will have to make concerted efforts at increasing investment in the agricultural infrastructure and encouraging labour participation in the agricultural sector.

In a bid to account for model validation and bridge the theory-data gap in, Spanos and Papadopoulou (2013) constructed a small macroeconometric model for Cyprus. The model contains 8 endogenous variables and 20 exogenous variables. Quarterly time-series data from 1995Q1 to 2012Q4 was estimated and the estimates were used to forecast from 2013Q1 to 2020Q4. The results showed a less severe recession in Cyprus in 2013 and a positive GDP growth rate in 2017.

In their study, Asteriou *et al.* (2011) developed and estimated a small macro-econometric model for Greece purposely to examine various economic policy scenarios and their effectiveness in the debt crisis confronting the Greek economy. The study adopted a standard post-Keynesian approach to model the Greek economy. More precisely the model contains behavioral equations for investment, consumption, prices, imports and exports, labor, wages, factors demand and potential GDP. The data for the macroeconomic variables are annual data for the period between 1980 and 2010. The results of the estimation of the equations showed that no particular policy can effectively tackle the high public debt to GDP ratio in Greece. Thus, it was recommended that the Greek government boost competitiveness and create jobs in order to raise GDP growth rates beyond the EU average.

Several individuals and institutions have made efforts geared towards building a macroeconometric model for the Nigerian economy in the past. The purpose of their construction varied from purely academic exercise, to practical policy applications. Recent efforts have been made to improve the macroeconometric model for Nigeria as the previous studies were not simulated for numerical solution and their common features are their emphasis on demand side and neglect of micro considerations. For instance, Akanbi and Du Toit (2011) developed all-inclusive macroeconometric models for Nigeria to bridge the gap between growth and poverty in Nigeria. The models examined the existing demand-side and supply-side constraints hampering growth and it identified socio-economic constraints as the major sources of poverty in Nigeria. Using annual time-series data for the period 1970-2006, the models were estimated using the Engle-Granger two-step cointegration technique to capture the dynamic short-run and long-run properties of the Nigerian economy. The models were subjected to policy scenarios to find the

appropriate policy options capable of stimulating growth and reducing poverty. The result revealed that the supply side will in no small way help devise suitable policies to address the high and sticky poverty level in Nigeria.

In addition, Udah (2009) developed a model broadly classified into six blocks: aggregate demand, fiscal, monetary, labour market, production and the external sector block, for Nigeria. The results showed that the government's debt to the banking system is a medium through which government finance and monetary variables are linked. The model was simulated for the period 1970 to 2004 and the results showed that a monetary squeeze of 20 percent would reduce inflation rate faster than if there was a 10 percent reduction in money supply. As a result of this reduction in money supply, employment, output and government expenditure will also reduce which may have devastating effects on the domestic economy. The paper thus concluded that Nigeria has to choose between higher GDP growth or inflation as a trade-off exists between these variables in Nigeria.

Moreover, CBN (2010) constructed a medium macroeconometric model which disaggregated the Nigerian economy into five sectors (i.e. the real, the external, the fiscal, the monetary and the price sectors) discussed under six blocks namely supply, private demand, government, external, monetary/financial and price blocks. The linkages of the six blocks were identified and the model solved simultaneously to incorporate those linkages. The model was simulated and model evaluation tests were performed. Single-equation analyses indicated that the stochastic equations were well specified and in-sample performance was satisfactory. The dynamic simulation results showed that the simulated and actual data are very close.

Evaluating the response of some macroeconomic variables to changes in fiscal and monetary variables, Egwaikhide *et al.* (2012) developed a structural macroeconomic and estimated it using the ordinary least squares technique. The result showed that monetary policy is more effective in stabilizing and managing counter-cyclical output in the Nigerian economy than fiscal policy. Specifically, interest rate is a very tool for stimulating aggregate output. However, fiscal policy play more important role than monetary policy in the long-run as monetary policy wanes as time goes by. Similarly, Nworuh and Nwachukwu (2010) developed a macroeconometric model for Nigeria. The result showed a desirable variance proportion, bias proportion, covariance proportion and Theil's inequalities indicating that the model depicts reality and is useful for policy prescription.

Olofin *et al.* (2014) built a small macroeconometric model of Nigeria to support the efforts of the Central Bank of Nigeria (CBN) in developing a pragmatic model that will help provide evidence-based monetary policy decisions. The model is termed 'CBN MAC II' and is a revised edition of the CBN MAC I. The model was subjected to sensitivity analysis and was found to be adequate in tracking developments Nigeria's key macroeconomic indicators. The results showed that the monetary authority has to choose between the objectives of lowering the lending rate and maintaining a stable exchange rate.

Similarly, Nkoro and Uko (2018) constructed small macroeconometric model for Nigeria to evaluate the impacts of oil price shock and monetary policy on the economy. The model contains 19 equations (12 behavioral equations, 3 definitional equations and 4 identities) and was estimated using the ordinary least square method using data from 1981 to 2012. The results showed that the model tracks historical data well and that an increase in monetary policy rate will make private investment, nominal interest rate, inflation, and GDP dwindle while unemployment will remain constant. Likewise, a rise in crude-oil price make government revenue and GDP increase while lending rate, inflation and exchange rate will remain unchanged.

4. The Structure of the Model

This study builds a small macroeconometric model of Nigeria. The model comprises ten behavioural equations and five identities with ten endogenous variables and thirteen exogenous variables. The autoregressive distribution lag (ARDL) framework is used to estimate the behavioural equations in the model using annual data sourced from Central Bank of Nigeria Statistical Bulletin, OPEC Annual Statistical Bulletin and World Development Indicators (WDI) for the period between 1981 and 2014. The validity of the model is checked through both within-sample and out-of-sample forecasts.

4.1. Model Specification

4.1.1. Aggregate Output

Following Cobb-Douglas production function, aggregate capital stock and aggregate labour force are the major drivers of aggregate output in an economy. Also, following the specification of the aggregate output function in the studies by John and Chris (2000) labour force (LABF), human capital measured using expenditure on education (HCAP) and physical capital represented by gross fixed capital formation (GFCF) are determinants of aggregate output (RGDP). Aggregate output is also a function of exchange rate. Thus, the aggregate output model can be specified as follows:

$$RGDP = \gamma_1 + \gamma_2 HCAP + \gamma_3 GFCF + \gamma_4 LABF + \gamma_5 EXR + \mu$$

A priori Expectation: $\gamma_2, \gamma_3, \gamma_4 > 0$ $\gamma_5 < 0$

4.1.2. Interest Rate

The nominal interest rate equation is assumed to be an inverted Keynes' money demand function where interest rate is influenced by money demand represented in this study by total monetary assets (M2) and national income (RGDP). The studies by Folawewo and Tennant (2008); Ferdinand *et al.* (2015) and Anthony and Babatunde (2012) show that interest rate is influenced by money supply (M2), consumer price index (CPI), exchange rate (EXR), reserve requirement (RR), and aggregate output (RGDP). Thus, the nominal interest rate can be specified as:

$$INT = \text{ƪ}_1 + \text{ƪ}_2 M2 + \text{ƪ}_3 CPI + \text{ƪ}_4 RR + \text{ƪ}_5 RGDP + \text{ƪ}_4 EXR + \mu$$

A priori Expectation: $\text{ƪ}_2, \text{ƪ}_3, \text{ƪ}_5 > 0$ while $\text{ƪ}_4, \text{ƪ}_5 < 0$

4.1.3. Consumer Price Index

Fatukasi (2005) showed that the Nigerian consumer price index is influenced by interest rate (INT), exchange rate (EXR) and money supply (M2). Furthermore, Saravanan (2015) included money supply (M2) and government expenditure (GEXP) as drivers of consumer price index. Olatunji *et al.* (2010) incorporated real GDP (RGDP) into their CPI model specification. Hence, the CPI model can be specified as:

$$CPI = \mho_1 + \mho_2 INT + \mho_3 EXR + \mho_4 M2 + \mho_5 RGDP + \mho_6 GEXP + \mu$$

A priori Expectation: $\mho_3, \mho_4, \mho_5, \mho_6 > 0$ while $\mho_2 < 0$

4.1.4. Exchange Rate

Following the specification of Ajao and Igbekoyi (2013) exchange rate (EXR) is driven by trade openness (TROP), interest rate (INT) and money supply (M2). Udousung *et al.* (2012) also incorporated trade openness into their exchange rate model. Ben (2011) in his model of exchange rate, included the price of oil (OILP) to depict that the price of oil in the international market determines the value of naira in relation to the US dollars.

$$EXR = \hbar_1 + \hbar_2 TROP + \hbar_3 INT + \hbar_4 M2 + \hbar_5 OILP + \mu$$

A priori Expectation: $\hbar_2, \hbar_3, \hbar_5 > 0$ while $\hbar_4 < 0$

4.1.5. Consumption

Consumption is the largest component of aggregate demand. It can be divided into private consumption (PCON) and government consumption (GCON). Following the Keynes' absolute income theory of consumption and Kuznet's theory of consumption, the primary determinants of consumption are income (RGDP). Also, in line with the law of demand, price level (measured with CPI) is a major determinant of quantity demanded (consumption). Due to the import-dependent nature of the Nigerian economy, the exchange rate (EXR) is also a major determinant of consumption expenditure in Nigeria. Because foreign remittances (REM) have become a significant source of income for many households in the country, net income from abroad is incorporated into the consumption model. The consumption model, which follows (CBN, 2010) model closely, is specified as follows:

$$CON = \yen_1 + \yen_2 RGDP + \yen_3 CPI + \yen_4 EXR + \yen_5 REM + \mu$$

A priori Expectation: $\yen_2, \yen_5 > 0$ while $\yen_3, \yen_4 < 0$

4.1.6. Gross Fixed Capital Formation

Investment is the second key component of aggregate demand after consumption because it is a veritable instrument for achieving and sustaining economic growth. Aggregate investment can be decomposed into private investment (PRINV) and public investment (PUINV). Following Keynesian and classical investment theories, interest rate (INT) and income (RGDP) drive investment. Duruechi and Ojiegbe (2015) incorporated inflation rate (CPI), exchange rate (EXR) and interest rate (INT) into their investment model as explanatory variables. Investment is measured by gross fixed capital formation (GFCF). Thus, the investment model can be specified as follows:

$$GFCF = \hbar_1 + \hbar_2 INT + \hbar_3 RGDP + \hbar_4 EXR + \hbar_5 CPI + \mu$$

A priori Expectation: $\hbar_3 > 0$ while $\hbar_2, \hbar_4, \hbar_5 < 0$

4.1.7. Export

Nigeria's export can be disaggregated into oil export and non-oil export. While oil export dominates Nigeria's export portfolio, non-oil only constitute a small proportion of the overall export of the country.

4.1.7.1 Oil Export

Nigeria's major export product is crude-oil whose price is exogenously determined at the world market and whose quota is regulated by OPEC. Thus, the barrels of crude oil extracted per day determine the volume of crude oil Nigeria will supply to the world market. United States of America is the major buyer of Nigeria's export product as she imports about 40 percent of Nigeria's crude-oil thus a change in US' national income and the naira/US$ exchange rate directly affects the Nigerian economy. From the foregoing, Nigerian oil-exports (OILX) can be said to be influenced by price of crude-oil in the world market (OILP), OPEC quota (OPEC), foreign demand of crude-oil represented as United States GDP (USGDP) and exchange rate (EXR). This specification is in consonance with that of CBN (2010). Thus, the oil-export equation can be specified as follows:

$$OILX = \delta_1 + \delta_2 OILP + \delta_3 OPEC + \delta_4 USGDP + \delta_5 EXR + \mu$$

A priori Expectation: $\delta_2, \delta_3, \delta_4, \delta_5 > 0$

4.1.7.2. Non-Oil Export

Prior to the discovery and exploration of crude oil in commercial quantities in the early 1970s, the mainstay of the Nigerian economy was agriculture. Although, crude-oil dominates the Nigerian exports profile, non-oil products and other natural resources are still being exported to other nations of the world but at a relatively lower rate than what obtained before the 1970s. Non-oil export is influenced by production in the non-oil sector (NOILY) and exchange rate (EXR). This specification follows (CBN, 2010) specification of the non-oil sector equation. Thus, the non-oil export (NOILX) equation can be specified as follows:

$$NOILX = \varphi_1 + \varphi_2 NOILY + \varphi_3 EXR + \mu_{10}$$

A priori Expectation: $\varphi_2, \varphi_3 > 0$

4.1.8. Import

Nigeria is highly import-dependent such that we import both consumer and capital goods. Imports constitute a significant share of inputs for both domestic production and final consumption. This study disaggregates import into oil and non-oil import.

4.1.8.1. Oil Import

Nigeria exports crude-oil and imports its refined products. Nigeria's refineries refine crude-oil but not efficiently thus, the little production is augmented with import to meet the growing demand for crude-oil products. Exchange rate and price of crude-oil in the international are other important determinants of oil import. Hence, demand for oil imports (OILM) is influenced by domestic production of crude oil (DPRO), the price of crude-oil (OILP) in the international market and the exchange rate (EXR). Thus, the oil-import equation can be specified as follows:

$$OILM = \Omega_1 + \Omega_2 DPRO + \Omega_3 EXR + \Omega_4 OILP + \mu$$

A priori Expectation: $\Omega_2, \Omega_3, \Omega_4 < 0$

4.1.8.2. Non-Oil Import

Usually, countries import goods and service they cannot produce, goods in which they do not have comparative advantage, and to augment domestic production, among other reasons. The latter reason implies that the volume of Nigeria's imports depend on the country's non-oil output (NOILY). The tariffs (TAR) levied on imported goods also influence the volume of import together with exchange rate (EXR) and domestic interest rate (INT). This specification follows closes that of CBN (2010). Thus, non-oil imports model can be specified as follows:

$$NOILM = \S_1 + \S_2 NOILY + \S_3 TAR + \S_4 EXR + \S_5 INT + \mu$$

A priori Expectation: $\S_2, \S_6 > 0$ while $\S_3, \S_4, \S_5 < 0$

Identities

CON = PCON + GCON
GFCF = PRINV + PUINV
EXP = OILX +NOILX
IMP = OILM +NOILM
RGDP = CON + GFCF + GEXP + EXP – IMP

4.2. Empirical Results

4.2.1. Augmented Dickey Fuller Unit Root Test

The results of the augmented dickey-fuller unit root test are presented in Table 1. The results show that the first difference of most of the variables were taken before they became stationary thus they are integrated of order 1, that is, I(1). A few variables like interest rate, non-oil export, OPEC quota and tariff are found to be stationary without differencing their series. Hence, it is necessary to check if long-run relationship exists among the variables. The autoregressive distributed lag (ARDL) Bounds test approach to cointegration is employed to investigate if these variables converge in the long-run. The choice of this approach is premised on the fact that the series are a combination of I(0) and I(1) without the inclusion of I(2).

Table-1. Augmented dickey fuller unit root test result.

Variables	Level	1st difference	I(d)	Variables	Level	1st Difference	I(d)
INT	-2.979575^{a**}	-6.027197^{c*}	I(0)	LNOILY	-1.068062^{b}	-3.850615^{a*}	I(1)
LCON	-2.777769^{b}	-3.065783^{c*}	I(1)	LOILM	-1.579322^{a}	-7.106029^{a*}	I(1)
LCPI	-1.670254^{a}	-2.706235^{a***}	I(1)	LOILP	-2.104341^{b}	-6.089483^{c*}	I(1)
LDPRO	-1.103451^{b}	-5.763333^{c*}	I(1)	LOILX	-0.967106^{a}	-6.246777^{a*}	I(1)
LEXR	-2.319449^{a}	-4.945028^{b*}	I(1)	LOPEC	-3.450675^{a**}	-6.566612^{c*}	I(0)
LGEXP	-0.960402^{a}	-4.349583^{b*}	I(1)	LREM	-1.967389^{a}	-5.645840^{c*}	I(1)
LGFCF	-2.994514^{b}	-2.953288^{c*}	I(1)	LRGDP	-1.873552^{b}	-4.247826^{a*}	I(1)
LHCAP	-1.842259^{b}	-6.693017^{b*}	I(1)	LRR	-2.056679^{b}	-4.758919^{a*}	I(1)
LLABF	-1.760340^{b}	-5.093305^{a*}	I(1)	LTAR	-4.599778^{b*}	-7.910454^{c*}	I(0)
LM2	-2.909531^{b}	-3.730620^{a*}	I(1)	LTROP	-1.390444^{b}	-6.572491^{a*}	I(1)
LNOILM	-2.255197^{b}	-7.094259^{a*}	I(1)	LUSGDP	-3.028256^{a**}	-5.371590^{b*}	I(0)
LNOILX	-4.245504^{b**}	-7.130983^{a*}	I(0)				

Source: Author's computation using eviews9.
Note: *, ** and *** implies statistical significance at 1 percent, 5 percent and 10 percent respectively.
a, b and c implies model with intercept, trend and intercept and none respectively.
I(0) and I(1) implies that the time series is stationary at level and first difference respectively.

4.2.2. Autoregressive Distributed Lag (ARDL) Bounds Test Approach to Cointegration

Sequel to the result of the unit root test, cointegration test is carried out using ARDL Bounds Test approach to cointegration. The choice of this approach is premised on the fact that our variables are not integrated of the same order, thus negating the use of Engle-granger and Johansen Cointegration test approach. Pesaran and Shin (1999) and Pesaran *et al.* (2001) developed the ARDL cointegration approach which has three major advantages over other traditional cointegration approaches. Firstly, ARDL does not require that all the variables under study have the same order o integration; it can be used if the series are I(0) or I(1) or both. Secondly, it is relatively more efficient using small sample sizes. Thirdly, unbiased estimates of long-run model are obtained using ARDL method (Harris and Sollis, 2003).

Cointegration test is carried out to determine the existence of a long-run relationship between the dependent and explanatory variables. The rule of ARDL Bounds test of cointegration states that the null hypothesis be rejected if the value of the computed F-statistic is greater than the upper bounds value and accepted if the F-statistic is less than the lower bounds value. The ARDL cointegration test will be said to be inconclusive should the computed F-statistic falls between the lower and upper bound.

The result of ARDL bound test is presented in Table 2. The result shows that the null hypothesis for CPI model, consumption model, GFCF model and non-oil imports model should be rejected since the value of their computed F-statistic is greater than the upper bound critical value at 1 percent level of significance and at 10

percent level of significance for the interest rate model. This implies that there is a long-run relationship among the endogenous variables and their respective explanatory variables. However, real GDP model, exchange rate model, oil export model, non-oil export model and oil import model are found not to be cointegrated because the values of their computed F-statistic are less than 5 percent, 1 percent, 5 percent, 10 percent and 10 percent level of significance respectively. We will proceed to estimating the ARDL error correction model (short run) and their respective long run models for each of the models.

Table-2. Results of ARDL bounds test approach to cointegration.

Endogenous variables	Significance	Lower bound	Upper bound	Computed F-statistic	Cointegration status
LRGDP	10%	2.45	3.52	2.49	Not cointegrated
	5%	2.86	4.01		
	1%	3.74	5.06		
INT	10%	2.26	3.35	3.39	Cointegrated
	5%	2.62	3.79		
	1%	3.41	4.68		
LCPI	10%	2.26	3.35	5.58	Cointegrated
	5%	2.62	3.79		
	1%	3.41	4.68		
LEXR	10%	2.45	3.52	3.38	Not cointegrated
	5%	2.86	4.01		
	1%	3.74	5.06		
LCON	10%	2.45	3.52	6.61	Cointegrated
	5%	2.86	4.01		
	1%	3.74	5.06		
LGFCF	10%	2.45	3.52	7.73	Cointegrated
	5%	2.86	4.01		
	1%	3.74	5.06		
LOILX	10%	2.45	3.52	2.72	Not cointegrated
	5%	2.86	4.01		
	1%	3.74	5.06		
LNOILX	10%	3.17	4.14	2.69	Not cointegrated
	5%	3.79	4.85		
	1%	5.15	6.36		
LOILM	10%	2.72	3.77	2.32	Not cointegrated
	5%	3.23	4.35		
	1%	4.29	5.61		
LNOILM	10%	2.45	3.52	5.07	Cointegrated
	5%	2.86	4.01		
	1%	3.74	5.06		

Source: Author's computation using eviews9.

4.3. Presentation and Interpretation of Results

The results from the estimation of the autoregressive distribution lag (ARDL) model of each of the endogenous variables are presented and interpreted below. The optimal lag lengths for the selected ARDL Error Correction representation of each model are determined by the Schwarz Criterion (SC). The results of the long run coefficient and error correction representation of the selected ARDL model for individual equation are presented in Table 3.

4.3.1. Aggregate Output

The result of the estimation of aggregate output (real GDP) equation is presented in Table 4. The result reveals that the estimated error correction coefficient is negative and significant at 5 per cent level of significance and shows that approximately 32 percent of disequilibrium from the previous year's shock of the explanatory variables converges back to the long-run equilibrium in the current year. More precisely, the result shows that a one percent increase in human capital and gross fixed capital formation will bring about approximately 0.06 percent and 0.07 percent increase and decrease in aggregate output in the short run respectively. Also, a one percent increase in labour force will lead to 0.11 percent fall in aggregate output which implies that marginal product of labour fall as output increases in Nigeria. This result is plausible because the service sector which is capital-intensive is the booming sector of the economy and in recent times, contributes immensely to the Nigeria's aggregate output. Furthermore, a one percent depreciation of the exchange rate will decrease aggregate output by 0.05 percent in the short-run. On the other hand, whereas human capital, gross fixed capital formation and exchange rate have a positive relationship with aggregate output in the long-run, labour force is inversely related to aggregate output. However, only human capital was found to be significant in explaining changes in aggregate output both in the short-run and the long-run. Put differently, human capital is a determinant of aggregate output in Nigeria both in the short-run and long-run. The result also shows that the model explains about 99 percent of the variation in aggregate output. Interestingly, the long run impacts of each of the explanatory variables on aggregate output exceed their short-run impacts.

4.3.2. Interest Rate (Monetary Policy Rate)

The result of the estimated interest rate short-run equation shows that interest rate will fall by 6.5 percent if money supply increases by one percent indicating that interest rate and money supply are inversely related. This result is plausible and it supports economic theory which posits an inverse relationship between money supply and interest rate. Also, a one percent increase in price level and reserve requirement will lead to approximately 1.06 percent and 1.67 percent increase in interest rate; a one percent increase in real GDP will raise interest rate by

approximately 7.22 percent; and a one percent depreciation of exchange rate will result in about 4.66 percent fall in interest rate. This implies that the interest rate is very sensitive to changes in the explanatory variables of the model. However, only exchange rate and money supply are significant in influencing interest rate in Nigeria while other variables of the model are not significant in the short-run. The result also shows that about 59 percent of the variation in interest rate is explained by the explanatory variables of the model. The coefficient of the error correction term is very high indicating a high speed of adjustment to equilibrium following short-run shocks that is, about 90 percent of the disequilibrium, caused by previous period shocks converges in the long-run. On the other hand, the long run results show that exchange rate has a positive and significant relationship with interest rate such that interest rate increases by 5.2 percent if exchange rate depreciates (increases) by one percent. Also, money supply has a negative but significant relationship with interest rate in the long-run such that interest rate falls by 7.26 percent if money supply increases by one percent. In addition, consumer price index, reserve requirement real GDP and exchange rate have a positive relationship with interest rate while only money supply is inversely related to interest rate in the long run in Nigeria. However, only money supply and exchange rate are determinants of interest rate in the long run in Nigeria. Interestingly, the long run impacts of each of the explanatory variables on interest rate exceed their short-run impacts.

4.3.3. Consumer Price Index (CPI)

The result in Table 3 also shows that the first-period lag of CPI has a positive relationship with CPI such that a one percent increase in its lag will bring about, on the average, 0.56 percent increase in the present price level. This indicates that CPI in Nigeria follows adaptive expectation in that the previous value of CPI predicts its present value. In addition, the result shows that a one percent depreciation of exchange rate will bring about approximately 0.1 percent fall in price level; a one percent increase in real GDP will bring about 0.45 percent decrease in price level; and a one percent change in money supply and government expenditure will bring about approximately 0.18 percent and 0.15 percent change in price level respectively. However, among all the explanatory variables, only real GDP, lag of interest rate and lag of CPI are found to be significant in determining CPI in Nigeria in the short-run. In sum, whereas first period lag of CPI, interest rate, money supply and government expenditure have a positive relationship with CPI in the short-run, first period lag of interest rate, exchange rate and real GDP are inversely related to CPI in Nigeria. Furthermore, the result shows that the model explains about 99 percent of the variation in the price level. The speed of adjustment of the explanatory variables to long-run equilibrium is about 46 percent. However, the long run coefficients result reveals that the estimated coefficients of real GDP and government expenditure are significant in determining price level. It shows that in the long run, a one percent increase in real GDP will lead to 0.98 percent fall in CPI and a one percent increase in government expenditure will lead to approximately 0.81 percent increase in CPI. Also, an increase in interest rate and money supply by one percent will lead to 0.03 and 0.39 percent increase in CPI respectively. In sum, interest rate money supply and government expenditure have positive impacts on CPI while exchange rate and real GDP are inversely related to CPI in the long-run.

4.3.4. Exchange Rate

Table 3 also shows that the coefficient of the error correction term in the estimated exchange rate equation is negative and significant. It reveals that the speed of adjustment of the model to its long run equilibrium is about 42 percent. The result also shows that, in the short-run, a percent increase in interest rate, money supply and oil price will lead to approximately 0.02 percent, 0.58 percent and 0.07 percent depreciation (increase) in exchange rate respectively. Also, exchange rate will depreciate by 0.18 percent if trade openness increases by one percent. However, it is found that, of all the explanatory variables of the model, only money supply is significant in explaining exchange rate movement in Nigeria in the short-run. The positive relationship between oil price and exchange rate in Nigeria is plausible because the price of crude-oil is quoted in US dollar and the effect of the increase in price on the naira is not direct as the increase in price of oil only increases Nigeria's foreign exchange earnings. The coefficient of the Adjusted R-square shows that about 98 percent of the variation in exchange rate is explained by the trade openness, interest rate, money supply and oil price. However, in the long run, trade openness and oil price have a negative impact on exchange rate while interest rate and money supply have positive influence on exchange rate in Nigeria. Nonetheless, only money supply and oil price are significant determinants of exchange rate in Nigeria in the long-run. In sum, trade openness has an inverse relationship with exchange rate both in the short-run and long-run; interest rate and money supply have a direct relationship with exchange rate both in the short-run and long-run; and oil price is positively related to exchange rate in the short-run but inversely related to it in the long-run. This suggests that if oil price changes persist, it will transit from having a positive impact on exchange rate to have a negative impact.

4.3.5. Consumption

The result of the estimated consumption equation in Table 3 shows that there is a positive relationship between real GDP and consumption such that a one percent rise in real GDP will bring about approximately 0.18 percent increase in consumption. This result parallels the theory of the absolute income which states that consumption is a function of income (real GDP in our case). Also, a one percent increase in price level will lead to about 0.37 percent fall in consumption indicating that inflation reduces the purchasing power of consumers thereby reducing their consumption; a one percent depreciation in exchange rate will bring about 0.1 percent fall in consumption; and a one percent increase in remittance will lead to a 0.02 percent increase in consumption. In addition, a one percent increase in the lag value of both consumption and exchange rate will lead to 0.39 percent and 0.27 percent decline in consumption. However, of the six explanatory variables of the consumption model, only the lag value of both consumption and exchange rate are significant in explaining changes in consumption. The adjusted R-squared value shows that about 97 percent of the variation in consumption is explained by GDP, CPI, exchange rate and remittance and the Durbin-Watson autocorrelation coefficient of 1.97 shows the absence of autocorrelation among the explanatory variables. The speed of adjustment of the model to its long-run equilibrium

state is about 42 percent. However, in the long run, real GDP, exchange rate and remittance have a positive but not significant relationship with consumption while CPI has a negative but insignificant relationship with consumption in Nigeria. This implies that only exchange rate is a determinant of consumption in the long-run in Nigeria. Interestingly, the long run impacts of each of the explanatory variables on consumption exceed their short-run impacts.

4.3.6. Gross Fixed Capital Formation (GFCF)

The result of the short-run estimation shows that only the lag of interest rate and real GDP are statistically significant to influence GFCF such that a one percent increase in lag of interest rate and real GDP will bring about 0.002 percent and 0.7 percent increase in GFCF. Similarly, interest rate has an insignificant positive effect on GFCF such that an increase in interest rate by one percent raises investment by 0.002 percent. This result is against theoretical postulation which posits an inverse relationship between interest rate and investment (gross fixed capital formation). Also, a one percent increase in CPI and one percent depreciation in exchange rate will bring about 0.01 percent and 0.02 percent fall in GFCF indicating that they are both inversely related to GFCF. In sum, in the short-run, interest rate and its first period lag as well as real GDP are positively related to GFCF while exchange rate and CPI are inversely related to GFCF. Furthermore, the coefficient of the error correction term indicates that approximately 51 percent of disequilibrium from the previous year's shock of the independent variables converges back to the long-run equilibrium in the current year. Furthermore, it is apparent that about 93 percent of the variation in GFCF is explained by the explanatory variables. In the long run, however, GFCF will fall by 0.01 percent, 0.03 percent and 0.02 percent if interest rate, exchange rate and CPI increase by one percent respectively. Also, real GDP has a positive and significant relationship with GFCF in the long run such that GFCF will increase by 1.37 percent if real GDP increases by one percent. Hence, only real GDP is a driver of investment in the long-run in Nigeria. As is the case with previous equations, the long-run impacts of the explanatory variables (interest rate, real GDP, exchange rate and CPI) of the GFCF equation exceed their impacts in the short-run.

4.3.7. Oil Export

The result of the oil export equation shows that a one percent increase in oil price, OPEC quota and exchange rate will bring about approximately 0.75 percent, 0.02 percent and 0.16 percent increase in oil export respectively. These results are in line with a priori expectation as exchange rate depreciation will make exports cheaper thus, increasing output as well as the volume of oil exports. Also, OPEC gives quota for exports to its member nations including Nigeria; an increase in this quota means an increase in the volume of export while an increase in oil price will encourage producers and exporters to increase the volume of both production and export thereby, increasing their revenue. Furthermore, a one percent increase in United States' GDP, which implies an increase in US national income, will lead to approximately 1.81 percent increase in oil export. This result implies that oil export responds to changes in the explanatory variables of this model. This result is plausible in that a change in the national income the United States, which is the major importer of Nigerian crude-oil, will greatly affect the volume of Nigeria's oil export and revenue. This was evident during the recession in the US in 2008 when Nigeria was also badly hit by the recession which originated in the United States. However, only oil price is significant in explaining the changes in oil export in Nigeria in the short-run. On the other hand, oil price and OPEC quota have negative impacts on oil exports while US GDP and exchange rate have positive effects on oil export in Nigeria in the long-run. However, none of these variables is a determinant of oil export in the long-run. Furthermore, the model explains about 99 percent variation in the volume oil export in Nigeria and the coefficient of the Durbin-Watson (1.86) indicates the absence of autocorrelation in the model. Interestingly, the long run impacts of each of the explanatory variables on oil exports exceed their short-run impacts.

4.3.8. Non-Oil Export

Non-oil output and exchange rate are incorporated into Nigeria's non-oil export equation. The result shows that only non-oil output is significant in explaining the movement in non-oil export Nigeria in the short-run while both non-oil output and exchange rate drive non-oil export in the long-run. Also, the result shows that in the short run, a one percent change in non-oil output will bring about approximately 1.27 percent change in non-oil export while non-oil exports will fall by about 0.09 percent when exchange rate depreciates (increases) by one percent. The result implies that non-oil export gives a sharp response to shocks in non-oil export in Nigeria. In the long run, however, non-oil exports have a positive relationship with exchange rate such that non-oil exports will increase by approximately 0.7 percent when exchange rate appreciates by one percent. This implies that the impact of exchange rate on non-oil exports moves from positive to negative as time progresses. Furthermore, the model explains about 98 percent variation in the volume non-oil export in Nigeria and the Durbin-Watson coefficient reveals that there is no serial correlation in the model. The coefficient of the error correction term reveals that approximately 49 percent of disequilibrium from the previous year's shock of the independent variables converges back to the long-run equilibrium in the current year. Interestingly, the long run impacts of each of the explanatory variables on non-oil exports exceed their short-run impacts.

4.3.9. Oil Import

The result of the estimated oil import equation shows that exchange rate and oil price are positively related to oil imports such that one percent exchange rate depreciation and one percent decline in crude-oil price will result in approximately 0.78 percent and 0.01 percent increase in oil-import respectively. Also, a one percent increase in domestic crude-oil production will lead to about 0.17 percent fall in oil-import. This result is plausible in that an increase domestic production should reduce the imports of the same product although this implies that the domestic production of crude-oil products is not enough to meet the energy demand of the teeming population of the Nigerian economy. However, only exchange rate is found to be significant in influencing oil import in Nigeria both in the short and long run. In addition, about 96 percent of the variation in oil import is explained by the

explanatory variables of the model. In sum, domestic production of crude-oil is inversely related to imports both in the short-run and the long-run while exchange rate and oil price are positively related to oil import in Nigeria both in the short-run and the long-run. The coefficient of the error correction term implies that that approximately 48 percent of disequilibrium from the previous year's shock of the independent variables converges back to the long-run equilibrium in the current year. The coefficient of the Durbin-Watson (2.19) indicates the absence of serial correlation in the model. Interestingly, the long run impacts of each of the explanatory variables on oil imports exceed their short-run impacts.

Table-3. Results of short-run and long-run coefficients of selected ARDL models.

Regressors	Short-run coefficients	Long-run coefficients	Regressors	Short-run coefficients	Long-run coefficients
Aggregate output equation			**Interest rate equation**		
C		27.943437	C		-212.010636
D(LHCAP)	0.059001**	0.187105**	D(LM2)	-6.501138**	-7.255029**
D(LGFCF)	0.067482	0.214002	D(LCPI)	1.058286	1.181008
D(LLABF)	-0.113243	-0.359121	D(LRR)	1.674527	0.340235
D(LEXR)	-0.011596	0.219883	D(LRR(-1))	2.214642***	
D(LEXR(-1))	-0.053117		D(LRGDP)	7.217633	8.054611
ECM(-1)	-0.315333**		D(LEXR)	4.658220*	5.198401*
Adjusted R-squared	0.9867		ECM(-1)	-0.896087*	
Durbin-Watson	1.88		Adjusted R-squared	0.5893	
			Durbin-Watson	2.17	
CPI equation			**Non-oil import equation**		
C		26.238690**	C		-2.617710
D(LCPI(-1))	0.564784*		D(LNOILM(-1))	-0.357448*	
D(INT)	0.003747	0.030354	D(LNOILY)	-1.875787	1.235078
D(INT(-1))	-0.018297*		D(LNOILY(-1))	1.913407	
D(LEXR)	-0.102748	-0.225096***	D(LTAR)	0.296322**	1.541259
D(LM2)	0.177042	0.387854	D(LEXR)	-0.125161	0.494570
D(LRGDP)	-0.447983**	-0.981416**	D(INT)	-0.017603***	-0.187511***
D(LGEXP)	0.145423	0.811245*	D(INT(-1))	-0.036215**	
ECM(-1)	-0.456466*		ECM(-1)	-0.192260**	
Adjusted R-squared	0.9981		Adjusted R-squared	0.9940	
Durbin-Watson	1.79		Durbin-Watson	2.62	
Consumption equation			**GFCF equation**		
C		-8.627151	C		-19.300394***
D(LCON(-1))	-0.388340**		D(INT)	0.001948	-0.006785
D(LRGDP)	0.182747	0.434877	D(INT(-1))	0.024696**	
D(LCPI)	-0.366074**	-0.232034	D(LRGDP)	0.699998*	1.369061*
D(LEXR)	-0.099164	0.405210***	D(LEXR)	-0.019461	-0.038061
D(LEXR(-1))	-0.271237*		D(LCPI)	-0.009047	-0.017694
D(LREM)	0.015245	0.036279	ECM(-1)	-0.511298*	
ECM(-1)	-0.420227**		Adjusted R-squared	0.9255	
Adjusted R-squared	0.9730		Durbin-Watson	1.69	
Durbin-Watson	1.97				
Oil export equation			**Exchange rate equation**		
C		-163.931707	C		-0.518808
D(LOILP)	0.753157*	-0.058075	D(LTROP)	-0.181612	-0.436298
D(LOPEC)	0.016205	0.050296	D(INT)	0.025115	0.060336
D(LUSGDP)	1.808769	5.614029	D(LM2)	0.579170*	1.391373**
D(LEXR)	0.158039	0.490519	D(LOILP)	0.069543	-1.530567**
ECM(-1)	-0.322187*		ECM(-1)	-0.416257*	
Adjusted R-squared	0.9865		Adjusted R-squared	0.9825	
Durbin-Watson	1.86		Durbin-Watson	2.01	
Oil import equation			**Non-oil export equation**		
C		3.496850	C		-13.850723*
D(LDPRO)	-0.173225	-0.361106	D(LNOILY)	1.274462***	2.602096*
D(LEXR)	0.777420*	1.620612*	D(LEXR)	-0.094395	0.703143*
D(LOILP)	0.009267	0.019318	ECM(-1)	-0.489783*	
ECM(-1)	-0.479708*		Adjusted R-squared	0.9750	
Adjusted R-squared	0.9631		Durbin-Watson	1.83	
Durbin-Watson	2.19				

*, ** and *** implies significance at 1%, 5% and 10% respectively.
Source: Computed by author using eviews9.

4.3.10. Non-Oil Import

The result of the estimated non-oil import reveals that all the explanatory variables, except non-oil output and exchange rate, are significant in determining changes in non-oil imports in Nigeria in the short-run. It is apparent from the result that non-oil imports in Nigeria follows adaptive expectation in that the previous value of non-oil imports predicts its present value as depicted by the coefficient of the non-oil imports and its corresponding probability value. The result shows that in the short-run, a one percent increase in the lag of non-oil import, non-

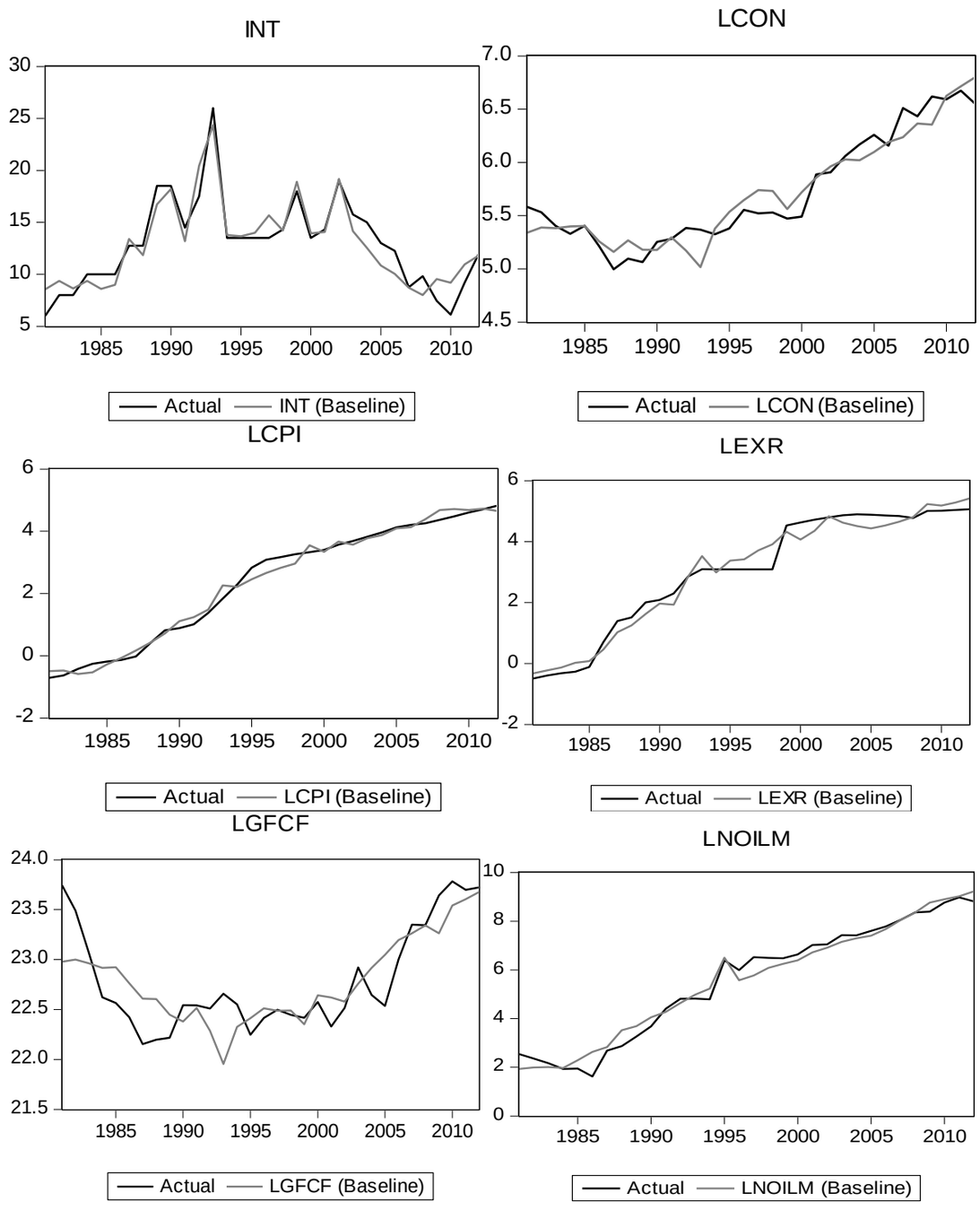
oil output, exchange rate, interest rate, and the previous value of interest rate will result in approximately 0.36 percent, 1.88 percent, 0.13 percent, 0.02 percent and 0.04 percent decline in non-oil imports. Also, a one percent increase in lag of non-oil output and tariff will lead, on the average, to about 1.91 percent and 0.3 percent increase in non-oil imports. In addition, about 99 percent of the variation in oil import is explained by the explanatory variables of the model. In the long run, non-oil output, tariff and exchange rate are found to have positive relationship with non-oil import while interest rate has an inverse relationship with non-oil imports. Moreover, only interest rate significantly influence non-oil imports in Nigeria in the long run. Interestingly, the long run impacts of each of the explanatory variables on non-oil imports exceed their short-run impacts.

4.4. Model Forecast Evaluation and Simulation

The primary purpose of this macroeconometric model is to explain the relationships between major macroeconomic variables, forecast and simulate future time paths of selected economic variables. The predictive accuracy of the model is crucial because it shows the closeness of the solution values of each equation in the models to the time paths of their actual values. The model is evaluated for both within-sample and out-of-sample predictive performance and the results are presented below.

4.4.1. Within-Sample Performance

Time series data running from 1981 to 2014 is used to generate a static solution for the model. The actual values are plotted against the static simulation values for the endogenous variables in Figure 1. The figure shows that the predicted series are very close to actual series except for gross fixed capital formation (GFCF) which has few gaps between actual and predicted series. However, the closeness of the predicted series to the actual series indicates a good forecasting power of the model thus, suggesting that the simulation result will be valid for policy prescriptions.



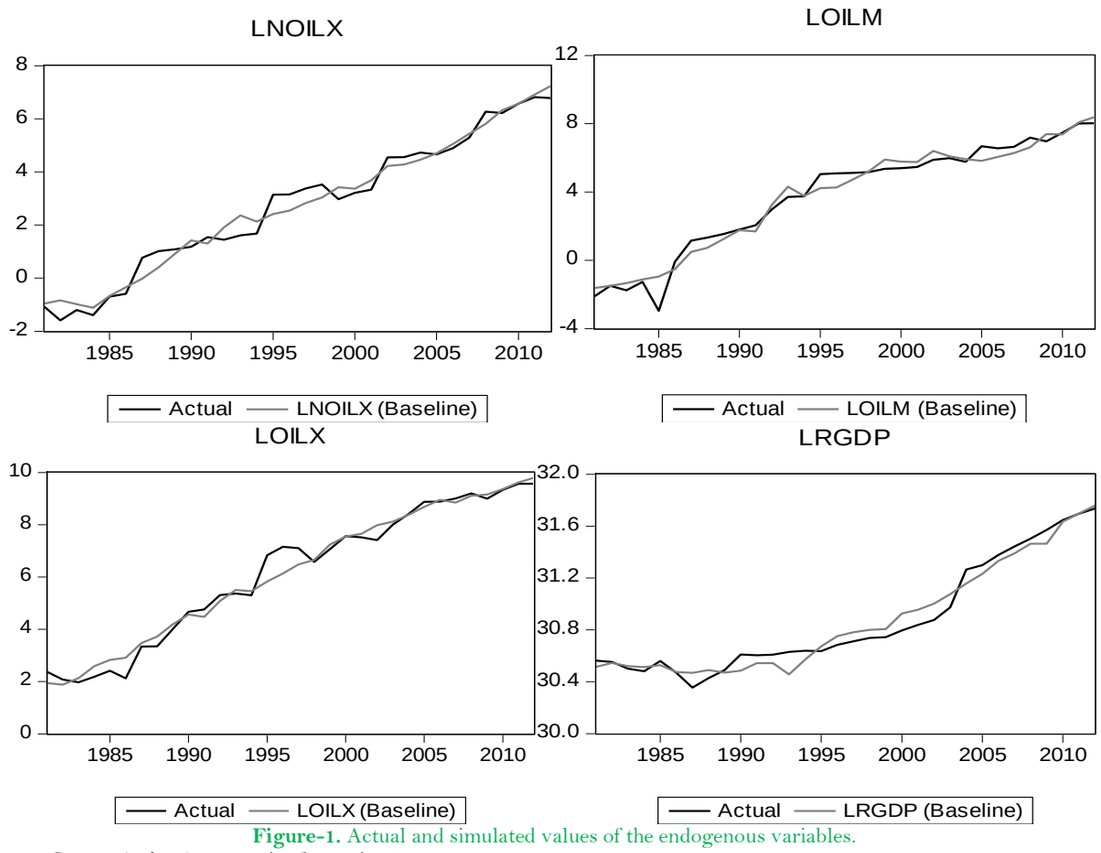


Figure-1. Actual and simulated values of the endogenous variables.

Source: Authors' computation from eviews9.

4.4.2. Out-of-Sample Performance

Time series data spanning the period between 1981 and 2014 are estimated to generate static solution of the model and one-step ahead out-of-sample predictions were made. The focus of the out-of sample forecast is to compare the forecast figure of each of the endogenous variables with their actual figures. This will help ascertain the accurate predictive performance of our model. The statistics used to evaluate the predictive performance of a model are mean absolute errors (MAE), root mean square errors (RMSE) and Theil inequality coefficient. Table 4 presents these statistics for all the endogenous variables and it shows that the errors are considerably small indicating that the model predicts historical data well.

Table-4. Prediction statistics of the macroeconometric model.

Endogenous variables	Mean absolute error (MAE)	Root mean absolute error (RMSE)	Theil inequality coefficient
Real GDP	0.061	0.071	0.001
Consumer price index	1.891	2.542	0.094
Interest rate	0.144	0.173	0.027
Exchange rate	0.293	0.338	0.046
Consumption	0.103	0.124	0.011
Gross fixed capital formation	0.182	0.241	0.005
Oil export	0.298	0.427	0.031
Non-oil export	0.369	0.455	0.057
Oil import	0.482	0.682	0.066
Non-import	0.300	0.435	0.031

Source: Computed from eviews9.

4.5. Analysis of Impact of Shocks on the Endogenous Variables

The model checked for the impact shocks have on the endogenous variables using stochastic simulation exercises. Given the above tests and the level of satisfactory performance observed in many of the variables and equations, simulation on possible outcomes of changes in selected variables (government expenditure, money supply and oil price) are provided. The process involves introducing shocks to selected policy variables and tracing their impacts given the relationships in the model. The aim is to examine what will happen to the endogenous variables if a particular policy instrument is altered. This study looks at the impact of three sets of shocks:

Scenario 1: A 10 percent increase in government expenditure.

Scenario 2: A 10 percent depreciation of exchange rate.

Scenario 3: A fall in oil price in the international market by 10 percent.

4.5.1. Simulation Results

There are three policy variables used for the simulation: government expenditure, exchange rate and crude oil price. The actual figures of these policy variables for 2015 and 2016 are inserted into the model and the result of the simulation is presented in Table 5.

Scenarios 1: A 10 percent Increase in Government Expenditure

Scenario 1, which depicts the impact of an increase in government expenditure by 10 per cent on the model of the Nigerian economy, shows that real GDP will increase by 3 percent consecutively in 2017 and 2018

respectively; this shows that there is a positive relationship between government expenditure and real GDP. The results of this scenario also show that the shock will make consumption increase by 4 percent consecutively in 2017 and 2018 respectively. Furthermore, the result revealed that exchange rate is expected to depreciate by 16 percent and 14 percent in the immediate future if the economy is hit by a positive government expenditure shock. Also, there will be a surge in the general price level as CPI will increase as well as gross fixed capital formation while interest rate will nosedive in 2017 and 2018. Furthermore, as a result of the 10 percent positive shock in government expenditure, oil export, non-oil exports, oil imports and non-oil imports is expected to increase in 2017 and 2018 respectively. This confirms the positive relationship between government expenditure and each of the other endogenous variables (real GDP, consumption, exchange rate, CPI, oil exports, non-oil exports, oil imports and non-oil imports). In sum, the effects of an increase in government expenditure by 10 percent is that real GDP, consumption, price level (CPI), oil exports, non-oil exports, oil imports and non-oil imports will increase while exchange rate will depreciate in the following years.

Scenarios 2: A 10 percent Fall in Oil Price in the International Market

Table 5 shows that a 10 percent decrease in the price of crude-oil in the international market will result in an increase in real GDP by 3 percent in 2017 and 2 percent in 2018. The oil price shock is expected to lead to a depreciation of exchange rate by 3 percent and 23 percent in 2017 and 2018 respectively. Also, interest rate is expected to rise by 7 percent and 36 percent and gross fixed capital formation will fall by 1 percent consecutively in 2017 and 2018. Total export (oil and non-oil) and total imports (oil and non-oil) are expected to increase in 2017 and 2018 if oil price falls by 10 percent. This result is plausible because the recent incessant fall in oil price propels Nigeria to export more crude-oil to increase her revenue since the proceeds from this product is the major source of revenue to the government. Furthermore, the oil price shock will lead to an increase in consumer price index 11 percent and 8 percent in 2017 and 2018 respectively. Summarily, the impact of a 10 percent fall in oil price in the international market is that whereas real GDP, interest rate, oil and non-oil exports and imports will increase, exchange rate will depreciate and gross fixed capital formation will fall in subsequent years.

Scenario 3: A 10 percent Depreciation of Exchange Rate

The result of introducing a shock of a depreciation of exchange rate by 10 percent would lead to a rise in real GDP by 4 percent in 2017 and 3 percent in 2018; an increase in consumer price index (CPI) by 6 percent in 2015 and 11 percent 2018. The depreciation of exchange rate will bring about an increase in interest rate and also an increase in gross fixed capital formation in 2017 and 2018. The shock to exchange rate will lead to increases in the values of oil export, non-export, oil import and non-oil imports in the years under review. Furthermore, the exchange rate shock will lead to an increase in consumption by 4 percent in 2017 and 3 percent in 2018. Summarily, the impact of a10 percent exchange rate depreciation on the Nigerian economy is that real GDP, price level (CPI), interest rate, gross fixed capital formation, consumption, oil export, non-export, oil import and non-oil imports will all increase although with different magnitude. This implies that exchange rate depreciation will have diverse effects on the Nigerian economy. However, depending on the policy objective of the government and monetary authorities, this policy stance can be used albeit it has its inherent trade-offs.

Table-5. Policy scenarios.

Endogenous variables	Year	Scenario 1	Scenario 2	Scenario 3	Endogenous variables	Year	Scenario 1	Scenario 2	Scenario 3
Real GDP	2016	31.94	31.94	31.94	Gross fixed capital formation	2016	23.84	23.84	23.84
	2017	31.97	31.97	31.98		2017	23.86	23.83	23.88
	2018	32.01	32.00	32.01		2018	23.89	23.83	23.91
Consumer price index	2016	4.85	4.85	4.85	Oil export	2016	10.22	10.22	10.22
	2017	5.00	4.96	4.91		2017	10.38	10.43	10.33
	2018	5.10	5.07	4.99		2018	10.53	10.60	10.48
Interest rate	2016	13.45	13.45	13.45	Non-oil export	2016	8.58	8.58	8.58
	2017	13.43	14.15	13.94		2017	8.99	9.08	8.95
	2018	13.37	14.51	14.42		2018	9.42	9.56	9.37
Exchange rate	2016	6.13	6.13	6.13	Non-oil export	2016	9.36	9.36	9.36
	2017	6.29	6.43	6.28		2017	9.54	9.75	9.42
	2018	6.43	6.66	6.43		2018	9.73	10.06	9.57
Consumption	2016	6.87	6.87	6.87	Non-oil import	2016	10.38	10.38	10.38
	2017	6.91	6.89	6.91		2017	10.71	10.80	10.64
	2018	6.95	6.92	6.96		2018	11.03	11.17	10.92

Source: Author's computation using eviews 9.

5. Conclusion and Policy Recommendations

This study presents a small macroeconometric model of Nigeria. The model is estimated and simulated to describe time paths of the endogenous variables of the system of equations specified in the study. The results shows that a positive shock in government expenditure raises aggregate national output, total exports (oil and non-oil), total import (oil and non-oil), gross fixed capital formation, exchange rate, consumption, and inflation rate while interest rate falls; a negative shock (depreciation) to exchange rate has a negative effect on gross fixed capital formation and a positive effect on aggregate national output, consumer price level, interest rate, consumption, total export and total imports; and a negative shock in oil prices results in an increase in total imports, total exports, consumption, exchange rate, gross fixed capital formation and aggregate national output.

The study reveals that exchange rate plays a vital role in determining the behaviour of almost all the endogenous variables in the model thus recommends that the monetary authorities should ensure stability in exchange rate by employing a managed-floating exchange rate regime as a fixed exchange rate regime will make her lose control of her monetary policy and floating exchange rate regime subject the value the naira to market forces which is not in Nigeria's favour as a result of the import-dependent of the country. Also, the government

should also provide enabling and conducive environment where investment can thrive and gear efforts towards formulating and implementing policies to diversify the economy to prevent it from the shocks that result from oil price volatility in the international market.

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