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THE IMPACT OF CORRUPTION AND FISCAL COUNCILS ON BUDGET TRANSPARENCY

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Abstract

In this paper, we test the hypothesis that corruption hinders budget transparency and that countries with a Fiscal Council are more likely to have transparent budget processes. Budget transparency, measured by the open budget index, is first regressed on corruption perception index using a cross-sectional data set from a sample of countries including Sub-Saharan African countries. We performed both an ordinary least squares regression and robust least squares regression to deal with outliers in the data set. We, then, added GDP per capita as a control variable for better regression results. To address the issue of endogeneity, we performed a two-stage least squares regression using ethno-linguistic fractionalization index as instrument for corruption. The results of all the regressions confirmed, at 1% significance level, that corruption does impede upon budget transparency. Finally, we included a Fiscal Council dummy variable in the model to attest the influence of a fiscal council on budget transparency. The regression results show that countries with existing fiscal council are more transparent in their budget processes than otherwise.

Keywords: Corruption, government budget, open-budget, fiscal transparency, budget transparency

JEL Code: C21, H60

1. Introduction

The need for transparent budget processes to avoid the misuse of government revenues is essential for good governance and growth. Fuduka-Parr et al. (2011) have argued that countries with high levels of budget transparency are more likely to fully realize the economic and social rights of their citizens and to achieve better development outcomes than those with low levels of budget transparency. Transparency in government budget processes should most likely lead to a better use of government revenues, as funds are openly spent on policies and programs that are beneficial to the welfare of the society.

Unfortunately, government's officials in countries with higher levels of corruption, have little or no incentive to fully disclose information about budget processes in order to conceal their corrupt activities. The expectation is that, as countries become less corrupt, the more open their budgets will become, thereby enhancing their accountability to their citizens and improving the quality of their governance. Improvement in budget accountability is often seen as an

important goal that leads to the achievement of better development results. This is also indicated in Fukuda-Parr et al. (2011), which states that "donor agencies have emphasized improving budget processes including their transparency, accountability and participatory aspects as development goals" (p. 2).

With less disclosure in budget processes, government revenues could potentially be embezzled or used for programs not intended for and result in negative socio-economic and development outcomes. This is why budget transparency has gained stance in the past few decades as an issue worth paying close attention too. There are now standards and measurement of budget transparency developed by different international organizations such as the International Monetary Fund (IMF) and the International Budget Partnership (IBP). For instance, the IMF in 1998 published its "Code of Good Practices on Fiscal Transparency." (IMF 1998). This was later revised in 2007 (IMF 2007). The principles of the Fiscal Transparency Code are built around openness on "(i) fiscal reporting; (ii) fiscal forecasting and budgeting; (iii) fiscal risk analysis and management; and (iv) resource revenue management" (IMF 2014). In 2006, IBP decided to publish for the first time the Open Budget Index (OBI) which attempts to measure the level of budget transparency in the majority of countries around the world (IBP, 2007).

If it is, indeed, true that corruption is one of the factors that can prevent a government from fully disclosing budget information, then, it should have a negative impact on budget transparency. Thus, we decided to examine the impact that corruption could have on budget transparency using a cross-sectional data set. We hypothesize that a country with higher level of corruption will tend to have more of a closed budget with less transparency, less accountability, and low public participation in budget processes. We use the OBI as a measure of budget transparency and the Corruption Perception Index (CPI) as a measure of corruption. The hypothesis is that corruption hinders budget transparency. We, therefore, expect the relationship between OBI and CPI to be negative.

We conducted both an OLS regression and a robust least squares regression to test the above hypothesis. We regressed OBI on CPI using a cross-sectional data set of one hundred countries including Sub-Saharan countries. The robust least squares regression was performed to deal with existing outliers in the data set. We, then, added GDP per capita as a control variable in both regressions to see if we get better results. Data show that higher income countries, on average, tend to have more transparent budget processes than low income countries and, thus, have higher OBI. Consequently, we should expect per capita GDP to be positively related with OBI. Moreover, to deal with the issue of endogeneity of causality, we

performed a Two-Stage Least Squares (2SLS) regression using Ethno-Linguistic Fractionalization (ELF) index as instrument for CPI. We expect all the regressions to show that corruption hinders budget transparency as anticipated.

Finally, to attest the influence that the existence of a fiscal council in a country could have on budget transparency, we added a Fiscal Council dummy variable in the regression model. A fiscal council functions more like an oversight entity on Budget offices. Its existence is more likely to cause countries to be more transparent in their budget among other things. Indeed, the works of fiscal councils on fiscal issues are more thorough and their reports about budget issues should be easily available. We expect countries with a fiscal council to have higher OBI scores, thus, to be more transparent in their budget processes.

The paper is organized as follows: section 2 gives a brief review of the literature on corruption and budget transparency. Section 3 discusses regression models and the data used in the study. Section 4 presents the regression results and section 5 highlights the conclusion and limitations of the paper.

2. Literature Review

The literature on the influence of corruption on various socio-economic aspects of a country is vast. Some studies have shown strong evidences on the detrimental effect of corruption on growth and social welfare (Beekman et al., 2013; Koyame, 2007; Guetat, 2006; Pellegrini and Gerlagh, 2004; Mauro, 1995). Others such as Asieudu and Freeman (2009) and Boycko et al. (1996) have looked at the impact of corruption on investment. Asieudu and Freeman (2009) used firm-level data on investment and measures of corruption both at the firm and country levels to empirically examine the effect of corruption on investment. They found that corruption has a significantly negative impact on investment growth for firms in Transition countries but not for firms in Latin America and Sub-Saharan Africa. Boycko et al. (1996) demonstrated that corruption causes a decline in expected returns on investments due to the resulting rise in uncertainty and costs given that corruption usually acts as a tax.

The literature on fiscal transparency has likewise seen faster growth in the past few decades due to a rising concern about the socio-economic impact of good governance. A growing number of studies; Cimpoeru (2015), Fukuda-Parr et al (2011) and Haque and Neanidis (2009); have examined the effects of fiscal transparency on development outcomes such as human development index (HDI), per capita income, education, under five mortality rates, improvement in drinking water, and so on. These studies determined that fiscal transparency improves upon development outcomes. Nevertheless, the reverse causality

between fiscal transparency and growth is also possible. Indeed, one could argue that developed countries, on average, tend to have more of a transparent budget process than developing countries. This implies that growth has the potential of causing more openness in budget processes than otherwise.

Hessami (2013), Haque and Neanidis (2009), Gupta et al. (2001) and Mauro (1998) are among the studies that have empirically examined the relationship between corruption and government budget processes. Hessami (2013) empirically examined the relationship between corruption and the composition of public expenditures for OECD countries. The hypothesis was that corruption in a country could distort government budget composition assuming that rent-seeking firms pay bribes to politicians and bureaucrats to affect public procurement decisions. To test this hypothesis, the paper used a panel data on CPI and budget composition of 29 OECD countries over the 1996 – 2009 time periods. The results showed that the relative share of expenditures on categories that involve public procurement such as high-technology goods and non-competitive markets increased with corruption.

Haque and Neanidis (2009) tested the hypothesis that fiscal transparency, as measured by OBI, reduces corruption. Using a cross sectional data set, they found that OBI had a significant adverse effect on corruption which implies that increasing fiscal transparency could significantly lower corruption. Gupta et al. (2001) presented evidences that corruption changes the composition of government spending. They empirically determined that more corrupt countries have a higher military spending as share of GNP compared to less corrupt Countries. In addition, bribes accounted for about 15% of military spending in low-income countries. Mauro (1998) offered more evidences of the corruption's ability to change the composition of government budget towards spending that gives more lucrative opportunities for personal gain to government officials. The paper also empirically established that corruption was associated with a bias against government spending on education and similarly against spending on healthcare.

Unlike papers that have studied the impact of corruption on government budget composition and those that examined the influence that budget transparency has on corruption, this study is the first that empirically examined the influence that corruption has on government budget transparency. The direction of causality between corruption and budget transparency can go both ways, but, the focus in the literature has been one sided, that is, looking at the impact of budget transparency on corruption. This study focus is on the reverse effect, that is, the impact of corruption on budget transparency. We expect highly corrupt

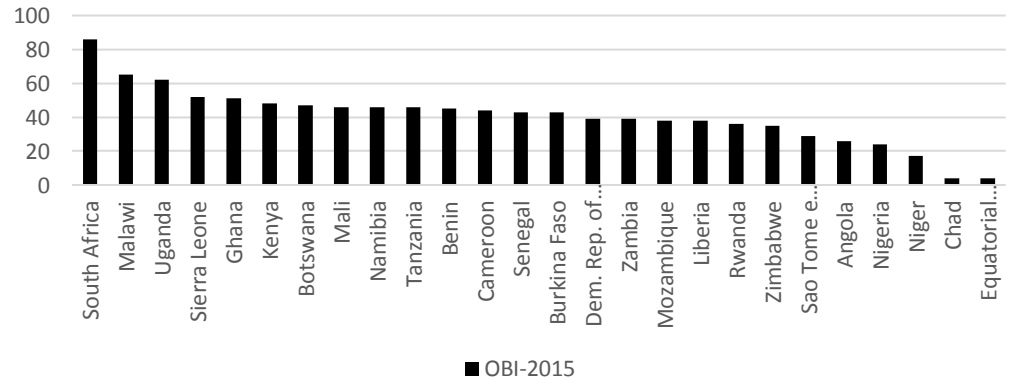
countries to have less transparent budget processes. Moreover, this is the first study that examines the impact of a fiscal council on a country budget processes.

3. Model and Data

Using a 2015 cross-sectional data set of one hundred countries that comprises a set of Sub-Saharan African countries, we regressed OBI on CPI using first an OLS method, then a robust least squares regression, and finally a two-Stage Least Squares (2SLS) regression using Ethno-Linguistic Fractionalization (ELF) index as instrument for CPI. GDP per capita is added as a control variable in both the OLS and the robust least squares regression for strong results. GDP per capita is from the World Bank database (World Bank 2016). The OBI is published by the IBP and is the result of a partnership among IBP and 102 research institutions and civil society across the world. It is computed based on a survey whose questions examine the amount of budget information that is made available to the public, the opportunities for public participation in budget processes and the strength of the legislature and the supreme audit institutions (IBP 2015). It ranks countries on a scale of 0 (no budget information) to 100 (extensive budget information).

Except for South Africa, most of the Sub-Saharan African countries in our sample have low OBI scores indicating that they have one or a combination of the following: insufficient budget transparency, little or no opportunities for public participation in budgeting and weak formal oversight bodies (IBP, 2015). They also tend to have lower CPI scores which imply higher levels of corruption. South Africa has an OBI score above 80 while Malawi and Uganda have OBI scores that are slightly above 60 while the rest of the countries have OBI scores of under 60 has shown in the Figure 1 below.

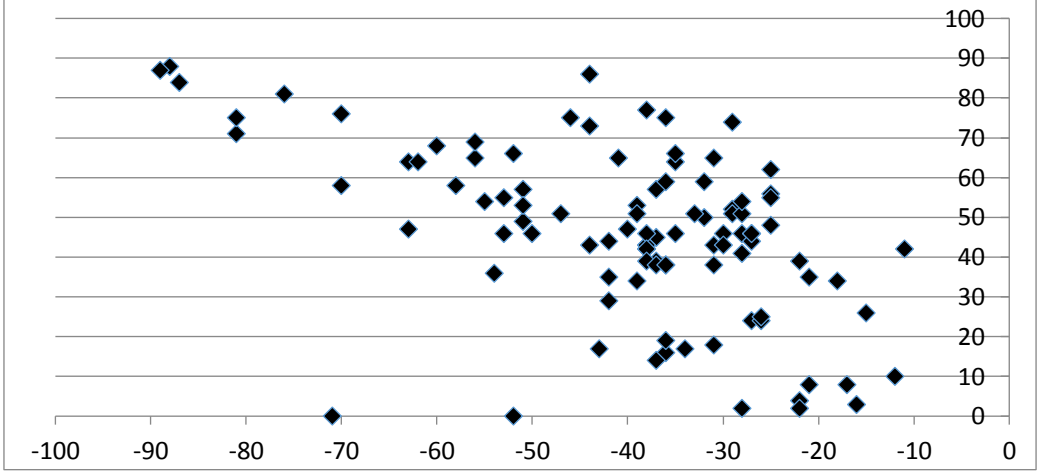
Figure 1: The OBI-Sub-Saharan African Countries (2015)



The CPI is published by Transparency International. It measures the level of corruption in public office as perceived by individuals and businesses (Transparency International 2015). The CPI is the most commonly used index in the empirical studies on corruption. It ranks countries on a scale of 0 (highly corrupt) to 100 (highly clean). However, since higher level of corruption is expected to be associated with lower level of budget transparency, the sign of the estimated coefficient of corruption must be negative. To avoid any confusion about the latter, a negative sign has been added to the CPI so that higher score means higher level of corruption and lower score means lower level of corruption. Figure 2 below gives a preliminary evidence of the negative relationship between budget transparency and corruption, in addition to pointing out the existence of outliers.

Figure 2. Correlation OBI - CPI

ρ = -0.52



To resolve the issue of endogeneity of causality, the Ethno-Linguistic Fractionalization (ELF) index is used as an instrumental variable for CPI in the 2SLS estimation of Equation (1). The ELF index is a good instrument because it is correlated (r = 0.42, significant at 5% level) with CPI while being exogenous to OBI. It has been argued in the literature that more fractionalized countries have higher level of corruption (Shleifer and Vishny 1993). The ELF index is from a discussion paper by Alberto Alesina et al. (2002) in the Harvard Institute of Economic Research. The paper, provides new comprehensive measures of ethnic, linguistic and religious fractionalization for about 190 countries. We measured ELF index as the average of the ethnic and linguistic fractionalization indices.

We, finally, estimated the following model that includes a Fiscal Council (FISC) dummy variable:

$$OBI_i = \beta_0 + \beta_1 CPI_i + \beta_2 FISC_i + \varepsilon_i \quad (1)$$

FISC = 1 If a country has a Fiscal Council
FISC = 0 Otherwise (Base Group)

We, then, added GDP per capita as a control variable in a second regression for comparison purposes. Data on fiscal council are from the IMF (IMF, 2013). Fiscal councils are considered to be independent bodies responsible for fiscal projections and analysis. There might be variants of fiscal councils from one country to another. However, the IMF refers to a Fiscal Council as a "permanent agency with a statutory or executive mandate to assess publicly and independently from partisan influence government's fiscal policies, plans and performance against macroeconomic objectives related to the long-term sustainability of public finances, short-medium term macroeconomic stability, and other official objectives. In addition, a fiscal council can perform one or several of the following functions: (i) contribute to the use of unbiased macroeconomic and budgetary forecasts in budget preparation (through preparing forecasts, or proposing prudent levels for key parameters), (ii) identify sensible fiscal policy options, and possibly, formulate recommendations, (iii) facilitate the implementation of fiscal policy rules, and (iv) cost new policy initiatives". (IMF, 2013)

The estimated coefficient of the dummy variable is expected to be positive showing that countries that have a fiscal council are more likely to have a higher OBI or to be more fiscally transparent than those without it. The slope effect (β_1', estimated coefficient of CPI) is expected to be same for the two groups of countries while the intercept is assumed to be different. Indeed, ($\beta_0' + \beta_2'$) shall be the intercept and the notional value of OBI at zero corruption level for countries with a fiscal council, while (β_0') shall be the notional value of OBI at zero corruption level for countries without a fiscal council. The estimated coefficient of the dummy variable, β_2', represents the average difference in OBI between countries that have a fiscal council and those that do not.

4. Regression Results

4.1 The OLS, Robust Least Squares and 2SLQ Regressions

We first regress the OBI on CPI using an OLS estimation method. A Robust Least Squares regression was subsequently conducted using MM-estimation to avoid the pitfalls of outliers. The MM-estimation takes care of outliers in both the

dependent and the independent variables (Stuart 2011). It is a combination of the M-estimation and the S-estimation. The M-estimation takes care of outliers in the dependent variable, while the S-estimation addresses outliers in the independent variables (high leverages). We, then, added GDP per capita as a control variable in both regressions. The regression results are presented in Table 1. The results of the 2SLS estimation that uses ELF index as instrument for CPI are also presented in Table 1.

Table 1. The Impact of Corruption on Open Budget

Dependent variable: OBI

Variables	**OLS**		**Robust Least Squared**	**2SLS (**ELF as instrument)	
Constant	*16.91***	*20.78***	*19.06***	*27.21***	*22.61**
	(4.079)	*(4.024)*	*(4.325)*	*(4.024)*	*(2.082)*
CPI	*-0.76***	*-0.60***	*-0.72***	*-0.44***	*-0.587**
	(-7.875)	*(-3.901)*	*(-7.711)*	*(-2.793)*	*(-2.221)*
GDP per Capita		*0.0002*		*0.0002*	
		(1.249)		*(1.856)*	
Observations	*100*	*98*	*98*	*98*	*96*
R^2	*0.39*	*0.40*	*-*	*-*	*0.27*
Rw-Squared	*-*	*-*	*0.47*	*0.48*	*-*

Notes: t-statistics are in parentheses; **significance at 1%, *significance at 5%.
z-statistic in parentheses for Robust Least Squared regression.

The OLS and the robust least squares estimations show that CPI has a negative impact on OBI at 1% significance level even after including GDP per capita as a control variable. The coefficient of GDP per capita is positive but statistically not significant in both cases. The impact of corruption on OBI continues to be negative but statistically significant at 5% level in the 2SLS regression. The results of the robust least squares and the 2SLS estimations provide stronger support for our hypothesis that corruption reduces budget transparency and address the issue of endogeneity. The robust least squares estimations also show much improvement in the coefficient of determination. We use the Renaud and Victoria-Feser's (2010) Rw-Squared (R_w^2) in this case because it is assumed to be a better measure of fitness than the robust R-squared.

4.2 Regressions with a Fiscal Council as Dummy Variable

Equation (1) is estimated using both OLS and robust least squares regressions. It was estimated the second time with the inclusion of GDP per capita as a control variable. The results of all the regressions are presented in Table 2.

Table 2. The Impact of Corruption and Fiscal Council on Open Budget

Dependent variable: OBI
Fiscal Council as Dummy Variable

Variables	**OLS**		**Robust Least Squared**	
Constant	*22.80***	*18.64***	*22.05***	*27.33***
	(5.100)	*(3.427)*	*(4.962)*	*(4.665)*
CPI	*-0.497***	*-0.66***	*-0.58***	*-0.41**
	(-4.529)	*(-4.043)*	*(-5.607)*	*(-2.464)*
Fiscal Council	*17.50***	*17.90***	*13.125***	*11.88***
	(3.717)	*(3.811)*	*(3.071)*	*(2.845)*
Per Capita GDP		*-0.0002*		*0.0003*
		(-1.335)		*(1.369)*
Observations	*100*	*100*	*100*	*100*
R^2	*0.37*	*0.38*	*-*	*-*
Rw-Squared	*-*	*-*	*0.50*	*0.51*

Notes: t-ratios are in parentheses for OLS regression.
z-statistic in parentheses for Robust Least Squared regression.
**significance at 1%, *significance at 5%.

The estimated coefficient of CPI continues to be negative and statistically significant at 1% and 5% levels. The estimated dummy variable coefficient, β_2', represents the average difference in the intercepts of the two groups or the average difference in OBI between countries with a fiscal council and countries without a fiscal council. β_2' is about 17.5 in OLS estimation and 13.1 in robust least squares estimation and is statistically significant at 1% level in both cases. Therefore, in the robust least squares estimation, we can infer that the average difference in OBI of the two groups of countries is about 13.1, that is, countries with

a fiscal council have an OBI that is on average 13.1 point higher than countries without a fiscal council office. In other words, budget processes in countries with a fiscal council are more opened than in countries without it.

5. Conclusion

At the outset of this research, the objective was to study the relationship between corruption and the openness of government budget and to examine the impact of a fiscal council on budget transparency. In principle, we hypothesize that once a country is inflicted with the corruption disease, chances are that the entire budget process-formulation, execution and reporting will not be publicly available or at least will be limited. Mainly, our conviction is that less corrupt countries hardly have anything to hide with their budgets, while more corrupt countries have plenty to hide and are less likely to put forward budget information. However, if a country has a fiscal council, it will most likely have more transparent budget processes.

Consistent with our theory, the CPI showed negative and significant relationship with the OBI even after the inclusion of GDP per capita as a control variable and after controlling for endogeneity. In fact, the results of all the regressions show that corruption hinders budget transparency as anticipated and they are robust in all scenarios. To further strengthen our point, we added a dummy variable for the existence of a fiscal council in a country. Interestingly, we found that countries without a fiscal council also tend to have less transparency in government budget. In the robust regression, the estimated coefficient of the dummy variable is positive and statistically significant at 1% level suggesting that countries with a fiscal council have an OBI that is on average 13.1 point higher than countries without a fiscal council. Sub-Saharan African countries should, thus, think about establishing a fiscal council in their respective country if they want to improve transparency in their budget processes.

The relevance of transparency in the Budget Processes cannot be overemphasized. In fact, the IMF showed its importance by promulgating the Fiscal Transparency Code in 1998 which was later revised in 2007. The Citizens budget is a by-product of the revised 2007 edition. This is a simpler and less technical document meant for the ordinary populace to understand the national budget. All the major efforts of the IMF and other international bodies to encourage transparency in the budget processes are premised on the fact that it is part and parcel of good governance. And good governance reduces corruption and less corruption means a more transparent budget process. Corruption is not only detrimental to budget transparency but also to economic growth as evidenced in the literature. Governments should, thus, appropriate

adequate resources to fight corruption given the substantial negative impacts that it has on good governance and the economy.

The Policy relevance of this research is that it validates the IMF's recent emphasis on good governance which will eventually reduce corruption. One way for countries to improve budget transparency is to create a fiscal council that will have oversight over fiscal issues which should improve budget transparency and curb the effect of corruption on the latter. This is particularly important for a region like sub-Sahara Africa where there are more or less no fiscal councils and where countries have poor OBI and CPI scores. Controlling corruption and having a fiscal council should positively influence budget transparency and could lead to effective utilization of resources to improve growth by enhancing spending and protecting social spending, especially in sub-Saharan African countries where they are critically needed. It's only then that the IMF's efforts towards fiscal transparency could become successful.

Finally, it is worth noting that the negative relationship between corruption and open budget could go either way. Indeed, too much corruption in a country might hinder budget transparency as we have shown in this paper. However, a country with more of an open budget tends to have less corruption as also shown in the literature. It should, thus, be interesting to determine the direction of causality between these two variables using a time-series data set. However, the unavailability of a larger time series sample on open budget index is not conducive to such research in the present, but hopefully in the future.

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DOES A CASE EXIST FOR A MULTIPLE MONETARY TARGETS IN NIGERIA?

Ladi R. Bala-Keffi, Moses O. Oduh, Chidi C. Ihediwa

Abstract

The study evaluates the extent to which the Central Bank of Nigeria (CBN) has pursued a single objective of price stability, given its multiple monetary policy strategies. Based on the principle of realized policy outcomes as opposed to intensions, a central bank is said to pursue a particular target if it controls closely and precisely the relevant variable within a tight limit relative to other policies. The study concludes that CBN pursues multiple targets, output, inflation, and exchange rate. In terms of policy objectives, the paper finds that, though inflation is the intended objective, output target is the dominant objective that emerges from monetary policy, while inflation is the Bank's second best. Consequently, the spillover effects or the realized outcome of pursuing price stability, to a very large extent, is stronger than the intended objective.

Key word: Monetary Policy, Policy Objectives
JEL Classification: E52, E61

1. Introduction

In many jurisdictions, the ultimate goal of monetary policy is price stability and it is pursued through the application of short-term interest rate. But there is often a lag between the application of monetary policy action and the achievement of price stability. Therefore, central banks usually have other targets (intermediate targets), such as exchange rate, a monetary aggregate or a more direct measure of inflation in the medium term. Intermediate targets can be considered as the link between the instruments applied in monetary policy and the objective(s)/target(s). The intermediate targets may be in a continuum, lying at various points in the path between instruments and objectives. Some intermediate targets may lie closer to the instruments, in which case it is easier to ensure compliance with the intermediate target by adjusting the instruments. Others would lie closer to the final objective, so that compliance with the intermediate target very much contributes to meeting the final objective. For example, exchange-rate targets are typically close to the instruments, while inflation targets are close to the final objective. In the chain between instruments and the final objective of price stability, would be monetary aggregates, lying between other intermediate targets. Ostry, Ghosh, and Chamon (2012) have argued that having low and stable inflation or price stability as the only goal of monetary policy is based on the logic that the inflation target coexists with every other objective of monetary policy such that there would be no tension between different objectives.

In many countries, central banks are charged with more than price stability. The United States of America's Federal Reserve has two basic goals: to promote maximum sustainable output and employment and to promote stable prices (Federal Reserve Act, 1977). Similarly, the European Central Bank (ECB), under the Treaty on the Functioning of the European Union, Article 127 (1), is required to maintain price stability as the primary objective of the single monetary policy and contributing to the achievement of the full employment and balanced economic growth objectives of the Union. In the Bank of England, an inflation targeting Monetary Authority has two chief purposes; one is monetary stability (meaning stable prices) and the other is confidence in the currency. No country, including those that have flexible exchange rate systems, has shown sufficient willingness to allow unlimited currency volatility. Hence foreign exchange market intervention is a commonly used instrument of monetary policy with a view to achieving price stability.

The objectives of monetary policy are macroeconomic objectives and so, monetary policy alone cannot achieve all of them because developments in the general price level are influenced by many other factors outside the purview of monetary policy. Thus, in collaboration with other authorities, central banks use instruments other than interest rate and liquidity management tools to achieve monetary policy objectives.

In the aftermath of the global financial crisis of 2007 to 2009, central banks around the world adopted unusual policies to contain the crisis. For instance, the Reserve Bank of India (RBI) had a programme of buying government bonds, which boosted stock prices on the SENSEX. RBI equally stepped in to moderate the selling off of the rupee to buy gold, by making it mandatory for importers of gold to set aside twenty per cent for re-export as jewelry. This measure increased the premium paid by jewelers to importers of gold, thus tightening the monetary stance. In the circumstance, RBI engaged in monetary easing to achieve economic growth and monetary tightening to moderate inflation at the same time.

The Central Bank of Nigeria (CBN) had similar experience: it tightened the monetary policy stance by raising the monetary policy rate and using open market operations to soak up excess liquidity in order to drive inflation down to single digit. It also eased liquidity through investing in the Asset Management Corporation of Nigeria (AMCON) and giving liquidity status to AMCON and other long-term bonds. By investing in AMCON, the CBN expanded its mandate to include financial stability objective.

In reality, most central banks have more than one objective and use instruments available to achieve them as occasions demand. At a minimum now, central banks have responsibility for monetary policy and financial stability (particularly when there is financial market turbulence). The question therefore arises as to how central banks can achieve their many objectives, some of them conflicting with the limited instruments available to them. Tinbergen (1952) suggested that to achieve desired values of a certain number of macroeconomic variables, it is important that the policy maker have available, an equal number of targets. His thought has influenced monetary policy management in different jurisdictions. Especially, in inflation-targeting central banks, where there is overtly, one target (an announced rate of inflation) and one instrument (the short-term interest rate). The role and functions of central banks differ from country to country and in developing countries like Nigeria, it is common for them to have more than one goal. But financial underdevelopment is one of the characteristics of developing countries which limits the number of instruments available to financial and monetary policy authorities. This study is intended to examine the epochs of monetary policy in Nigeria to identify the different targets and instrument regimes that had been in operation.

Debates over targets and instruments of monetary policy were almost ended before the global financial crisis. Before the crisis, inflation-targeting was viewed as best practice and major central banks adopted it explicitly, others adopted it implicitly. Inflation-targeting banks used only one instrument, the short-term interest rate.

The CBN had made elaborate arrangement starting from 2006, to adopt an inflation-targeting framework of monetary policy. However, in the current circumstances, the Bank is operating a monetary-targeting framework, using interest-rate targeting within a monetary policy rate (MPR) corridor, and exchange-rate targeting within a band. Economic liberalization has also enabled foreign portfolio investors to hold fixed income instruments in the domestic market and foreign banks to extend foreign currency loans for domestic economic entities. In a way therefore, Nigeria can be said to operate a limited open capital account regime. Therefore, we analyze the behavior of the CBN under its different monetary policy regimes, to identify the number of targets it has pursued and the number of instruments it has used to achieve the targets.

Following this introduction, section two covers the overview of monetary policy in Nigeria; section three reviews the literature, while sections four and five presents the methodology and analysis of the research findings, respectively. Section six concludes.

2. Overview of Nigeria's Monetary Policy

Since the establishment of the central bank of Nigeria in 1958, it has pursued vigorously a monetary policy that is targeted at achieving full employment of resources, external balances, price stability, and economic growth. In order to accomplish these, the bank has implemented two policy regimes namely the exchange rate targeting (1959-1973); and the current monetary targeting which started in 1974.

The conduct of monetary policy under the exchange rate targeting was largely dictated by the prevailing economic conditions in Britain, the United States of America, and Nigeria's major trading partners. At inception, the value of the Nigerian pound (now naira) was fixed in relation to the British pound. However, following the devaluation of the BP from £1=$2.80 to £1=2.40 on November 18, 1967 (Newton, 2010), it ceased to be a reference currency for the Nigerian Pound (NP) because Nigeria reasoned that the devaluation of the NP would have induced inflationary pressures in the economy by raising the price of import, given that the country lacked the immediate capacity to increase exports. Consequently, the United States dollar (USD) replaced the BP as the reference currency, leading to the devaluation of the NP in order to align it with the USD, even though the economic fundamentals did not support it. The use of the BP and USD as reference currencies provided effective mechanism for the maintenance of balance of payment viability, control of inflation as well as stimulation of the industrial sector.

Again like the BP, the NP parity value with the USD was jettisoned because of the devaluation of the USD, following the financial crisis of the 1970s and the eventual collapse of Bretton Woods adjustable peg system in 1971, which lead to rise of new pattern of par value. In addition, the collapse of Smithsonian agreement in 1973 and the subsequent floating of major currencies around the world, which incidentally coincided with the change of Nigeria's currency from pound to naira, marked another phase of exchange rate policy.

Even though the Naira was floated like other major currencies, the use of the BP and the USD as reference currencies were reexamined, because pegging became expensive and not amenable to the country's peculiarities in international trade policy, especially for developing economy like Nigeria that had balance of payment challenges. Besides these challenges, the new regime was also, predicated on the need to cope with inflationary pressures; high fiscal deficits owing to the Nigeria post-civil war reconstruction efforts; and the effects of the indigenization policy. These factors led to a major structural change that

influenced the conduct of monetary policy as Nigeria shifted from exchange rate to monetary targeting in 1974, which is still operational till date.

Although the new policy, at inception, did not abandon the pegging regime, however, it redesigned it such that naira was pegged to a basket of currencies of Nigeria's major trading partners. The monetary targeting framework is designed to use growth in monetary aggregates as a target to achieve the long-term objective of price stability. As a way of addressing liquidity surfeits which followed the new regime, between April 1976 and December 1981, CBN used a combination of credit ceiling, cash reserve ratios, stabilization securities, the exclusion of deposits against letters of credit from eligible liquid assets and interest rate charges to address the persistent excess liquidity in the system. Since then various policy options have being used under monetary targeting including the indirect control which was associated with the adoption of the structural adjustment programme (SAP) in 1986. Consequently, monetary policy was refocused and a number of monetary targets and instruments were adopted within a one year horizon.

Following the liberalization of exchange rate market through the introduction of the Second-tier Foreign Exchange Market (SFEM) in September, 1986 the Bureau de Change was introduced in 1989 to increase the scope of the market and give access to small users of foreign exchange, thereby reducing speculative activities. Consequently, CBN became an active participant, buying and selling foreign exchange as the situations arise. Since then, many other reforms have been made, including the centralization of foreign exchange in the CBN in 1994, the restructuring of the institutional framework of the SFEM into a new market called 'The Foreign Exchange Market, (FEM)', the 'Autonomous Foreign Exchange Market, (AFEM)', 'the Dutch Auction System, (DAS)', 'the Wholesale Dutch Auction System, (wDAS)', and 'the Retail Dutch Auction System, (rDAS)'.

Today, the bank operates a two-year medium-term monetary programme horizon, which started in 2002 and aimed at limiting the challenges associated with monetary policy such as time inconsistency and overreaction due to temporary shocks. The new policy horizon is based on the evidence that monetary policy actions affect the ultimate objectives with a substantial lag. Thus, the medium-term takes account the monetary policy guidelines, which are open to half-yearly review in line with developments in monetary and financial market conditions, in order to achieve medium-to long-term goals. Consistent with the framework, attention has also been focused on the need for a more competitive financial sector geared towards improving the payments system. The OMO has continued to be the primary tool of monetary policy, and is complemented by

reserve requirements, discount window operations, foreign exchange market intervention and movement of public sector deposits in and out of the DMBs. The CBN has also continued to ensure banking soundness and financial sector stability, not only to ensure the effective transmission of monetary policy to the real sector but also to enhance the efficiency of the payments system. The focus of the monetary targeting regime and the associated instruments and targets are illustrated in table 2.1.

Table 2.1: Monetary Policy Regimes, Instrument and Targets

Monetary Policy Regime	Monetary Policy Targets	Monetary Policy Instruments	Monetary Policy Objectives
Inflation Targeting	Interest rate on overnight debt	Policy interest rates	A given rate of change in CPI
Monetary Aggregates	Money Supply (M2)	Reserve Money	Price Stability
Exchange Rate	Nominal exchange rate stability currency of the reference country	Interest rate changes and foreign exchange interventions	Maintaining low inflation differentials vis-a-vis the reference country. B) Favourable BOP
Price Level Targeting	To target an implicit nominal variable (Interest rate, Inflation rate)	Open Market Operation, CRR	Reduce banks' reserves, and moderate prices
Interest Rate Targeting	Money Supply (M2)	Reserve Money	Reduce inflation
Credit Targeting	Full employment	Channeling credits to preferred sectors	Employment and Economic growth

3. Literature Review

The creation of fiat money required that central banks manage the monetary system independent of other executive functions of government, in order to maintain the value of money. Provision of lender of last resort function by central banks to Deposits Money Banks (DMBs) necessitated the maintenance of monetary stability for the health of the whole economy.

The granting of legal tender status to fiat money by governments made it necessary that there be public policy rule guiding money and credit supply. Central banks were assigned responsibility for managing the monetary system independent of other executive functions of government. As the monetary

authority, central banks had to make rules in respect of three things: stability of the value of money; stable real economy; and financial stability (Bordo, 2007). Rules guiding central bank regulation in these respects have emerged in economic studies as policies. This is how monetary policy, as part of public policy, came to be embodied in statutes and regulatory measures.

3.1. Theory of Monetary Policy Strategy

According to Preston and Pagan (1982), the theory of economic policy addresses the problem of policy-making in a situation where the policy maker's desire (policy objective) interacts with a policy model (policy instruments) which represents the feasible outcomes of policy actions. Tinbergen et al. (1936) classical theory of economic policy, put forward the conditions for achieving a fixed set of targets by a policy maker who is guided by a given parameter of instruments. In the aftermath of the Second World War, the Netherlands, like other countries, affected by the war faced the constrained condition of limited means and many hard to satisfy, but not unreasonable desires. This was the perfect occasion for inconsistent public policy formulation and economists came to the rescue with decision-models in which endogenous variables were included as desired outcomes while exogenous variables were considered as dependent on the values of the endogenous variables. This amounted to reversal of the operations of models implying that previously known variables were considered as unknown whereas those which were previously unknown were considered as given.

Tinbergen and Theil (1936) were pioneers in this field and contributed to solving the problem of the policy maker who aimed to achieve certain values of policy targets or to minimize a loss function defined on policy target values, by using available policy instruments. To apply a decision model to a public policy problem, what was required was to quantify the targets and to assume as given, the structure of the economy and the type of instruments. The challenge was to find numerical values for the instrument variables. Policy instruments were expected to be effective with respect to a target variable; an instrument is judged effective if when it is changed, the equilibrium value of the target variable changes as a result. Thus when there is ineffectiveness in all policy instruments with respect to a target variable, it is concluded that economic (exogenous) policy is neutral in that regard. Public policy is expected to apply in systems where the public sector has control because controllability is necessary for policy effectiveness. The policymaker can ascertain the values of the target variables by choosing appropriate policy instruments.

This theory and the associated econometrics dominated economic policy thinking throughout the 1950s, 1960s and a part of the 1970s. In practical terms, the Tinbergen rule suggest that to achieve economic stabilization, a country experiencing balance of payment surplus and inflationary pressure should reduce policy interest rate and increase liquidity supply (i.e. ease monetary conditions) and raise taxes (or reduce government spending), applying fiscal consolidation. On the other hand, a country experiencing balance of payments deficit and growth in unemployment would tighten the monetary stance (increase the policy interest rate) and lower taxes or increase government spending (expansionary fiscal policy).

Tinbergen's decision model was however static and consistency amounted to the number of targets being less than or equal to the number of instruments for attaining them evolved as the simple necessary condition. Otherwise, the model was judged inconsistent. Where there are more instruments than targets, the policy maker has degrees of freedom as there would be more than one way of achieving one or more of the targets. But the necessary and sufficient condition was that the instruments must also be linearly independent. The theory was normative in the main and less interested in analyzing the effectiveness of specific policy instruments such as monetary policy. Instead, it focused on the general conditions for the controllability of an economic system $K \leq L$, where K and L are vectors of targets and instrument variables respectively. An unspoken assumption of the Tinbergen-rule was that the policymaker was free to pursue his objectives in a system that does not react to policies. The introduction of model building into economic policy-making and the conditions of optimal strategies for the policy-maker by Tinbergen and the Classical School was a major advance in public policy formulation. Furthermore, the propositions as simple as they were, are important for institution building, because they provide guide to the situations under which equilibrium may or may not exist (Hallet, Bartolomeo and Acocella, 2008).

Lucas (1976) challenged the propositions in the static decision models by showing that the system cannot be parametric because it does actually react to policies. The golden rules of the Lucas classical theory of economic policy for the controllability of a system were questioned by critiques by showing that it could not accommodate rational expectation. Instead, Lucas argued that in the manner of a game, there are at least two players in a public policy decision model: the private and public sector (Agent and Government). There is a possibility that whereas the Government and the Agent would each, as players, have their specific target variables, they could at the same time share some target variables. Lucas therefore argued that the parameters of a traditional

macro econometric model depended implicitly on agents' expectations of the policy process which may or may not remain stable as the policy maker changes his/her behaviour.

As Tinbergen's formulation was a rule for matching targets and instruments, Lucas (1976) similarly specified a policy rule in the form.

$X_t = G(Y_t, \lambda, v_t)$, where ($\lambda$) is a parameter vector; and (v_t) are random shocks.

With the introduction of rational expectation, alternative policy rules became possible, and each rule can be evaluated by changing λ and incorporating Agents' expectation of future policy actions. Alteration in policy (i.e. in λ) will affect the economic system behavior in two broad ways. First, it will change the time series behaviour of the vector of policy instruments, X_t. Second, it will lead to the modification of the parameters governing the rest of the system behaviourally. The gravamen of the Lucas critique Rudebusch (2002), considered the sensitivity of the reduced-form Lucas specification to the expectational effects of structural policy changes.

3.2. Monetary Policy Rules

Since Tinbergen's work, monetary policy rules have become fairly common place in many jurisdictions. Meltzer (1993) defined a rule as "nothing more than a systematic decision process that uses information in a consistent and predictable way." The Central Bank is said to follow a monetary policy rule, when this principle is applied in the implementation of monetary policy. Goodhart (2010) identified three main objectives or functional roles which central banks generally play namely: (a) maintenance of price stability, within a monetary policy framework; (b) maintenance of financial stability, and to foster more broadly, financial development; and (c) provision of support for the State's financial powers and financing needs in times of crisis, and in normal times to constrain misuse. In doing any and all of the three things, the goal of monetary policy is to make the economy better, not worse.

Monetary policy affects interest rates, and economic agents gain or lose money when interest rates fluctuate. Therefore, the markets are constantly trying to forecast the next monetary policy (interest rate) adjustment. The task of designing an optimal monetary policy rule is challenging because central banks strive to understand private market players while the market players are striving to forecast the central bank's future behaviour. Well known monetary policy rules are:

(1) Friedman's (quantity) rule which was that the US Federal Reserve should establish a constant rate of growth for the stock of money and maintain that growth rate regardless of the state of the economy because in his view, inflation is always and everywhere, a monetary phenomenon.

(2) Taylor's (interest rate) rule for setting the federal funds rate on the basis of three basic terms: the funds rate should equal an estimate of the economy's real rate of interest at a zero rate of inflation plus the Fed's target rate of inflation; adjustment to the intended federal funds rate when the inflation rate deviates from the FOMC's target inflation rate; and the deviation of real gross domestic product (GDP) from the path of potential GDP.

(3) Volcker rule which prohibits a bank or institution that owns a bank from engaging in proprietary trading that is not at the behest of its clients, and from owning or investing in a hedge fund or private equity fund, and also limits the liabilities that the largest banks can hold.

3.3. Conflict among goals of monetary policy

The goals of monetary policy in most jurisdictions include price stability, high employment, economic growth, financial market stability, interest rate stability and exchange rate stability. Price stability is widely viewed as the most important long-run goal of monetary policy on account of the costs of inflation. On account of the primacy of the low and stable prices goal, monetary policy strategies commonly incorporate the use of a nominal anchor, a variable that helps tie down the price level.

High employment or low unemployment is good for the economy, especially for human welfare. However, low unemployment conflicts with low and stable prices. Similar to the goal of high employment is the goal of economic growth because growth draws more and more resources into employment. Expansionary monetary policy which can increase employment and economic growth can, if the unemployment is structural, increases inflation.

Financial crisis is injurious to the economy as it destroys financial assets and damages financial institutions. This is why financial market stability is a goal of monetary policy because monetary policy requires stability of the financial system for transmission of policy shocks. Before the series of financial/currency that started with the economic crisis in Mexico in 1994, monetary policy goal of financial stability was pursued with instruments of micro prudential regulation. A new tool introduced after the crises is macro prudential regulation to contain

system-wide risks which micro prudential regulation could not do. Macro prudential policy is proactive by leaning against the financial cycle (Jordan, 2010). Monetary policy has a role in macro-prudential regulation because asset prices and credit cycles are influenced by the stance of monetary policy. But using interest rate alone to achieve counter cyclical objectives may conflict with other monetary policy goals and thus may be inadequate to achieve even the objective of financial stability.

Interest rate stability reduces uncertainty in the financial markets in particular and the economy at large. Uncertainty about the future path of interest rates leads to lowering of demand for credit and investment because investment decisions are often costly to reverse (Bernanke, 1993; Dixit and Pindyck, 1994). Household demands for durables are also constricted by uncertainty. From the supply side, the demand for savings balances are reduced and flight to safety takes place in an environment of interest rate instability (Bloom, Kose and Terrones, 2013). Open Market Operations (OMO) is the first choice monetary policy instrument for stabilising interest rate but it can hurt market liquidity and economic growth.

The exchange rate stability goal of monetary policy is important for international competitiveness of industries (Telyukova, 2008). Exchange rate stability is often regarded as favourable to trade and therefore welfare enhancing although Bacchetta and van Wincoop (2000) found that it is not necessarily associated with more trade. Different monetary policy strategies are applied to achieve exchange rate strategy. Monetary Authorities that are mandated to maintain stable exchange rates usually operate a fixed exchange rate or Currency Board system. Central Banks such as the Saudi Arabian and the Hong Kong Monetary Authorities tailor their monetary policy instruments to manage their exchange rates against a benchmark (Filardo, Ma and Mihaljek, 2011). All central banks, whatever their monetary policy regimes, also pay attention to stability of exchange rates for two major reasons. One set of reasons can be termed short-term motives and the other long-term motives.

Among short-term motives are exchange rate fluctuations that deviate from fundamentals because they stimulate general price fluctuations or inflation since exchange rate is a key price in an economy. Another short-term motive for central banks pursuing exchange rate stability is that exchange rate volatility transmits shocks to the financial system and the real sector, if the volatility does not derive from the fundamental determinants of exchange rates.

Competitiveness in the international markets of a country's tradables is among long-term motives for central banks deploying monetary policy towards

achieving exchange rate stability. Appreciation of a country's exchange rate relative to the rest of the world would put the country at a disadvantage vis-à-vis her competitors in the export market. Furthermore, the non-tradable sector of the economy expands while the tradable sector shrinks in the domestic market, if the exchange rate appreciates. When this happens balance of payments problems emerge and the financial system become vulnerable to instability. A different long-term motive for adopting a strategy of exchange rate stability is to avoid the impact of exchange rate misalignment on resource allocation.

Monetary policy instruments adopted to target nominal exchange rate are interventions in the foreign exchange market and sterilisation to mop up liquidity that result from interventions at considerable costs. Intervention increases liquidity and amount that are not sterilized contribute to credit growth (with consequences for inflationary development) therefore have the potential to increase credit. The conflict between targets and instruments make it necessary that for every objective a central bank has, there must be an appropriate instrument to guarantee that the pursuit of one objective does not undo another objective.

Overall, although there is some consistency among some of the goals, there is also conflict among others. Whereas interest-rate stability with financial market stability and high employment with economic growth are consistent, the goals of interest-rate stability often conflicts with price stability and high employment in the short run. If an economy is increasing and unemployment is falling, interest rates and inflation may begin to rise.

To prevent rise in interest rate, a central bank could inject liquidity by reducing the policy interest rate or buying securities from Deposit Money Banks through open market operations. But this may overheat the economy, cause inflation to rise and induce capital outflows. Where on the other hand, the central bank wants to prevent inflation by increasing policy interest rate, in the short run, unemployment could rise. Hence, conflict among monetary goals necessitates the assignment of appropriate instruments to each monetary policy goal.

3.4. Comparative experience

Traditionally, monetary policy has only one instrument to set: either a short-term interest rate or the quantity of some subset of central bank liabilities (monetary aggregates such as M1, M2, M3 or RM). High and persistent inflation in the 1970s caused the major central banks to switch their monetary policy orientation towards control of money growth. But monetary targeting proved short-lived,

especially in industrialised countries, because different monetary aggregates within the same economy exhibited widely different growth rates.

Also, the introduction of new electronic technologies that enabled the creation of new forms of money changed well-known money demand functions. At the same time the link between the growth of money and the rate of growth of inflation or output, also became uncertain. These developments weakened policy making on the basis of monetary aggregates hence some central banks had to return to interest rate as an instrument, though under an inflation-targeting framework. The numerical inflation target became the nominal anchor, under this regime and the inflation target was the only goal of monetary policy. In reality, however, no central bank relied on one policy instrument and pursued only one target, under any monetary policy regime.

In Nigeria, for example, the major instrument of monetary policy of the Central Bank of Nigeria is the Monetary Policy Rate (MPR) and the Bank uses it to respond to either contemporaneous or forecast observations of target variables, particularly, inflation and overnight interest rates. In addition to the MPR, the Bank uses the instrument of foreign exchange market intervention to respond to observations of target variables, especially, the exchange rate of the domestic currency. Cash Reserve Requirement (CRR) is another instrument the Bank uses to respond to observations of the Reserve Money target. According to King (2013), having more instruments defines the possibilities open to policy makers. Macro-prudential tools and micro-prudential supervision have come in handy as instruments of monetary policy, to achieve financial stability. Therefore, new macro-prudential tools and better micro-prudential supervision increases the number of instruments available to Monetary Authorities for managing the economy.

Experience since the global financial crisis of 2007/2008 in inflation-targeting central banks shows that they have used both policy rates and associated instruments to achieve price stability and macro-prudential tools to achieve financial stability. The import of this is that in a number of jurisdictions, central banks are using multiple instruments to achieve more than one target, hence bearing out the Tinbergen rule that a policy maker can reach any given number of independent targets if the number of independent instruments equals or exceeds the number of targets. Other country experience: Bank of England, European Central Bank, People Bank of China, the Federal Reserves, and the South African Reserve Bank are illustrated in Table 3.1

Table 3.1: Summary of Relevant Central Bank Experiences

S/N	Central Banks	Monetary Policy Instrument	Operating Targets	Intermediate Targets	Ultimate Target
1	Central Bank of Nigeria	Open Market Operation, Cash Reserve Requirement, Monetary Policy Rate	Reserve Money and Exchange Rate	Short-Term Interest Rates, Money Supply (M2)	Inflation and Output Growth
2	Bank of England	Open Market Operation, Standing Facilities	Interest Rates and Asset prices and Exchange Rates		Price Stability (Defined at 2 per cent inflation rate), Support of the Domestic Currency and financial stability
3	European Central Bank	Open Market Operation, Standing Facilities, Minimum Requirement for Credit Institutions	Money Market Conditions (Interbank Interest Rates)	Money Supply (Broad Money M3) and other information variables	Price Stability, Full employment and Balanced Economic Growth
4	Peoples Bank of China	Open Market Operations, Reserve Requirement, Interest Rates	Credit Control, Direct Controls	Broad Money (M2), Credit Level	Exchange rate stability, Price Stability and Promoting Economic Growth
5	The Federal Reserve	Open Market Operations, Reserve Requirement, Discount Rate and Standing Facilities	Interest rate		Maximum Employment, Stable Prices and Moderation of Long term Interest Rates
6	South African Reserve Bank	Repurchase interest Rate	Nominal interest and exchange rates		Inflation Rate

4. Methodology

Two approaches were adopted: in order to determine evidence of multiple objective/target in the CBN objective function, the framework used in (Cobham, 2015) was adopted. In the framework, the focus is on realized outcome rather than intension i.e. regardless of the monetary authority's stated intension, the evaluation of whether it is pursuing a single or multiple objectives is determined by the outcome of the policy objective. Thus, a central bank is said to successfully pursue a single objective if it controls some relevant economic variables closely and precisely, implying that the stated objective is controlled within some tight limit. On the other hand, a multiple objective is said to have been pursued if the policy maker declines to control any variable to that degree of precision, but may be stabilizing more than one variable within loser limits. In pursing multiple objectives, the policy may have decided that the cost of pursing single objective, in terms of its effects on other variable, is too high.

In the second and complementary approach, we developed a framework based on Tinbergen (1952 and 1956), which asserts that for a policy maker to achieve a multiple target, there must be more policy or instruments at the disposable of the policy maker – such that the number of valid instrument should be more than the policy objectives.

4.1. The Model

(1) Testing for multiple and Single Policy Objective

In practice, (Cobham, 2015) approach compares the degree of control over various variable, by finding a common way of measuring performance of the different variables and assesses degree of control across different variables. This is done by comparing the standard deviation of each variable. The principal variables in this regards are: inflation (π), growth rate of real output (γ) and nominal output (η), growth rate of broad money (θ), and exchange rate (χ). Using the standard deviation approach, a central bank is said to be pursuing a single target, example inflation, if the following conditions holds:

(1.1) standard deviation of inflation is less than the standard deviation of every other policy variable. This is also called the relative criteria

(1.2) the relevant standard deviation being below some absolute threshold. This is known as the threshold criteria. But if, these criteria are not fulfilled for any single objective, it is assumed that the monetary policymakers are implicitly trading off between more than one objective, that is, pursuing multiple objectives.

Combining (1.1) and (1.2), we obtained a reduced form criteria equation for all the monetary policy objectives as in equation (1).

$$\sigma_{x_i} < \sigma_{y_j} \ [s.t \ \sigma_{x_i} < \lambda] \qquad (1)$$

where (σ_{x_i}) is the standard deviation of stated policy objective (x), (σ_{y_i}) is the standard deviation of vector of other policy objectives (y), while (λ) is the country-specific optimal criteria threshold for each policy target. Using the symbols stated earlier, single objective criteria for monetary policy targets variables may be specified as:

$$\sigma\pi < \sigma\gamma, \sigma\eta, \sigma\theta, \sigma\chi \ [s.t \ \sigma\pi < 0.09] \qquad (2)\ ^{1}$$
$$\sigma\gamma < \sigma\pi, \sigma\eta, \sigma\theta, \sigma\chi \ [s.t \ \sigma\gamma < 0.5] \qquad (3)$$
$$\sigma\eta < \sigma\gamma, \sigma\pi, \sigma\theta, \sigma\chi \ [s.t \ \sigma\eta < 0.5] \qquad (4)$$
$$\sigma\theta < \sigma\gamma, \sigma\pi, \sigma\eta, \sigma\chi \ [s.t \ \sigma\theta < 1.0] \qquad (5)$$
$$\sigma\chi < \sigma\gamma, \sigma\pi, \sigma\eta, \sigma\theta \ [s.t \ \sigma\chi < 0.035] \qquad (6)$$

Where equations (1.2) to (1.6) are relative and threshold criteria for inflation, real output, nominal output, growth of money, and exchange rate, respectively.
The assumption is that the monetary authorities could always, if they really wanted to, control a single objective (though the costs might be high), so that if they do not do this, they are said to be implicitly trading off between more than one objective, that is, pursuing multiple objectives. In terms of data application, we used quarterly data covering the periods, 1997-2015. Estimation for each calendar year is based on a six-quarter data points:

(1) Last quarter of the preceding year to the calendar year;
(2) First quarter of the succeeding year to the calendar year; and
(3) The four quarters of the calendar year

Example for the year 1997, the applied data is:
(1) 1996q4
(2) 1997q1-1997q4
(3) 1998q1
The use of the last and first quarters of the preceding and succeeding years to the calendar year ensured that there is overlap to avoid spike in end-year

[1] The optimal threshold for WAMI is 6-9 per cent, while the Nigeria optimal and long term trend threshold are 9 and 10 per cent respectively.

changes unnoticed, while the standard deviation which covers the six as against four-quarters are less prone to the effects of individual outlier.

(2) Modelling multiple and single policy outcome

As a complementary approach, we modelled policy outcome by using shifting regression based on the identified policy outcomes in equations (1.1) to 1.6. The idea is to examine the potency of monetary policy in each of the policy outcome. Where a multiple policy target is concluded, monetary action is expected to impact on each of the policy targets (inflation, real output, and exchange rate).

Two approaches are used as estimators namely the seemingly unrelated regression equation (SUR-E) and ordinary least square (OLS).

(a) Seemingly Unrelated Regression Equation (SUR-E)

A simplified basic sur-e model for the (i^{th}) policy target (example inflation) can be expressed as:

$$y_{it} = x_i\beta_i + e_i \text{ for all (i)} \quad (7)$$

where the (ß's) vary across the individual variables, but constant over time. In addition, each case of dependent variable (y) can have different sets of explanatory variables, but with the same number of observations. Thus staking all the (nth) policy targets generates:

$$y_\pi = x_\pi\beta_\pi + e_\pi \quad (8)$$

$$y_\gamma = x_\gamma\beta_\gamma + e_\gamma \quad (9)$$

$$y_\eta = x_\eta\beta_\eta + e_\eta \quad (10)$$

$$y_\theta = x_\theta\beta_\theta + e_\theta \quad (11)$$

$$y_\chi = x_\chi\beta_\chi + e_\chi \quad (12)$$

Equations (8) to (12), have their individual parameters (ß's), but in the language of seemingly unrelated regression, they may be related through the random shocks, which captures the effects of other unknown determinants of these policy targets i.e. cross dependence of random error. Where this hypothesis fails, then OLS will be an efficient estimator.

5. Result and Analysis

Table 5.1: Estimated Monetary policy targets

Year	Nominal Output	Real Output	Inflation	Exchange Rate	Broad Money	**Target** Multiple	Single
1997	0.15	0.00	0.03	0.00	0.04	ϒ, χ	
1998	0.10	0.01	0.03	1.21	0.06		ϒ
1999	0.18	0.02	0.06	1.66	0.05		ϒ
2000	0.20	0.01	0.08	1.37	0.11		ϒ
2001	0.15	0.00	0.02	0.02	0.17		ϒ
2002	0.09	0.02	0.04	0.04	0.08		ϒ
2003	0.09	0.07	0.07	0.04	0.11		χ
2004	0.09	0.10	0.06	0.04	0.09		χ
2005	0.04	0.05	0.05	0.01	0.06		χ
2006	0.04	0.01	0.03	0.01	0.12	ϒ, χ	
2007	0.07	0.01	0.02	0.04	0.13		ϒ
2008	0.08	0.01	0.04	0.13	0.19		ϒ
2009*	0.14	0.01	0.02	0.11	0.19		ϒ
2010*	0.15	0.01	0.01	0.07	0.07	ϒ, π	
2011	0.13	0.01	0.01	0.01	0.04	ϒ, π, χ	
2012	0.04	0.01	0.02	0.02	0.03		ϒ
2013	0.04	0.01	0.02	0.00	0.08		χ
2014	0.03	0.01	0.00	0.10	0.09		π
2015	0.03	0.02	0.02	0.11	0.06	ϒπ	
Average	**0.10**	**0.02**	**0.03**	**0.26**	**0.09**		**γ**

//Source: Authors Estimates//*2010 rebasing of GDP //real output (γ), exchange rate (χ), inflation (π)

5.1. Policy Targets

Result in Table 5.1 shows a clear evidence of multiple target regimes by the CBN. Between the periods 1996-2016, there are eleven policy shifts. These are 1997(multiple targets of real output and exchange rate), 1998-2005(single target of real output and exchange rate, respectively), 2006(multiple target of real output and exchange rate), 2007-2009 (single target of real output), 2010(multiple target of real output and inflation), 2011 (multiple target of real output, inflation, and exchange rate), 2012-2014 (single target of real output, exchange rate, and inflation), and 2015(multiple target of real output and inflation).

Laying emphasis on the principle of policy outcome as opposed to intension, it could be inferred that the central bank of Nigeria's main policy targets tilted towards real output and exchange rate stability. Secondly, except in 2014, the pursuit of inflation as a single target has never been the focus. Consequently, every stated objective of prioritizing price stability is associated with unintended multiple targets. On the average, of real output has been the greatest beneficiary of the CBN policy target since 1997.

5.2. Monetary Action and Target Regimes

As a complementary approach, we present results of regression of monetary action corresponding with each policy target in Table 5.1. For each identified policy target, a regression is fitted as a way of validating the regime target and the potency of monetary policy. The first period covers (1996-2009) where both the exchange rate and real output are individually and jointly targeted i.e. combination of two regimes of multiple (1997 and 2006) and single target (1998-2005 and 2007-2009). The second period in Table 5.1 covers 2010-2015 i.e. multiple target (2010-2011 and 2015) and single target (2012-2013). For single targets, operational target is used since all monetary actions are targeted at influencing money supply, while for multiple targets; we deployed the three most commonly used CBN instruments: monetary policy rate (MPR), currency reserve ratio (CRR), and open market operations (OMO).

5.2.1. Single Target Regimes

(a) **Real Output (1998-2002)**

The focus of these periods was to target real output as shown in Table 5.1. In Table 5.2, we analyzed the implications of the single target regime by evaluating the potency or effectiveness of monetary policy and the attendant spillover effects. The result shows that an expansionary monetary policy tailored towards output expansion results in exchange rate depreciation and increase in the general price levels. This is both economically and intuitively consistent and shows that a single policy target is capable of generating multiple outcomes.

(b) **Exchange Rate (2003-2005)**

Table 6 shows that monetary policy action is impotent when exchange rate is targeted as a single policy objective. Though not statistically significant, an expansionary monetary policy leads to economic *a priori* question between monetary policy (leads to exchange rate appreciation), but raises price level and real output.

(c) **Inflation Rate (2014)**

Inflation as a single target as shown in Table 5.4 is similar to output target (Table 5.2). The only distinguishing feature is the direction of movement in exchange rate. In the former, lose monetary action targeted at inflation raises both output and inflation, and appreciates exchange rate. In the later, it results to the depreciation of exchange rate.

Table 5.2: Single Target [real output] Regime (1998-2002)

VARIABLES	(sur) Inflation	(sur) Exchange rate	(sur) Real Output	(ols) Inflation	(ols) Exchange Rate	(ols) Real Output
Exchange rate	13.57***		0.00967	13.57***		0.00965
	(3.720)		(0.00772)	(3.922)		(0.00814)
Broad Money supply	53.47***	1.288***	0.155***	53.47***	1.287***	0.155***
	(10.15)	(0.331)	(0.0104)	(10.70)	(0.346)	(0.0109)
Real output	-304.4***	-1.791		-304.4***	-1.783	
	(61.60)	(2.236)		(64.94)	(2.336)	
Trade openness	-227.3***	5.953***	-0.219***	-227.3***	5.953***	-0.219**
	(33.62)	(0.877)	(0.0817)	(35.44)	(0.916)	(0.0861)
Supply shock(oil)	-17.69***	-0.338	-0.0483***	-17.69**	-0.338	-0.0483***
	(6.715)	(0.231)	(0.0118)	(7.078)	(0.242)	(0.0124)
Inflation			-0.00109***			-0.00109***
			(0.000221)			(0.000233)
Constant	2,814***	7.474	9.548***	2,813***	7.403	9.548***
	(602.7)	(21.91)	(0.108)	(635.3)	(22.88)	(0.114)
Observations	60	60	60	60	60	60
R-squared	0.694	0.815	0.912	0.694	0.815	0.912
DW (SUR) [OLS]		**(2.59)**			**[2.59]**	

Standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Table 5.3: Single Target [Exchange Rate] Regime (2003-2005)

VARIABLES	(sur) Inflation	(sur) Exchange rate	(sur) Real Output	(ols) Inflation	(ols) Exchange Rate	(ols) Real Output
Exchange rate	71.58**		0.687	71.65**		0.702
	(31.48)		(0.432)	(34.48)		(0.474)
Broad Money supply	2.343	-0.0220	0.0925	2.361	-0.0216	0.0920
	(10.71)	(0.0560)	(0.143)	(11.73)	(0.0603)	(0.157)
Real output	52.60***	0.208***		52.53***	0.207***	
	(9.944)	(0.0496)		(10.89)	(0.0535)	
Trade openness	16.04	0.0103	-0.212	16.03	0.0100	-0.212
	(16.92)	(0.0883)	(0.228)	(18.54)	(0.0951)	(0.250)
Supply shock(oil)	12.08**	-0.00998	-0.0846	12.09**	-0.00991	-0.0845
	(5.015)	(0.0261)	(0.0721)	(5.493)	(0.0282)	(0.0789)
Inflation			0.00907***			0.00906***
			(0.00170)			(0.00186)
Constant	-1,033***	2.799***	7.241**	-1,033***	2.808***	7.177**
	(181.0)	(0.768)	(2.857)	(198.3)	(0.827)	(3.129)
Observations	36	36	36	36	36	36
R-squared	0.823	0.207	0.605	0.823	0.208	0.604

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 5.4: Single Target [Inflation Rate] Regime (2014)

VARIABLES	(sur) Inflation	(sur) Exchange rate	(sur) Real Output	(ols) Inflation	(ols) Exchange Rate	(ols) Real Output
Exchange rate	34.22***		2.043***	34.11**		2.092***
	(10.99)		(0.496)	(15.54)		(0.701)
Broad Money supply	27.60**	-0.779***	2.084***	27.38	-0.758**	2.089***
	(11.63)	(0.256)	(0.265)	(16.45)	(0.335)	(0.375)
Real output	-11.82**	0.373***		-11.70	0.361**	
	(5.392)	(0.119)		(7.625)	(0.156)	
Trade openness	2.533	0.310	-0.443	2.603	0.305	-0.451
	(16.09)	(0.411)	(0.754)	(22.75)	(0.538)	(1.067)
Supply shock(oil)	9.713***	-0.228***	0.588***	9.666**	-0.224***	0.593***
	(2.606)	(0.0410)	(0.0841)	(3.685)	(0.0537)	(0.119)
Inflation			-0.0242**			-0.0240
			(0.0108)			(0.0152)
Constant	-473.5***	12.83***	-30.86***	-471.0*	12.66***	-31.21***
	(164.4)	(2.938)	(5.865)	(232.5)	(3.846)	(8.295)
Observations	12	12	12	12	12	12
R-squared	0.654	0.789	0.868	0.655	0.791	0.865

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

5.2.2. Multiple Target

(a) **Real Output and Exchange Rate (1996-2009)**

Table 8 shows that monetary policy target during the period effectively brought about exchange rate depreciation and an increase in real output, while inflation

was unperturbed. This is expected given that the dominant policy target was on exchange rate management and output growth (jointly and individually) as shown in Table 5.1.

(b) **Inflation, Real Output (2010)**

In the first regression (Table 9.1), we used all the three policy instruments[2]. But given the small sample period, we used the operating target as policy instrument. As an extension, we used generalized ridge regression (GRR) to re-estimate the result in Table 9.1 using all the three instruments (MPR, CRR, and TBR). Table 9.1 shows that the operational target affects exchange rate and real output, while the use of the three instruments (Table 9.2) affects exchange rate. Implicitly, targeting output and inflation had a transmission effect on exchange rate, without having a significant impact on inflation and output.

(c) **Inflation, Real Output, and Exchange Rate (2010-2016)**

Consistent with Table 4, we also show in Tables (9) and (10) that the periods 2010-11 and 2010-2016 the multiple policy target focused on inflation, exchange rate and real output. Despite the *a priori* relationship in the result, monetary action was significant on inflation, exchange rate, and real output.

In Table 9, the multiple objectives (inflation, exchange rate, and real output) is matched with equal policy instruments (monetary policy rate, open market operation, and currency required ration) – which in the language of Tinbergen is said to be exactly identified. However, only two out of the three deployed instruments were statistically speaking effective. The TBR have significant influence on exchange rate and real output, MPR impacts on inflation and real output, while there is no evidence to suggest that CRR had significant impact on all the target variables. The result however varies when the survey period is expanded (2010-2016) to accommodate all the three targets (there single target component inclusive). The entire three instrument influences the level of real output and inflation without affecting exchange rate. This is expected given real output and inflation rate are the dominant targets in the sampled periods (see Table 5.1).

One could therefore infer from the foregoing that two instruments were effectively deployed for the three policy targets in the periods 2010-2011, while

[2] The sample size is small to use all the three instruments in addition to other the determinants of inflation, particularly the OLS. We therefore suppressed the constant term to improve on the relationship between the number of observation and estimated parameters. As a complementary technique we used instead the operating target (m2) and dropped all three instruments (see Table 9.2).

all the three were effectively deployed in the periods 2010-2015 as shown in Tables (5.8 and 5.8.1).

On the average, the dominant policy target between the periods 1996 and 2016 i.e. from 1996 to the first quarter of 2016, is exchange rate and real output. But, statistically, exchange rate is more significant than targeted real output. The expected a priori of monetary policy action on the entire three macroeconomic fundamental (inflation, exchange rate, real output) is satisfied.

Table 5.5: Multiple Target [real output and exchange rate] Regime (1996-2009)

VARIABLES	(sur) Inflation	(sur) Exchange rate	(sur) Real Output	(ols) Inflation	(ols) Exchange Rate	(ols) Real Output
Exchange Rate	1.992		-0.101***	1.992		-0.102***
	(2.589)		(0.0144)	(2.637)		(0.0147)
Broad Money Supply	-2.207	1.140***	0.230***	-2.207	1.139***	0.230***
	(3.629)	(0.0773)	(0.0155)	(3.695)	(0.0785)	(0.0158)
Real Output	-2.186	-2.511***		-2.186	-2.508***	
	(12.88)	(0.357)		(13.12)	(0.362)	
Trade Openness	-72.22***	5.646***	0.442***	-72.22***	5.647***	0.443***
	(24.70)	(0.582)	(0.149)	(25.15)	(0.590)	(0.152)
Supply Shock(oil)	8.624**	-0.628***	0.00529	8.624**	-0.629***	0.00516
	(4.186)	(0.111)	(0.0249)	(4.263)	(0.112)	(0.0254)
Inflation			-7.57e-05			-7.57e-05
			(0.000445)			(0.000453)
Constant	41.63	18.60***	8.730***	41.63	18.57***	8.729***
	(116.9)	(3.313)	(0.122)	(119.1)	(3.363)	(0.124)
Observations	168	168	168	168	168	168
R-squared	0.059	0.765	0.898	0.059	0.765	0.898

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 5.6: Multiple Target [Inflation and Real output] regime (2010)

VARIABLES	(sur) Inflation	(sur) Exchange rate	(sur) Real Output	(ols) Inflation	(ols) Exchange Rate	(ols) Real Output
Exchange Rate	9.658		276.0***	11.17		288.2**
	(86.13)		(73.18)	(121.8)		(103.5)
Broad Money Supply	12.76	0.0701**	-26.57**	12.63	0.0696*	-27.17*
	(10.11)	(0.0277)	(10.46)	(14.29)	(0.0363)	(14.79)
Real Output	0.390*	0.00232***		0.384	0.00224***	
	(0.230)	(0.000555)		(0.325)	(0.000727)	
Trade Openness	27.63***	0.0468*	-29.99***	27.47**	0.0448	-29.73**
	(8.786)	(0.0271)	(9.329)	(12.42)	(0.0355)	(13.19)
Supply Shock(oil)	-15.87**	-0.0595***	27.88***	-15.70	-0.0577**	27.90***
	(6.639)	(0.0173)	(4.324)	(9.389)	(0.0227)	(6.115)
Inflation			0.448*			0.442
			(0.249)			(0.353)
Constant	-185.9	4.094***	-1,059***	-192.0	4.096***	-1,111**
	(376.7)	(0.421)	(348.3)	(532.8)	(0.551)	(492.5)
Observations	12	12	12	12	12	12
R-squared	0.508	0.496	0.843	0.509	0.505	0.839

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 5.7: Multiple Target [Inflation and Real output] regime (2010)

VARIABLES	(sur) Inflation	(sur) Exchange rate	(sur) Real Output	(ols) Inflation	(ols) Exchange Rate	(ols) Real Output
Exchange Rate	122.2		-122.6	122.2		-124.5
	(127.6)		(149.8)	(221.1)		(259.4)
Treasury Bills Rate	-0.391	-0.00143***	0.364	-0.391	-0.00143	0.361
	(0.302)	(0.000544)	(0.355)	(0.523)	(0.000842)	(0.615)
Currency Reserve Ratio	-22.90	0.193***	21.80	-22.90	0.193***	22.16
	(24.64)	(0.00273)	(28.97)	(42.67)	(0.00423)	(50.18)
Monetary Policy Rate	2.346	0.0548***	1.397	2.346	0.0548***	1.501
	(8.624)	(0.0115)	(9.943)	(14.94)	(0.0178)	(17.22)
Real Output	0.598***	-0.000108		0.597	-0.000103	
	(0.214)	(0.000521)		(0.371)	(0.000807)	
Trade Openness	23.78***	-0.0347**	-28.76***	23.78	-0.0346	-28.82
	(8.802)	(0.0177)	(9.815)	(15.25)	(0.0274)	(17.00)
Supply Shock (oil)	-12.46**	-0.0276***	16.18***	-12.46	-0.0276	16.12
	(5.816)	(0.0106)	(6.027)	(10.07)	(0.0165)	(10.44)
Inflation Rate			0.788***			0.788
			(0.283)			(0.489)
Observations	12	12	12	12	12	12
R-squared	0.567	0.821	0.876	0.567	0.821	0.876

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 5.8: Multiple Target [Inflation, Exchange rate, and Real output] regime (2010-2011)

VARIABLES	(sur) Inflation	(sur) Exchange rate	(sur) Real Output	(ols) Inflation	(ols) Exchange Rate	(ols) Real Output
Exchange Rate	10.01		-32.90	10.01		-33.48
	(22.00)		(22.82)	(26.94)		(27.95)
Treasury Bills Rate	0.159	0.00190*	0.396***	0.159	0.00189	0.396***
	(0.115)	(0.00103)	(0.0990)	(0.141)	(0.00122)	(0.121)
Currency Reserve Ratio	0.280	0.00168	-0.0310	0.280	0.00168	-0.0298
	(0.190)	(0.00172)	(0.209)	(0.233)	(0.00204)	(0.256)
Monetary Policy Rate	-0.493**	0.000253	-0.507**	-0.493*	0.000272	-0.506*
	(0.220)	(0.00203)	(0.231)	(0.270)	(0.00242)	(0.283)
Real Output	-0.268	-0.00279		-0.267	-0.00275	
	(0.189)	(0.00172)		(0.232)	(0.00205)	
Trade Openness	7.317	-0.0738	-5.611	7.318	-0.0736	-5.644
	(5.701)	(0.0512)	(6.149)	(6.983)	(0.0608)	(7.531)
Supply Shock (oil)	0.0159	0.0161	7.424**	0.0150	0.0158	7.420*
	(3.243)	(0.0300)	(3.044)	(3.972)	(0.0357)	(3.728)
Inflation Rate			-0.294			-0.294
			(0.208)			(0.255)
Constant	-40.88	4.948***	153.0	-40.89	4.949***	155.8
	(109.9)	(0.103)	(114.1)	(134.6)	(0.123)	(139.8)
Observations	24	24	24	24	24	24
R-squared	0.424	0.818	0.880	0.424	0.818	0.879

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 5.8.1: Multiple Targets [Inflation, Exchange rate, and Real output] regime (2010-2016)

VARIABLES	(sur) Inflation	(sur) Exchange rate	(sur) Real Output	(ols) Inflation	(ols) Exchange Rate	(ols) Real Output
Exchange Rate	14.77**		6.892***	14.77**		6.912***
	(6.593)		(1.982)	(6.987)		(2.100)
Treasury Bills Rate	1.110***	-0.000713	0.351***	1.110***	-0.000698	0.351***
	(0.165)	(0.00295)	(0.0472)	(0.175)	(0.00311)	(0.0500)
Currency Reserve Ratio	0.778***	0.00771	0.205**	0.778***	0.00772	0.205**
	(0.278)	(0.00481)	(0.0843)	(0.294)	(0.00506)	(0.0893)
Monetary Policy Rate	-1.894***	0.00812	-0.639***	-1.894***	0.00809	-0.639***
	(0.312)	(0.00554)	(0.0876)	(0.330)	(0.00583)	(0.0928)
Real Output	-1.677***	0.0163**		-1.677***	0.0163**	
	(0.357)	(0.00642)		(0.378)	(0.00675)	
Trade Openness	-2.298	0.101	-14.15***	-2.295	0.0999	-14.15***
	(10.48)	(0.188)	(2.589)	(11.11)	(0.198)	(2.743)
Supply Shock (oil)	0.120	-0.231***	1.024*	0.120	-0.231***	1.029*
	(1.843)	(0.0184)	(0.552)	(1.954)	(0.0193)	(0.585)
Inflation Rate			-0.153***			-0.153***
			(0.0325)			(0.0344)
Constant	-51.49	5.546***	-22.68*	-51.49	5.547***	-22.79*
	(38.56)	(0.166)	(11.69)	(40.86)	(0.175)	(12.39)
Observations	73	73	73	73	73	73
R-squared	0.564	0.870	0.844	0.564	0.870	0.844

Standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Table 5.9: Multiple Targets [Inflation, Exchange rate, and Real output] regime (2010-2016)

VARIABLES	(sur) Inflation	(sur) Exchange rate	(sur) Real Output	(ols) Inflation	(ols) Exchange Rate	(ols) Real Output
Exchange Rate	16.86***		8.263***	16.87**		8.301***
	(6.481)		(2.476)	(6.723)		(2.568)
Broad Money Supply	-10.12***	0.203***	1.971**	-10.12***	0.203***	1.960*
	(2.545)	(0.0330)	(0.965)	(2.640)	(0.0340)	(1.001)
Real Output	1.168***	0.0214***		1.168***	0.0213***	
	(0.266)	(0.00422)		(0.276)	(0.00435)	
Trade Openness	32.55***	0.227**	-13.81***	32.55***	0.227**	-13.81***
	(6.220)	(0.103)	(2.270)	(6.452)	(0.106)	(2.355)
Supply shock(Oil)	1.136	-0.181***	3.177***	1.137	-0.181***	3.182***
	(1.356)	(0.0149)	(0.431)	(1.407)	(0.0153)	(0.447)
Inflation			0.165***			0.165***
			(0.0376)			(0.0390)
Constant	62.69*	2.185***	-72.62***	62.67*	2.181***	-72.65***
	(33.68)	(0.536)	(10.65)	(34.94)	(0.553)	(11.05)
Observations	85	85	85	85	85	85
R-squared	0.426	0.849	0.825	0.426	0.849	0.824

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

6. Conclusion and Policy Implications

6.1. Conclusion

The paper applied the concept of realized outcome as distinct from targeted or 'ideal preferred outcome' to evaluate whether the central bank of Nigeria had pursued multiple targets over the years. Three targets where identified and disaggregated into in 9 (nine) regimes, based on the principle of the constructed index of realized outcome. Given the small sample size of some of the regimes,

the seemingly unrelated regression estimation (SUR-E) was used in all the equations.

The results show that, indeed, the central bank of Nigeria had pursued multiple objectives. However, despite the 'preferred' policy objective of price stability, in reality, the central bank of Nigeria had pursued real output growth as its primary objectives i.e., the realized outcome. Therefore, rather than pursue inflation, the deployed instruments where more effective in promoting what can be referred to as the 'positive externalities' - real output growth - while inflation is the bank's 'second best'.

6.2. Policy Implications

The implications of output as the realized outcome or unintended consequences of monetary policy in Nigeria are depended, first, on the relationship between output and inflation. If they move in the same direction, then the continued increase in real output will continue to drag inflation along with it. Implicitly, the response of inflation to monetary action would be lagged, reacting only to growth in output – of which attempt to slow down inflation could be achieved by policies that reverses growth. If on the other hand they are negatively or inversely related, though the lagged effects remains, but the increase in real output would suppress inflation. Thus action geared towards increase in real output will have a depressing effects on inflation, meaning that low inflation can only be achieved when policies are stirred to increase real output. However, the magnitude of these interactions is dependent, inter alia, on whether output and inflation have threshold effects, and partly of the sacrifice ratio between output and inflation i.e., if they are inversely related.

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FACTORS AFFECTING EXPORT DIVERSIFICATION IN ECOWAS SUB-REGION

Oziengbe Scott AIGHEYISI

Abstract

The objective of the study is to investigate the factors affecting export diversification in the ECOWAS sub-region. To achieve the objective, fixed effect, random effect (feasible generalized least squares) and panel FMOLS estimators are employed for estimation of panel regression model using dataset that span the period from 1995 to 2015. The empirical evidence indicates that export diversification in the sub-region is affected by real GDP per capita, gross fixed capital formation, financial institutions' credit to the private sector and inflation. Specifically, increase in real GDP per capita and increase in gross capital formation reduce export concentration (or enhance export diversification), while increase in credit to the private sector adversely affects export diversification and encourage export concentration. This is attributed to the lending behavior of the lending institutions which tend to favour the extractive sector in allocation or extension of credits. Thus their credit tends to be concentrated in the extractive sector, and this in turn tends to exacerbate export concentration. Inflation is found to attenuate export concentration, suggesting existence of a threshold level of inflation for export diversification. The paper recommends for policy consideration, efforts by government of countries in the sub-region to take measures to enhance the growth of their economies and increase the rate of capital formation therein. Additionally, there is need to strengthen the regulatory apparatus of the financial systems to ensure efficient allocation of credits to various sectors of the economy so as to stymie concentration of credits in a single or few sectors.

Keywords: Export Diversification, Structural Transformation, ECOWAS
JEL Classification Codes: C23, F14

1. Introduction

A major problem plaguing the ECOWAS[1] sub-region is the concentration of their exports in a few primary commodities. For example, Nigeria concentrates mainly on crude oil production and export; Ghana concentrates on gold mining and exports, and also on crude oil production and export; Mali invests hugely on mangoes production and exports; Guinea Bissau concentrates to a large extent on cashew nuts production and exports; Burkina Faso concentrates in production

[1] Countries of the Economic Community of West African States (ECOWAS) include Benin, Burkina Faso, Cape Verde, Cote d'Ivoire, Gambia, Ghana, Guinea, Guinea Bissau, Liberia, Mali, Niger, Nigeria, Senegal, Sierra Leone, and Togo.

and export of cotton. Other countries in the sub-region whose export appears to be diversified are only diversified horizontally. That is, their export baskets are filled with several primary products contributing to their export earnings. Aggravating the problem of concentration on primary commodities export is the fact that the export items from the sub-region also have few countries as their destinations.

Primary product export concentration and geography concentration pose serious constraints to export earnings of ECOWAS countries, engenders deterioration of their terms of trade and exposes countries in the sub-region to adverse effect of negative shocks to commodity prices in the international market and negative shocks to economies of their export destinations. The Presbisch-Singer hypothesis highlights the adverse effect of primary export concentration to include declining and unstable export earnings resulting in highly volatile real exchange rates and incomes, unfavourable terms of trade and the exposition of primary-product exporting countries to exogenous shocks as sudden decline in the prices of primary products translates into sudden, unexpected decline in the exports earnings. Exporting to a single or few destinations also engenders much uncertainty in the exporting countries as events (including policies) in the importing countries determine to a very large extent the demand for the exported products. This leaves the exporting country's economy at the mercy of the importing country or countries.

In Africa, exports from the West Africa sub-region are the most concentrated, after exports from the middle Africa region. This is shown in Figure 1. The composition and destination of ECOWAS exports are shown in Table 1.

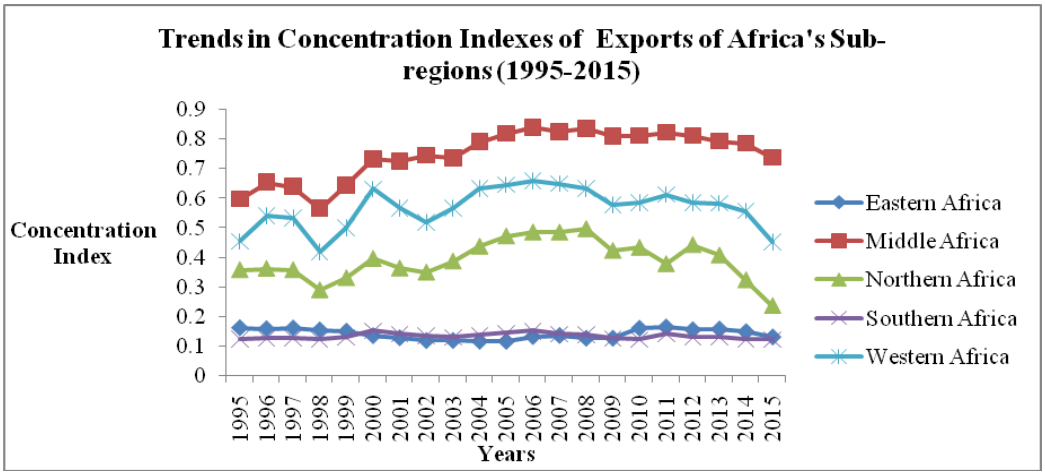

Figure 1: Trends in Export Concentration Indexes of Different Regions in Africa
Source: Data from United Nations Conference on Trade and Development Handbook of Statistics 2017.

Table 1. Major Exports of ECOWAS	
Export products	**% Contribution**
Fuels (from extractive industries)	75%
Cocoa and Cocoa Food Preparation	5%
Precious stone	3%
Cotton, edible fruits, rubber, plastics, wood and wood products , fish and shellfish	1% each
Destinations of ECOWAS Export Products	
Destinations	**Percentage**
Europe	28%
The Americas	40%
Asia & Oceania	16%
Source: ECOWAS Commission (2017).	

Table 1 shows that the major exports commodities of ECOWAS are primary commodities. The sub-region's exports are dominated by Nigeria and Cote d'Ivoire which account for a total of 87% of total exports, Nigeria contributing 77% of total exports and Cote d'Ivoire contributing 10%. Fuels from the extractive industry account for 75% of ECOWAS exports, with 73% of it originating from Nigeria. Ghana, Senegal and Mali provide 4%, 2% and 1.7% respectively of the sub-region's exports. Five countries in the sub-region namely Benin, Burkina Faso, Guinea, Niger and Togo each provide 1% of the sub region's exports (ECOWAS Commission, 2017). As for the destinations of ECOWAS export commodities, Europe accounts for 28% with 23% for countries of the European Union; the America's account for 40% with 34% for the Free Trade Area of North America (NAFTA); Asia and Oceania capture 16% of total exports.

Considering that prices of primary products in the international market are quite unstable and low (resulting in low export earnings), and considering that export earnings are major determinants of national incomes, the low export earnings resulting from concentration in primary product exports translate into low per capital incomes which is characteristic of low and lower middle incomes countries following the World's Bank classification. Countries in the sub-region are either classified as low income countries (having a GNI per capita of $1, 025 or less in 2015), or as lower middle income countries (having a GNI per capita between $1, 026 and $4, 035). According to the 2016 World Bank classification, 11

out of the 15 countries in the sub-region are classified as low income countries[2], while the remaining 4 are classified as lower middle income[3]. By these classifications, the sub-region is undoubtedly one of the poorest in the world, with some lackluster in inclusive growth in spite of recent growth performances of some countries therein.

In view of the foregoing introductory background information, the need for countries in the sub-region to diversify their export products and export product destinations cannot be overemphasized. The objective of this paper is to investigate the factors affecting export diversification in the ECOWAS sub-region with a view to proffering, as recommendations for policy considerations, measures to diversify the sub-region's exports. Though several studies have investigated the determinants of export diversification/concentration in various countries and regions, to the best of our knowledge, the factors affecting export diversification in ECOWAS sub-region has not yet been investigated. This paper contributes to the extant literature in its application of a more recent panel cointegration estimation technique – the panel Fully Modified Ordinary Least Squares estimator (amongst other techniques) to undertake a comprehensive investigation of the factors affecting export diversification in the ECOWAS sub region. The choice of the estimator was informed by the fact that potential endogeneity exists among the hypothesized factors affecting export diversification. The FMOLS esrtimator accounts for regressor endogeneity to yield consistent and efficient long run estimates of a regression model.

For ease of presentation, the remainder of the paper is organised as follows. The relevant literature (theoretical and empirical) is reviewed in Section 2. The theoretical model and the methods of estimation are presented in Section 3. The result of estimation are presented and discussed in Section 4. Section 5 presents evidence based policy recommendations and concludes the paper.

2. Literature Review

2.1. Brief Theoretical Literature

Export concentration has its root in the classical trade theories (such as Adam Smith's Absolute advantage theory of international trade and David Ricardo's Comparative Advantage theory of international trade) and the modern trade

[2] ECOWAS countries classified by the World Bank as Low Income Countries as at 2016 are Benin, Burkina Faso, Gambia (the), Guinea, Guinea Bissau, Liberia, Mali, Niger, Senegal, Sierra Leone and Togo.

[3] ECOWAS countries classified by the Bank as Lower Middle Income Countries as at 2016 are Cape Verde, Cote d'Ivoire, Ghana and Nigeria.

theories such as The Heckscher-Ohlin's Factor Endowment theory of international trade. While the comparative advantage theory (based on some underlying assumptions such as existence of two countries producing two commodities, zero transportation cost, no tariffs, perfect information, constant costs, no economies of scale, etc), premises trade between countries on differences in comparative advantage in production of goods, implying that countries are to specialize in the production and export of commodities for which they have comparative advantage, the factor endowment theory of trade which improves on the comparative advantage theory posits that the basis of trade between countries is differences in factor endowments: countries are to specialize in the production and export of commodities intensive in the factor of their relative abundance. In other words, if a country is endowed with resources required for the production of a commodity, such resources should be shifted to production of that commodity which will also be its export commodity. The underlying assumptions of the Heckscher-Ohlin theory include existence of two countries producing two different goods using two factors of production – labour and capital, same technology, constant return to scale, etc.) Clearly, these theories emphasise specialization which also connotes concentration, though incomplete specialization is assumed in the factor endowment theorem. Specialisation/ Concentration leads to expansion in output which is the basis for export where there is a surplus as posited by the Smith-Myint's Vent for Surplus theory.

The structuralist economists (including Presbisch (1950) and Singer (1950)) contend that export concentration especially on primary products by developing countries could adversely affect their economies as prices of primary products decline relative to those of manufactures in the long-run. Consequently, concentration on export of primary products would engender income volatility, reduction in terms of trade and reduction in economic growth rate. The policy prescription of the Presbisch-Singer hypothesis for developing countries is rapid diversification away from primary products exports to manufactured export (Chakraborty, 2012). Increase in manufactured exports requires expansion in manufactured output, which in turn requires relevant inputs such as physical capital, labour human capital, FDI, etc. as postulated by various growth theories especially the endogenous growth theories.

2.2. Empirical Literature

The factors affecting export diversification in different countries and regions have been investigated by different researchers. In this sub-section, we present a review of some of the various studies.

Bebczuk and Berrettoni (2006) examine the factors explaining export diversification in a sample of 56 developed and developing countries in the period from 1962 to 2002 using fixed and random effect estimators. The explanatory variables incorporated in the model include export to GDP ratio (to indicate a country's competitiveness in and integration with international markets), per capita GDP, access to credit, gross investment ratio, and the level of FDI, quality of infrastructure (using telephone lines per 1000 people as proxy), and the observed export composition (captured with the shares of fuels, manufactures and agricultural exports in total exports). The empirical evidence indicates that export to GDP ratio, per capita income, fuel export as percentage of total export, gross fixed capital to GDP ratio, and telephone lines (per 1000 people), are positively and significantly related to export diversification, while manufactures export to total export and net FDI to GDP ratios are negatively and significantly related to export diversification. The study further finds a u-shaped relationship between economic development and export diversification suggesting that diversification increases at low level of income, while concentration prevails at higher levels of income. It also finds, contrary to conventional knowledge, that export concentration (rather than export diversification) is stimulated by good macroeconomic performance.

Alemu (2008) employs the feasible generalized least squares (FGLS) estimator to analyse a balanced data set on 41 SSA and East Asian countries in a study to investigate the determinants of vertical and horizontal export diversification in sub-Saharan Africa. The study finds that human capital variables (education and health), income per capita, FDI, openness, population size, infrastructural development are important determinant of vertical and horizontal export diversification. FDI speeds up both vertical and horizontal diversification in East Asia, but only vertical diversification in SSA. The effect of FDI and human capital on vertical and horizontal diversification is stronger in East Asia than in SSA. Domestic investment enhances both vertical and horizontal diversifications in East Asian countries, but it only enhances horizontal diversification in SSA. Oil wealth negatively affects export diversification, while arable land resource enhances vertical and horizontal diversification. Political instability strongly and adversely affects export diversification especially in SSA. The effects of inflation, foreign aid and exchange rate on export diversification are mixed, and therefore inconclusive.

The political and economic factors affecting export diversification and export sophistication in sub-Saharan Africa (SSA) are investigated in Cabral and Veiga (2010). The pooled OLS with robust standard error and fixed effect estimators are applied to disaggregated data on 48 SSA countries for the period from 1960 to

2005. The empirical evidence emanating from the study is that good governance (characterised by low level of corruption, accountability and transparency) is an important factor determining (promoting) the scope of export diversification and the level export sophistication in SSA. The study also finds that human capital (level of education of the workforce) is positively related to export diversification and export sophistication, with higher level of education (tertiary education) playing more important role in explaining export sophistication and lower level of education (primary education) playing more important role in the determination of export diversification. The study further finds that both export diversification and export sophistication positively affect economic growth in SSA.

Parteka and Tamberi (2011) investigate the determinants of export diversification in sixty countries using fixed effect least square dummy variable (LSDV) estimator to analyse panel data set that span the period from 1985 to 2004. The study finds that export diversification is affected by distant from major markets and country size. All things being equal, the closer a country is to major markets (for export products), and the larger the size of the economy in terms of output, the more diversify is the economy.

Agosin, Alvarez and Bravo-Ortega (2011) use large dataset covering the last forty years of the twentieth century to investigate the determinants of export diversification around the globe. The two-step system GMM is employed for the analysis. The study finds that trade openness induces specialization, not diversification; financial development does not affect export diversification; real exchange rate volatility does not play any significant role in export diversification; higher schooling help to diversify export diversification; exports of more remote countries tend to be more concentrated.

The pattern and determinants of export diversification in East Asian Countries are investigated in Ferdous (2011). Employing fixed effect estimator for estimation of panel data set covering the period from 2000 to 2008 on eight East Asian countries (Indonesia, Malaysia, the Philippines, Singapore, Thailand, China, Japan, Korea), the study finds that greater economic integration of the East Asian countries drives export diversification in the sub-region, while exchange rates and tariffs negatively and significantly impact on specialization. GDP of exporting countries positively impacts on specialization.

The effect of trade facilitation on export diversification in a sample of 118 developing countries is investigated in Dennis and Shepherd (2011). The study which involves maximum likelihood estimation of a baseline Poisson model and application of various econometrics techniques such as the standard ordinary

least squares, Tobit and negative binomial model finds that 10% reduction in costs of international transport and exporting, that is, reduction in costs of trade facilitation (documentation, port/custom charges, inland transportation) are associated with export diversification gains of 4% and 3% respectively. Further evidence from the study is that lower market entry cost also promotes export diversification, though the effect is quite weak.

Using fixed and random effect and system GMM estimators, Balavac (2012) investigates the determinants of export diversification at the export margin for a sample of 27 transition economies using unbalanced panel for the period from 1997 to 2010. The study finds amongst others, that export diversification is supported by productive capacity. This implies that improvement in domestic productive capacity would translate into enhanced export diversification, all things being equal.

Alaya (2012) uses a fixed effect specification to investigate the determinants of export diversification in Middle East and North Africa Region using panel dataset for the period from 1984 to 2009 for 12 MENA countries. The potential endogeneity of the regressors (that is, feedback effects) is dealt with using instrumental variables. The study finds a u-shape relationship between economic development and export diversification. It also finds that natural resource endowment is a major determinant of export concentration in the region. Further evidence from the study are that trade openness and physical capital accumulation (domestic and foreign investment) enhance export diversification in the region.

In a study on the determinants of export commodity concentration and trade dynamics in Ethiopia, Makonnen (2012) finds that changes in real effective exchange rate, education spending, lagged value of GDP and lagged value of investment to GDP ratio are significant determinants of export concentration in the country. The researcher recommends that appropriate exchange rate and investment policy would enhance export diversification in the country.

Hussain and Chowdhury (2012) empirically assess the pattern and determinants of export diversification in Bangladesh in the period from 1980/81 to 2006/07 using trend analysis. The study finds that infrastructural development, communication, taking part in free trade agreement which engenders reduction in trade cost and barriers, export financing and human capital development will improve diversification of export in the country.

Kamuganga (2012) investigates the factors driving export diversification in Africa using data for the period 1995 to 2009. The study finds that the likelihood of an African nation to export across new-product and new-market margins is enhanced by intra-Africa regional integration. It also finds that product and market experiences derived from learning effects of trade (learning by doing and learning by exporting) also enhances African exporters' chances of exporting on extensive (new-product and new-market) margins. Further evidence from the study is that trade frictions associated infrastructure such as export cost, time to export, procedure to export, weak export supporting institutions (which are actually trade logistic issues on which several African countries have performed abysmally) adversely affect export diversification efforts in the continent. Additionally, the study finds that macroeconomic developments such as financial system underdevelopment, exchange rate volatility and inappropriate FDI hurt Africa's chances of diversifying her exports.

Iwamoto and Nabeshima (2012) investigate the potential of FDI (inflow and stock) to affect export diversification and sophistication using dynamic panel system GMM for analysis of data that span the period from 1980 to 2007 for a sample of 167 countries. The control variables assumed to be determinants of export diversification include real GDP per capita, population, inflation, trade openness and oil. The correlation matrix between the variables show that FDI inflow, FDI stock, real GDP per capita, population and trade openness are positively correlated with export diversification and sophistication, while inflation is negatively correlated with diversification and sophistication. The evidence from the system GMM analysis indicates that FDI inflow positively affect export diversification and sophistication, while FDI stock positively affects export sophistication only in developing countries.

Regolo (2013) examines the relevance of the choice of trading partner on export diversification in a panel of 102 trade partners over the period from 1995 to 2007 using fixed effect estimators. The study finds that similarities between trading partners in land, human capital endowment per worker, and physical capital, as well as low trade cost are associated with more diversified bilateral exports.

Arawomo, Oyelade and Tella (2014) employ the methodology of generalized method of moment (GMM) to investigate the determinants of export diversification in Nigeria. The study finds that FDI, currency depreciation and lack of democratic accountability discourage export diversification in Nigeria while domestic investment positively affects it.

Elhiraika and Mbate (2014) assess the determinants of export diversification in Africa using system GMM to analyse panel dataset covering the period from 1995-2011 for 53 African countries. The study finds that per capita income, human capital, infrastructure, public investment and institution framework are significant drivers of export diversification in Africa.

The effects of knowledge sharing from FDI and imports from south-south and south-north economic cooperation on export diversification in selected African countries is examined in Ndambendia (2014) applying the generalized method of moments and random effect which control for endogeneity. The study finds that FDI inflows and imports from the south and the north differently affect horizontal and vertical export diversification. FDI inflows have the strongest effect on vertical export diversification, while imports have the strongest effect on horizontal export diversification, with import from the south having the strongest effect. Further evidence from the analysis is that higher education is a necessary requirement for vertical export diversification.

Altowaim (2016) employs fixed effect estimation and panel dynamic ordinary least squares (DOLS) techniques to investigate the impact of financial development on export diversification in a sample of 38 resource-rich developing countries in the period from 1995 to 2013. The evidence from the fixed effect estimation indicates that the effect of financial system development on export concentration is not statistically significant. However, evidence from the panel DOLS shows that financial development impacts positively and significantly on export concentration, suggesting that the development of the financial system in resource-rich developing countries measured as the depth of the banking system is more likely to encourage specialization. The study recommends that government of these countries should provide alternative sources of finance targeted at diversifying the countries' export, such as establishment of industrial and development banks and setting up of publicly-funded venture funds.

Our review of the literature reveals that although the factors affecting export diversification has been investigated in several countries and regions whose exports tend to be concentrated in a few products, to the best of our knowledge, this is yet to be done for ECOWAS subregion. Investigating the factors affecting export diversification in ECOWAS is necessary in view of the potential benign effect it could have on long run economic growth of developing countries as argued by economist and policy makers (Hausmann, Hwang and Rodrik, 2006; Chakraborty, 2012).

3. Model and Estimation Technique

3.1. Model

Our aim in this subsection is to specify a model consistent with theory and empirical evidence to investigate the determinants of export diversification in ECOWAS sub-region. Macroeconomic factors affecting export diversification identified in the literature include real GDP per capita, physical capital accumulation, FDI, exchange rate, trade liberalization (trade openness) and financial development. Following the frameworks developed by Cabral and Veiga (2010), Parteka and Tamberi (2011), Agosin, Alvarez and Bravo-Ortega (2011), Alaya (2012), Kamuganga (2012), Arawomo *et al.* (2014)), we specify the model to investigate the determinants of export diversification in ECOWAS countries functionally as:

Expcon = f (pcy, gfcf, fdi, topen, fd, inf, exrt) [1]

The empirical specification of the model is written as:

$Expcon_{i,t} = \theta_{0i} + \theta_1 lnpcy_{i,t} + \theta_2 gfcf_{i,t} + \theta_3 fdi_{i,t} + \theta_4 topen_{i,t} + \theta_5 fd_{i,t} + \theta_6 inf_{i,t} + \theta_7 exrt_{i,t} + u_{i,t}$ [2]

Where Expcon = export concentration index. Quantitative indexes measure concentration rather than diversification. The most frequently used concentration indexes are the Herfindahl, Gini and Theil indexes. This study adopts the UNCTAD export concentration index based Herfindahl-Hirscmann index (HHI). The index is calculated using the formula:

$$H_j = \frac{\sqrt{\sum_{i=1}^{n} \left(\frac{x_{ij}}{X_j}\right)^2} - \sqrt{1/n}}{1 - \sqrt{1/n}}$$

Where

H_j = country or country group index; x_{ij} = value of export for country j and product i, X_j is the total value of exports of country j measured as:

$$X_j = \sum_{i=1}^{n} x_{ij}$$

where *n* = number of products (Standard International Trade Classification (SITC) Revision 3 at 3-digit group level). The SITC is a statistical classification of commodities entering external trade, designed to give aggregates needed for purposes of economic analysis and facilitation of international comparison of trade-by-commodity data. Each product considered in the computation of the index must represent more than 0.3% of total exports of a country. The index is normalized to take on values between 0 and 1. An index value closer to 1 indicates that a country's export is highly concentrated on a few products. On the other hand, values closer to 0 indicate that exports are more diversified. A limitation of the UNCTAD's HHI measure of export product concentration/diversification is that though it captures both vertical and horizontal diversification, as with other indexes, it does so imperfectly (Agosin, 2009).

pcy = real per capita income (real gross domestic product per capita); gfcf = gross fixed capital formation as percentage of GDP (proxy for domestic investment) fdi = net foreign direct investment as percentage of GDP; topen = trade openness (measured as total trade as percentage of GDP); fd = financial development (measured as credit to the private sector as a percentage of GDP); inf = inflation, measured as annual percentage change in consumer price index; exrt = nominal exchange rate (₦/$); $u_{i,t}$ = residual (error) term capturing other omitted factors affecting the dependent variable for all i and t; θ_is are estimates of the effects of the explanatory variables on the dependent variable.

The *a priori* signs on the coefficients are: $\theta_1 < 0$, $\theta_2 < 0$, $\theta_3 < 0$, $\theta_4 < 0$, $\theta_5 < 0$, $\theta_6 > 0$, $\theta_7 < 0$.

3.2. Theoretical Justification for the Included Explanatory Variables.

The New Trade theory argues that the degree of product differentiation which is key determinant of export diversification (Dixit and Norman, 1980; Helpman and Krugman, 1985; Ofa, Spence, Mavel and Karingi, 2012) is directly affected by market size. This position is upheld by the views presented in the monopolistic competition models which explain that bigger countries with higher per capita incomes produce (and consequently, export) wider range of products than smaller countries (Dixit and Stiglitz, 1977; Parteka and Tamberi, 2011). Thus increase in per capita income is expected *a priori*, to reduce export concentration or enhance export diversification.

The endogenous growth theories explain the relevance of human capital development (enhanced by schooling and improved health service delivery)

and technology in product differentiation (Mankiw, Romer and Weil, 1992; Aghion and Howitt, 1998; Liu and Shu, 2003). Well-developed human capital also enhances a country's absorption capacity and improves the relevance of FDI in technology transfers. Thus, FDI has been shown to have positive effect on export diversification of host countries, particularly developing countries (Iwamoto and Nabeshima, 2012).

Trade liberalization (particularly export trade orientation) can also engender product differentiation and expand export product destinations or markets (Krugmann and Venables, 1990; Costas et al, 2008; Dennis and Shepherd, 2011).
The J-curve effect in international trade theory can be used to explain the link between exchange rate and export diversification. All things being equal, currency devaluation or depreciation leads to improvement in the balance of trade in the long-run as a result of expansion in exports (and reduction in imports) it engenders since a country's export commodities become cheaper in foreign markets, given favourable demand for the exportable commodities, that is elastic demand. The devaluation/depreciation of the domestic currency could trigger shift of resources towards production of more (new) exportable commodities and this could improve as well as stabilize export earnings. Thus currency depreciation is expected to enhance export diversification or reduce export concentration.
The development of the financial system ensures efficient allocation of credit to various sectors of the economy as the financial system plays crucial role in trade finance. Allocation of credit to the export sectors of the economy enhances the performance of those sectors and hence engenders expansion of export products, thereby reducing export concentration (Manganelli and Popov, 2010).
The specified model is therefore consistent with the literature and economic theories, and allows for identification of determinants of export diversification in ECOWAS sub-region.

3.3. Estimation Techniques and Data Sources.

Equation [2] is estimated with static estimators namely fixed effect estimator and Panel Estimated Generalised Least Squares estimators also referred to as the feasible generalized least squares(for both fixed and random) estimators which corrects for autocorrelation. To check the robustness of the estimated parameters, the panel Fully Modified Ordinary Least Squares (FMOLS) estimator which corrects for autocorrelation, regressors endogeneity and reverse causality is also employed to estimate the model. The FMOLS is also able to accommodate considerable heterogeneity across individual members of a panel to produce asymptotic unbiased estimators and nuisance parameters free normal distributions (Pedroni, 2000). The outcomes of these estimators will form the basis of the analysis.

Data for the analysis are annual times series data spanning the period from 1995 to 2015 for the 15 ECOWAS countries. They were sourced from the UNCTAD Handbook of Statistics (2016) and the World Bank's World Development Indicators (2016). Specifically, data on export concentration were sourced from the UNCTAD Handbook of Statistics, while data on other variables were sourced from the World Banks's WDI. The study period is dictated by data availability as the current UNCTAD export concentration dataset spans the period from 1995 to 2015.

4. Results and Discussion

The results of estimation of the model using alternative estimators – Panel Least Square (Fixed Effect), Panel Estimated Generalised Least Squares (Random Effect with cross section weights) and Panel Estimated Generalised Least Squares (Fixed Effect with cross section weights) – are presented in Table 2. The result from alternative specification used for robustness checks (the FMOLS) is also presented. Main findings are that per capita income, gross fixed capital formation as a percentage of GDP, credit to the private sector as a percentage of GDP and inflation significantly affect export concentration in the ECOWAS sub-region. The coefficients of FDI-GDP ratio and trade openness show no statistical significance at the conventional levels, indicating that the variables had no significant bearing on export concentration in the sub-region within the study period. The diagnostic statistics (coefficient of determination and adjusted coefficient of determination, F- statistic and the long run variance of the panel FMOLS) are quite impressive, with exception of the coefficient of determination and adjusted coefficient of determination of the Random Effect model which is not unexpected considering that the estimation involved unbalanced panel dataset.

Table 2. Model Estimation Results

Dependent Variable is Export Concentration				
Regressors	**Panel LS (Fixed Effect)**	**Panel EGLS (RE with CSW)**	**Panel EGLS (FE with CSW)**	**FMOLS**
C	1.2682	1.0001	1.1934	-
	(4.8018)***	(4.4873)***	(7.3185)***	
Log. per capita income	-0.1140	-0.0702	-0.1056	-0.1252
	(-2.7473)***	(-2.0611)**	(-4.1472)***	(-2.0687)**
GFCF-GDP	-0.0043	-0.0047	-0.0029	-0.0056
	(-3.6995)***	(-4.1766)***	(-2.8004)***	(-3.1046)***
FDI-GDP	-0.0003	-0.0005	-0.0005	0.0008
	(-0.3482)	(-0.4746)	(-0.6196)	(0.5215)
TOPEN	0.0002	0.0002	0.0002	0.0004
	(0.5757)	(0.5081)	(0.7732)	(0.7570)
CPS-GDP	0.0011	0.0011	0.0012	0.0011
	(3.0644)***	(3.0611)***	(4.2862)***	(2.0000)**
INF	-0.0018	-0.0015	-0.0010	-0.0022
	(-2.5238)**	(-2.2593)**	(-2.1206)**	(-1.8346)*
EXRT	-2.87E-06	-5.07E-06	-1.88E-05	-8.50E-06
	(-0.1966)	(-0.3968)	(-1.2952)	(-0.3686)
Diagnostic Statistics				
R-Squared	0.7952	0.1721[w]	0.9417[w]	0.8031
Adj. R-squared	0.7782	0.1505[w]	0.9369[w]	0.7854
F-Stat.	46.96	7.9581[w]	195.38[w]	-
Long-run variance	-	-	-	0.0160

*****, **, * indicate statistical significance at 1%, 5% and 10% levels respectively;**
FE = Fixed Effect;
RE = Random Effect;
CSW = Cross Section Weight;
W = Weighted Statistics

Per capita income is observed to negatively and significantly affect export concentration. The implication is that increase in per capita income (that is economic growth) has the effect of reducing export concentration (or enhancing export diversification) in the sub-region. This conforms to *a priori* expectation and corroborates findings from previous studies such as Bebczuk and Berrettoni (2006), Alemu (2008), Parteka and Tamberi (2011), Elhiraika and Mbate (2014).

Increase in domestic investment measured as gross fixed capital formation as percentage of GDP has the effect of reducing export concentration or enhancing export diversification in the sub-region. The effect is highly significant even at the 1% level in all the specifications and underscores the relevance of domestic investment in various sectors of the economy in the diversification of the sub-region's exports. This is in sync with the findings of Bebczuk and Berrettoni (2006), Alemu (2008), Makonnen (2012), Alaya (2012). The effect of FDI on export concentration is not significant in any of the specifications. This suggests that more emphasis should be on domestic investment rather than foreign direct investment in the sub-region's quest to diversify her exports. The rationale for this is that foreign investors channel their investments to sectors of the economy they perceive to yield higher returns on investment. As a matter of fact, if left unchecked, activities of foreign investors could exacerbate the export concentration problem.

Domestic credit to the private sector is positively related to export concentration in the sub-region. The effect is highly significant even at the 1% level in all the specifications. The positive coefficient suggests that lending pattern and activities of the sub-region's financial system contribute significantly to the concentration of the sub-region's export. This points to financial system inefficiency and reveals that lending institutions in the financial systems tend to lend more to financing of activities in few sectors, while other sectors receive less financing. In order words, considering that the extractive sector accounts for the largest share of exports in the sub-region, this sector must have also attracted the largest share of loans from the financial institutions. Thus financial sector credits tends to be concentrated in a few sectors, and this engenders expansion in output of those sectors which in translates into concentration of exports as the country's exports would be mainly from the few sectors benefiting from financing by the financial institutions. This observation buttresses that of Kamuganga (2012).

Inflation is negatively and significantly related to export concentration in the sub-region. This implies that increase in general price level was associated with reduction in export concentration or increase in export diversification within the study period. The result suggests existence of acceptable levels of inflation for export diversification. It suggests also that within the period under review, inflation rate was within the threshold favourable to export diversification in the sub-region.

5. Policy Recommendations and Conclusion

5.1. Policy Recommendations

Based on the empirical evidence from the study, the following are recommended for policy consideration:

1. Considering that real GDP per capita was found to be negatively related to export concentration, implying that economic growth would enhance export diversification, there is need for countries in the sub-region to take measures to intensify the growth of their economies so as to achieve export diversification.

2. In view of the observation of an inverse relationship between gross fixed capital formation and export concentration, there is need to increase the rate of capital formation in the sub-region as this would enhance export diversification therein, all things being equal.

3. Proper regulation of the financial system is required to ensure efficient allocation of credits to different sectors of the economy to ensure expansion of output of the sectors and enhance exports from the various sectors, instead of concentrating credit in a few sectors which could have the effect of exacerbating the export concentration problem.

4. There is need to maintain inflation at levels that are compatible with export diversification. To this end, future researchers may investigative the threshold effect of inflation on export diversification with a view to determining the threshold inflation rate.

5.2. Conclusion

In this paper, an attempt has been made to investigate the factors affecting export diversification in the ECOWAS sub-region. In doing this dataset on relevant variables spanning the period from 1995 to 2015 were employed for estimation of various panel data regression models including fixed effect, panel EGLS (also known as feasible generalized least squares) and robustness of the results were tested by employing the panel FMOLS technique for estimation of cointegration models. The estimation results revealed that export diversification is affected by real per capita income, gross fixed capital formation, domestic credit to the private sector and inflation. While increase in real per capita income and increase in gross fixed capital formation were found to enhance export diversification in the sub-region, domestic credit to the private sector was found to adversely affect export diversification and promote export concentration. This was attributed to the lending patterns of the lending financial institutions in the sub-region which tend to favour firms operating in the extractive sector which accounts for the largest share of the sub-regions export. Inflation was also found to negatively affect export concentration, suggesting that it enhances export diversification. However caution was exercised in interpreting this relationship and it was attributed to the possibility of existence of a threshold level of inflation within

which inflation could be favourable to export diversification. This threshold level has been left for future researchers to estimate.

5.3. Future Research Direction

Factors affecting export diversification in ECOWAS subregion has been investigated in this paper. The factors affecting export diversification in other sub regions such as Central Africa subregion and Northern African subregion could be considered as issues for future research as the outcome of the studies could be deployed for formation of export diversification strategies that would position the continent (Africa) for sustainable growth. In addition, though this study relies on the index computed by the UNCTAD – The Herfindahl-Hirschman index – future studies may also consider using other indexes of export diversification such as the Theil index computed by the International Monetary Fund.

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INFLATION, INFLATION VOLATILITY AND CAPITAL ACCUMULATION IN NIGERIA: IS THE VARIABILITY OF INFLATION MORE PROBLEMATIC?

Hassan. O. Ozekhome[1]

Abstract

Uncertainty about the nature of inflation, particularly its variability- (a symptom of macroeconomic maladjustment (instability) can undermine investment. It is against this backdrop that this paper sought to examine the impact of inflation and inflation variability on capital accumulation in Nigeria, and in particular, whether the variability of inflation is more problematic, in terms of policy challenge. This is examined over the period 1986Q1-2015Q4. Employing Instrumental Variable (IV) Two Stage Least squares (2SLS) technique to control for potential endogeneity and simultaneous equation bias in the estimation of the final gross domestic investment model, having obtained the volatility of inflation through the Generalized Autoregressive Conditional Heteroskedasticity (GARCH, 1, 1), the empirical results reveal that inflation, inflation variability and real exchange rate have dampening effects on capital accumulation (real gross domestic capital formation) in Nigeria. The negative effect of inflation variability is found to be higher. Interest rate and real income on the other hand are both found to have positive and significant effects on capital accumulation. We recommend amongst others; the implementation of sound and stable macroeconomic policies, particularly with respect to low and stable inflation, realistic exchange rates and real interest rates, increase production (output) capacities, sound institutional structures and other ancillary fiscal incentives to stimulate gross domestic capital formation in Nigeria.

Keywords: *Inflation volatility, Gross capital formation, Nigeria, GARCH, 2SLS.*

1. INTRODUCTION

Recent years have witnessed increased empirical works on the effects of macroeconomic stability on capital accumulation among economists, policy makers and researchers. The renewed empirical interest has been spurred by two developments which stand out. First and foremost, the generation of quantitative models developed under the New Keynesian and monetarist paradigms that can be used to explicitly study the impact of stabilization policies on economic performance, in a more coherent and rigorous analytical context (Saborowoski, 2009).

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The second reason is advancement in macroeconomic policy management itself, which has enabled researchers investigate the link between financial and real variables. In traditional theory; this link is given by means of the real variable transmission mechanism (Lugo, 2003). Essentially, inflation is one of the most closely monitored macroeconomic variables and its movement is frequently detailed because of its effect on the economy.

As key indicator of macroeconomic stability in any economy, the inflation rate assumes greater importance, and thus has a significant effect on capital accumulation, as well as domestic and foreign resource allocation. Low inflation, particularly its stability is positively related to higher investment and long-term growth (Patnaish and Joshi, 2012). Inflation exerts influences on the economy through the allocation of resources between tradable and non-tradable goods production (investment) or between the production for domestic consumption and production for export via its effect on relative prices. High inflation has eroding effects on savings, investment and the value of financial assets. Of particular importance, it is not only the average level of inflation that is problematic but the variability of inflation. Inflation volatility is thus critical to the analysis of investment behaviour. Inflation instability may provoke pronounced vacillation in key macroeconomic aggregates, such as consumption, savings, investment, balance of payments, e.t.c, and consequently lead to destabilizing consequences on growth, with negative spillovers on specific sectors, such as manufacturing and industry (Ozekhome, 2017).

The federal government through the Central Bank of Nigeria has used key monetary variables like interest rate and exchange rate to stimulate domestic capital formation, over the years. Since capital formulation is regarded as engine of growth, greater policy attention is given to macroeconomic stability in order to facilitate the mobilization of domestic and foreign resources for investment purposes. Other fiscal policy measures such as tax holidays, tax concession, tax rebates, e.t.c aimed at improving the investment climate have over the years, been designed and implemented, particularly with respect to the stimultion of private capital (Olashore, 1991).

Compared with the performance of other countries (both developed and developing), the growth of gross capital accumulation in Nigeria was quite impressive during the 1960s. For instance, the annual growth rate of capital formation over the period of 1960 – 1970 was 7.4 percent for Nigeria, 5.7 percent for sub-Sahara Africa countries and 5.6 percent for group of industrialized countries (Olashore, 1991). The growth rate of capital formation was 5.8 percent in the period 1981-1990, 4.6 percent in 1991-2000, 3.8 percent in 2001-2010 and

2.8 percent in the period 2011-2015 (World Bank, 2016). The decline has been attributed to multiple issues, to include; financial credit constraints, infrastructural deficits, (in particular, the epileptic power supply), poor macroeconomic environment to include; policy inconsistency and multiple taxation, lack of adequate take-off incentives, amongst others.

According to Udegbunam (2002), the inflationary pressures in the face of escalating fiscal deficits also discouraged savings and real investment in Nigeria. This view is supported by Iyoha (1997) who argued that the economic downturn triggered largely by oil price collapse, contributed to an all-time external debt, which crowded-out investment expenditure.

Considering Nigeria's inflation rate movement over the years, large fluctuation have been observable since the introduction of the market-based rates under the Structural Adjustment Programme (SAP) in 1986. The deregulation of the Nigerian foreign exchange market in 1986, as part of implementation of SAP policies, which marked the switch from the fixed exchange rate regime to the flexible exchange rate regime also contributed to the rising inflation rate and its instability, via the exchange rate pass-through.

For an open, mono-product and highly import-dependent economy like Nigeria, with the adverse effects of externally generated and transmitted shocks, the effect of inflation volatility is pervasive and quite devastating (See Aghion et al, 2006), as inflation exhibited wide volatility over the years. The standard deviation of inflation growth rate for 1981-1990 was 4.1 percent; rising to 4.7 percent in the period 1991-2000; 5.5 percent in 2001-2010 and 15.3 percent in 2011-2014. Given the sharp reduction in crude oil prices owing to the oil price shock in the international market in the third quarter of 2014; marking a period of greater output volatility, the standard deviation of inflation growth in the third quarter of 2014 to the last quarter of 2017 rose to 21.5 percent. The soaring volatility in inflation growth was due to a combination of factors to include; growth contraction, surging and unstable exchange rates, rising real interest rate, including its variability, making Nigeria one of the most volatile economy in Sub-Saharan Africa during the period (WDI, 2016).

To the best of the author's knowledge, the simultaneous effects of inflation and inflation instability (instability) has not received any notable empirical attention in the literature, particularly in Nigeria. In addition, the few related studies on the subject matter (see Crosby, and Otto, 2000; Oshikoya, 2004; Ogunleye, 2008) did not consider the effect of inflation variability on capital formation, given the fact that the stability of inflation growth is much more important in investment

decisions. In particular, it is important in the context of macroeconomic management that inflation rate be kept stable even when it is low, as evidence indicates that the adverse effect of inflation volatility on investment is higher. A key challenge of this study is thus to determine whether the stability of inflation matters more to investment than just the average level of inflation. This aspect of analysis seems to be missing in the literature. This work therefore intends to fill this perceived gap in literature by empirically examining the simultaneous effects of inflation and inflation variability on investment in Nigeria. Such analysis will in no small measure aid macroeconomic policy focus and direction.

A novel feature of this study is the use of Instrumental Variable Technique (IV) to examine the effects of inflation and inflation variability on capital accumulation. This is an improvement on many previous studies (see Crosby and Otto, 2000; Varvarigos, 2008), which did not consider the effect of potential endogeneity between inflation and gross capital formation

Following this introduction, the paper is organized as follows. Section two consists of literature review which considers the theoretical, empirical and policy issues associated with inflation and its volatility, and, investment. Section three contains the methodology, model specification and data, while section four contains the empirical results and analysis. Section five contains the conclusion and policy recommendations.

2. LITERATURE REVIEW

2.1 Conceptual Issues

Inflation refers to a persistent general rise in the prices of goods and services, leading to a fall in the purchasing power of money. Inflation erodes the value of financial assets, money, savings and capital investment, since during accelerating inflation, the value of money is worth more today than tomorrow.

Volatility is defined as the variation or dispersion of a variable from its mean value over a given range of time (Kotze, 2005).

Inflation *volatility* thus, refers to vacillation (wide swings or gyrations) of inflation rates from their mean observed value or equilibrium value over a given range of time. It is a fundamental deviation from the mean growth of inflation over a persistent period of time. The wide swings are more frequently associated with macroeconomic instability. In general, instability in inflation rate is a symptom of instability in the underlying economic structure/conditions. Unstable economic

development or output volatility is a major cause of inflation volatility (Obadan and Ozekhome, 2016).

2.2. Inflation, Variability and Capital Accumulation

Two opposing views have been advanced in the literature regarding the effect of inflation and its volatility on capital accumulation; first, an increase in inflation reduces the real interest rate (Tobin effect) and consequently increases the accumulation of capital (Rapach and Wohar, 2005). In addition, higher inflation (or its variability) can also result to higher capital accumulation by increasing the savings of the agents for precautionary motives (Dotse and Sarte, 2000, cited in Khan and Rana, 2012). To Walsh (1998), the Tobin effect is only temporary since inflation increases consumption along the transition path that requires more capital to produce it, making the long run effect of inflation on capital accumulation negative. In line with this tenet, inflation reduces the accumulation of capital, since rising prices reduces the future worth of money through the erosion of its purchasing power. Consequently, agent increases consumption and reduces savings and investment.

Accordingly, inflation shortens the planning horizon of the entrepreneurs as volatile prices make the predictions about the future costs and effective demand more difficult (Khan and Rana, 2012). Given that most of the long run investment decisions are both flexible with respect to time and are irreversible in nature, entrepreneurs hesitate to make long run investment projects in high inflation regimes, particularly its variability. This leads to a reduction in investments (see Chirinko, 1996 and Dixit and Pindyck, 1994). In addition, since capital formation is usually channeled by the financial institutions, high inflation, and its variability impairs the efficient functioning of the financial institutions, and thus makes the capital formation more difficult. Carmichael (1989) using a model that that introduces a lag between income and consumption of the agent demonstrate the adverse effect of inflation and its variability on effective real return. He assert that inflation reduces the reward in the output sector; causing negative relationship between inflation and capital accumulation. Inflation and the its uncertainty associated generates forces which makes economic agents keep larger amount of real money balances, that would have been used for investment purposes (Gilman and Nakov, 2003, Khan and Rana, 2012, cited in Ozekhome, 2017).

Sidrauski (1997) uses the classical Fisherian theory of saving where individuals' saving behaviour is taken as a process of wealth accumulation to achieve the objective of utility maximization. With utility maximizing families as a basic unit of the economic system, Sidrauski advances the view that money growth affects

the real variables only in the short run, and that the long run growth of capital stock is actually independent of the rate of monetary expansion in an economy. This phenomenon known as 'super-neutrality of money' was however found to be untenable by Fischer (1979), who tested the steady state properties of the Sidrauski model along the transition path of the economy and finds no evidence of 'super-neutrality. Gillman and Kejak (2011) expand this framework by introducing a substitution of consumption from current to future period, which, as a result increases savings and capital accumulation with inflation. Nevertheless, this relationship is non-linear given that at a very high inflation rate, savings again declines and cause the real interest rate to increase (anti-Tobin effect). Stockman (1981) introduces a cash-in-advance (C.I.A) constraint on the representative agent to finance his consumption and investment expenditures. Since inflation forces the agent to economize the use of money for both consumption and investment purposes, it results negative relationship between inflation and capital accumulation, and hence steady state capital stock.

Further, the development of endogenous growth models view per capita GDP growth as an endogenous equilibrium outcome of the decisions by rational optimizing agents, whether firms or individuals, or the government in terms of investment, and hence, internalize the determinants of growth such as capital accumulation, technology, research and development, and macroeconomic policy. In theory and evidence, accelerating rates of inflation and inflation variability (both symptoms of macroeconomic instability) have negative effects on capital accumulation and growth (Ozekhome, 2017).

2.3. Theoretical Review

We review in this section some of the theories that explain the basic variables (factors) in the explanation of investment decisions. This is necessary in order situate the variables in this study.

2.3.1 Accelerator Theory of Investment

The accelerator theory of investment has the most appropriate link to the theoretical determination of investment. The theory posits that current net investment is a function of change in income. It explains that net investment is a function of growth in output. This implies the level of induced investment will be determined by the rate of change of national income.
In empirical form, it is specified as:

$$I_t = f(r, \Delta Y);\ I_r < 0,\ I\Delta_Y > 0 \qquad (1)$$

where ΔY= growth or change in output, r = interest rate and I_t= investment demand at time t.

The relationship between the growth rate of output and the level of net investment hypothesized in the (1) is called the "accelerator principle'' since it suggests that an increase in the growth of output-acceleration of output growth is needed to increase the level of investment. The intuition here is that it is not the level of output that induces new net investment, but rather, it is the change in output. Apparently, business firms will need to expand productive capacity only if output increases (Iyoha, 2004). Thus, new net investment is not output level-induced but change or growth-induced. The fixed accelerator model assumes that current net investment equals the value of the discrepancy between the capital stock desired in the current period and the actual capital stock in the previous period.

$$I_t = K_t - K_{t-1} = \Delta K \qquad (2)$$

A net investment rate that guarantees the optimality of capital stock would yield:

$$K_{t-1} = K_{t-1} = KY_{t-1} \qquad (3)$$

Substituting equation (2) into (1), yields:

$$I_t = KY_t - KY_{t-1} = \Delta KY_t \qquad (4)$$

Equation (3) is the accelerator expressions, which relates net investment to a change in the level of output. Thus the level of induced investment is determined by the rate of change of national income (i.e induced investment is output growth-induced). In this regard, net investment is proportional to the discrepancy between the actual level of income in the current period and the level of income in the immediate past period; the factor of proportionality being *K*, the assumed-fixed-capital-output ratio. It is this constant that is known as the accelerator and provided it is positive, even small changes in output will have an "accelerated" effect on net investment (Anyawu and Oaikhenan, 1997). In rationalizing the existence of an accelerator, Iyoha (2004) has shown that when income is increasing, it is necessary to invest in order to increase the capacity to produce consumption goods; however when income is decreasing, it may not even be necessary to replace old capital, as it wears out, let alone buy new capital goods.

2.3.2. The Hall-Jorgenson Cost of Capital Theory

In general, investment decision is a firm level decision, and the aggregation of micro-level activities adds up to macro-level activities. The Hall and Jorgenson model of investment also known as the 'user cost of capital theory' developed in separate works by Jorgenson (1963) and Hall and Jorgenson (1967) was developed against this backdrop. They consider the problem of a firm that produces output using capital k as its only input,

$y = f(k)$ (1)

and which acquires its capital, k, from a market in which a unit of capital is rented for a unit of time at rate μ_t. In period t, the firm maximizes profit,

Max $k_t^{\alpha} - \mu_t k_t$

yielding first order conditions

$$f'(k_t) = \mu_t \quad (2)$$

$$\alpha k_t^{\alpha-1} = \mu_t \quad (3)$$

$$(y_t/k_t)\alpha = \mu_t \quad (4)$$

$$k_t = \quad (5)$$

Based on the FOCs derived in equations (2) – (5), Hall and Jorgenson developed determinant of the cost of capital. With the assumption of no taxes and absence of capital market frictions of any kind, an investor must be indifferent between putting his money in the bank and earning interest at rate r, and buying a unit of capital, renting it out at rate μ_t, and then reselling it the next period, with the opportunity cost being the interest rate, r.

The price at which capital goods can be bought at date *t* is:

P_t (purchase price of one unit of capital), and in continuous time, the rate of change of P_t is $\dot{P}_t$. Assume that capital depreciates geometrically at rate δ, the net profit from the continuous time purchase-and-rent strategy is

$\mu_t - \delta P_t + \dot{P}_t$ (6)

Equation (6) indicates income from renting, minus loss from depreciation (as a result of the eroding effects of inflation) plus capital gain from the change in price of capital. Interest rate and price here represent significant cost (or price) in

investment adjustment, as well as acquiring new capital, as not only do they influence each other in a particular way; but also impact significantly on domestic and foreign resource allocation. In other words, interest rate influences aggregate expenditure (demand) by altering household decisions to consume or to save and business decisions to invest in capital goods by affecting the user-cost of capital. Inflation on the other hand, erodes the value of money and asset returns and thus, depreciates the value of money and investment returns.

Thus, the no-arbitrage condition for pricing capital is:

$rP_t = \mu_t - \delta P_t + \dot{P}_t$ (7) subsequently,

$(r+\delta)P_t = \mu_t + \dot{P}_t$ (8)

In constant capital goods prices, $\dot{P}_t$ is assumed to e equal to zero.
Thus, substituting the value for μ_t from (8) into (5) we have:

$$k_t = \alpha y_t/\mu_t \quad (9)$$

$$k_t = \alpha y_t/(r+\delta)P_t \quad (10)$$

Equation (10) depicts the level of capital accumulation (capital stock) in the absence of tax conditions. It shows that rising cost of capital (interest rate and inflation) tend to reduce capital accumulation. But net investment is the difference between the capital stock in period t and t-1. Thus, the Hall-Jorgenson model of gross investment (without continuous time factors) is:

$i_{t-1} = k_t - k_{t-1} + \delta k_{t-1}$ (11)

$$= \left(\Delta \frac{y_t}{\mu_t}\right)\alpha + \delta k_{t-1} \quad (12)$$

Where y_t is the real output by the firm.

Equation (12) shows that capital stock (investment) is determined inversely by changes in cost of capital) and directly by changes in real output (Ozekhome, 2017).

2.3.3. Uncertainty Theory (Macroeconomic Instability)

The macroeconomic instability theory (indicated principally by high inflation rate and inflation variability) posits that unstable environment has detrimental effect

on investment and growth. Low inflation, sustainable budget deficits, realistic exchange rates and appropriate real interest rates are among the indicators of a stable macroeconomic environment (Patnaik and Joshi, 2012). Accordingly, an uncertain macroeconomic environment characterized by high inflation and its variability, as well exchange rate variability and the variability of interest rates, alongside unsustainable fiscal is not conducive to investment and long-run growth. For instance, inflation shortens the planning horizon of the entrepreneurs as volatile prices make the predictions about future costs and effective demand more difficult (Khan and Rana, 2012).

Sustainable macroeconomic policies are therefore likely to attract private investment, both foreign and domestic. Macroeconomic instability characterized principally by high inflation rate and its variability discourages investors by reducing their confidence in investments that take a long time to mature (Hellerstein, 1997). In addition, in inflationary environment, intermediaries will be less eager to provide long-term financing for capital formation and growth. The theoretical relationship aptly demonstrates following transmission mechanism: Inflation and its variability adversely affects the financial market leading to lower savings mobilization, and the uncertainty in financial market translates into lower investment and the reduction in investment translates to lower economic growth (Gultekin, 1983; Boyd, Levine and Smith, 2001; Xu, 2000, cited in Iqbal and Nawaz, 2012).

Theory and evidence show that macroeconomic stability reflected in low inflation rates and inflation stability is crucial for investment and long-term growth, as no country has achieved sustained economic growth and capital accumulation in an unstable macroeconomic environment of high and variable inflation. If investment is assumed to be the engine of growth in a model of endogenous growth, an adverse impact of inflation on investment implies an inverse relationship between inflation and growth (Patnaik and Joshi, 2012). Unstable macroeconomic environment characterized thus destabilizes capital accumulation, and hence, growth (Ozekhome, 2017).

2.4. Review of Empirical Studies

A number of empirical cross-countries studies and country-case studies have examine the effects of inflation and its instability on investment. These studies are briefly reviewed.

Freidman (1977) using cross-country evidence finds evidence of a negative and significant relationship between inflation instability and capital accumulation. He

showed that inflation disrupts the information mechanism of the price system, and thus halts the investment decisions of economic agents.

De Melo and Tybout (1986) using evidence from Uruguay, investigate the effect of inflation variability after the liberalization of the financial sector on savings and investment. Employing an Instrumental variable (IV) technique, the empirical results reveal that rising inflation and its variability negatively affects capital accumulation. They recommend sound and stable anti- inflationary macroeconomic policies, as well as sequential liberalization policy to enhance investment in Uruguay.

Martin and Wasonu (1992) modeled private capital accumulation in Kenya with the inflationary pressures, inflationary variability, foreign exchange reserve, credit, public investment and income. The findings show that all variables, except interest rate and income were significant determinants of investment.

Soyibo and Adekanye (1992) find that macroeconomic instability negatively affects capital formation in Nigeria. Gomme (1993) using a model of money and growth, investigates the impact of inflation on capital accumulation and output. He finds that inflation and its variability reduces the reward in the output sector and, resulting to a negative relationship between inflation, and capital accumulation.

Fischer (1993) examines the role of macroeconomic factors in growth. He found evidence that capital accumulation, productivity and growth are negatively associated with inflation and positively associated with good fiscal performance and undistorted foreign exchange markets. He substantiates this view with the findings, that, unstable macroeconomic environment, characterized by high inflation and inflation variability, reduces both capital accumulation and productivity. He submits that it is important that the inflation rate be kept stable, even when it is low, as evidence indicates that the adverse effect of inflation variability on investment is higher. According to him, the variability of inflation serves as a more direct indicator of the uncertainty of the macroeconomic environment. Growth may be linked to uncertainty and macroeconomic instability where temporary uncertainty about the macroeconomy causes potential investors to wait for its resolution, thereby reducing the investment rate (Pindyck and Solimano 1993, cited in Patnaik and Joshi, 2012).

De Gregorio (1993) using evidence from 12 Latin American countries over the period 1950-1985, finds a significant negative relationship between inflation, its variability and output growth. According to his findings, it is the efficiency of

investment that is affected and that is what feeds into the effects of inflation on output.

Using U.S data, Goldberg (1993), find a negatively and significant relationship between inflation and domestic investment. Goldberg and Kolstad (1995) nevertheless find evidence that the impact of inflation on U.S investment behaviour was insignificant afterward. The reason for this discrepancy stem from the fact the latter result used data from pools of industries. Aigbokhan and Obadan (1995) and Oshikoya (1994) find evidence that inflation negatively affects domestic investment. They conclude that sound investment-enhancing macroeconomic policies are required in Nigeria.

Barro (1996) employing copious econometric techniques, examine the impact of inflation and its volatility on investment. The findings show that reduction in economic growth largely occurs due to reduction in the propensity to save and invest due to the eroding effects of inflation. His findings further reveal that an increase in average inflation volatility by 10 percentage points per year cause reduction in the ratio of investment to GDP by 0.4-0.6 percentage points and this reduction in investment reduces the real per capita GDP by 0.2-0.3 percentage points per year. He concluded that inflation and inflation variability (instability) reduces the level of investment and in turn, reduction in investment unfavourably affects economic growth.

McClain and Nicholas (1994) employ times series technique to investigate the long-run relationship between inflation and investment, using US time series data from 1927 to 1987. Unexpectedly, these authors found that investment and inflation are positively correlated to each other. They argued that this finding is consistent with the interpretation that the income effect of inflation increases savings, the incomplete 'Fisher effect' lowers the real cost of funds, and that bond price movements from inflation increases real corporate wealth, all leading to higher investment.

Haslag (1998) using a model where capital accumulation takes place through financial intermediation to channelize savings and other financial resources, finds evidence that inflation and its variability reduce capital accumulation. Inflation increases reserve requirements for the financial institutions and, as a result, reduces capital accumulation (see also Ireland, 1994). Accordingly to Haslag (1998, cited in Khan and Rana, 2012), since inflation forces the agent to economize the use of money for both consumption and investment purposes, it results to negative relationship between inflation and capital accumulation and hence steady state capital stock.

Pattilo (1998), using a model inspired by Bertola (1998) and a panel of 200 manufacturing firms in Ghana over two years (1994 and 1995), finds that due to demand and macroeconomic uncertainty, firms wait for the marginal productivity of capital to go beyond a threshold specific to each firm before investing. The level of this threshold rises as uncertainty rises. Pattilo results show that uncertainty caused by inflation variability has a negative effect on the level of investment. Busari and Olaniyan (1998), investigate the relationship between public capital accumulation and policy uncertainty in Nigeria over the period 1970 to 1994. The results revealed a weak negative relationship between inflation uncertainty and private capital formation.

Crosby and Otto (2000) use a structural VAR estimation approach to investigate the relationship between inflation volatility and capital accumulation for 34 countries. The findings show no evidence of robust relationship between these variables, in other words, 'super-neutrality of money' holds in most of the cases. Ahmed and Rogers (2000) use the long term U.S data of more than 100 years to investigate the effect of unanticipated inflationary shocks on consumption, investment and output. Empirical estimates based on Vector Error Correction Model (VECM) for the whole sample as well as for the sub-samples show that inflation exerts positive impact on the growth of these variables.

Bleaney and Greenaway (2001) using evidence from fourteen sub-Sahara Africa countries excluding Nigeria, find that inflation and its volatility negatively affects the growth of investment demand. However, Bhattacharya and Haslag, (2001) using models based on overlapping generations' framework show that the negative effects of inflation on investment can be removed if inflation tax (along with a non-distortionary tax in that case) is imposed. Gillman and Nakov (2003, cited in Khan and Rana, 2012), find that the relationship between inflation and capital accumulation can also be negative if agent prefers leisure over capital accumulation in an inflationary environment such that the marginal utility of leisure is higher than the marginal return of investment. This finding validates the results of the theoretical literature that inflation reduces the incentive to invest, leading to a reduction in capital formation. The evidence shows that the income effect of lower real wages obligates the agent to reduce their time spending for human capital accumulation. According to the finding, it is not only the average level of inflation that is problematic but the variability

Lugo (2003) investigates the impact of macroeconomic environment on private investment in Venezuela. Employing Vector Error Correction (VEC) model and non-linear transition path logistic model, the empirical findings reveal that, inflation particularly its variability; significantly distort the investment transition

path. He recommends the implementation of sound and stable macroeconomic policies to promote investment.

Rapach and Wohar (2005) using the effect of different inflation episodes, investigate the effect of inflation and its variability on investment, and find that high inflation, including its variability are detrimental to capital accumulation. Heylen and Pozzi (2007) examine how the accumulation of human capital performs with high inflation episodes. The study uses a panel data of 86 countries over the period of 1970-2000 and find evidence that inflation crisis enhance investment. The study, however, did not address the issue of how capital and growth nexus is influenced by different levels of inflation. Ogunleye (2008) examines the relationship between macroeconomic volatility and investment in selected Sub-Saharan Countries. The empirical findings revealed that instability negatively affect capital formation.

Varvarigos (2008) presents and estimate a model where output is a function of capital stock and work effort, while money facilitates the transaction cost of the agents. Higher inflation variability forces the agents to keep larger amount of real money balances, which can further be used to enhance capital accumulation. Nevertheless, the effect of average inflation on human capital accumulation is negative.

Gillman and Kejak, (2011) investigate the inflation, investment- growth nexus, using cross-sectional data from a group of developed and developing economies. Employing the various econometric techniques, the findings show that inflation instability negatively and significantly affects investment and growth. López-Villavicencio (2011) examines the impact of inflation and inflation uncertainty (proxied by inflation instability) on capital stock using data from a group of developing countries. The findings show that inflation and its instability have adverse effects on capital accumulation. At high level of inflation variability, capital accumulation diminishes by a greater effect.

Geng and N'Diaye (2012) examine the determinants of investment in China using evidence from cross-country firm data level. Adopting a modified Jorgenson model, the findings reveal that real GDP, interest rate, tax, inflation are significant determinants of investment. He further conclud that variation in these variables will in likewise induce variability in investment.

Iqbal and Nawaz (2012) using annual data from 1961 to 2008 in Pakistan examines relationship between inflation variability and investment in a model of inflation and capital accumulation. Employing non-linear threshold model, the evidence

reveal that inflation volatility reduces the incentive to invest due to the uncertainty syndrome it introduces into capital accumulation. He concludes that low and stable the inflation is helpful for the achievement of sustainable economic growth and investment.

Patnaik and Joshi (2012) investigate the nexus between inflation, investment and growth in the context of the role of macroeconomic policy in India, and finds evidence of negative and significant relationship between inflation and investment in the long run. The evidence further shows that macroeconomic stability (proxied by low inflation/ inverse of inflation) and the necessary infrastructure are critical to sustained capital accumulation (investment) and growth. He concludes that a critical channel through which inflation affects growth is investment. Low or moderate inflation is an indicator of macroeconomic stability and creates an environment conducive for investment.

Khan and Rana (2012) using empirical evidence from a large panel data of 104 countries over the period of 1971-2010, investigate the effect of inflation and its volatility on human and capital accumulation. The empirical results based on the instrumental variable 2SLS model show that inflation enhances the accumulation of physical capital, while it reduces the accumulation of human capital. The empirical findings further show that, certain macroeconomic developments i.e financial development and trade openness can increase the sensitivity of the relationship between inflation and capital accumulation. According to the findings, it is not only the average level of inflation that is always problematic for capital accumulation but the variability of inflation.

Yilmazkuday (2012) investigate the threshold of inflation for certain covariates of growth i.e financial development, government size, capital accumulation and trade openness etc. The study shows that, among the other channels, the positive effect of capital accumulation on growth is present (only) when inflation is below 15%. The effect of capital on growth becomes insignificant when inflation crosses this level. The study, however, ignores the direct effect of inflation on capital accumulation.

From the fairly large volume of literature, it appears that the findings of empirical studies on the effects of inflation and inflation volatility on investment are non-conclusive for the developing countries, hence warranting further empirical investigations.

3. METHODOLOGY

3.1. Model Specification

The model for this study is a modified version of the model previously used by Varvarigous (2008). The modification becomes necessary in order to examine inflation and inflation variability on real gross domestic investment. The model is specified functionally as:

INV = f(INF, VINFL, RINT, REXR, GRGDP) (13)

Where INV = real gross domestic capital formation (measured as gross fixed domestic investment to GDP percent)

INF= Inflation rate (measured as annual growth rate of the consumer price index)

INFV = Inflation volatility (The Generalized Autoregressive Conditional Heteroskedasticity (GARCH is used to generate inflation volatility from quarterly inflation rate

RINT = real interest rate (Nominal Interest rate/Consumer Price Index

REXR = real exchange rate (Nominal Exchange Rate /Consumer Price Index

GRGDP = growth rate of real GDP (a measure of real output growth)

The econometric form of the model is then specified as:

$$INV = \alpha_0 + \alpha_1 INF + \alpha_2 VINF + \alpha_3 RINT + \alpha_4 REXR + \alpha_5 GRGDP + \varepsilon_t \quad (14)$$

Where $a_0 - a_6$ are parameters to be estimated and ε is the error term.
Apriori expectation α_1- α_4 ; $\alpha_5 > 0$

3.3. Data Sources and Estimation Technique

Quarterly data spanning the period 1986Q1 2015Q4 is used for the study. All the relevant data are obtained from the Central Bank of Nigeria (CBN) Statistical Bulletin (various issues). The instrumental variable method is employed to examine their relationship between inflation, inflaton volatility and investment in order to avoid the problem of potential endogeneity between the regressand and regressors. The volatility equation follows the Generalized Autoregressive Conditional Heteroskedasticity (GARCH) technique.

4. EMPIRICAL RESULTS AND ANALYSIS

The empirical analysis of this study involves three processes. The first stage is the estimation of the GARCH model in order to determine the existence and extent of inflation volatility. Next, we perform the Haussman preliminary test of endogeneity for inflation volatility. Finally, the econometric estimation of the final gross capital formation model is done using instrumental variable (i.e two-stage least squares-2SLS) technique since OLS estimates will be biased and inconsistent.

4.1. The GARCH Analysis

The result of the volatility behaviour of inflation growth is estimated within a GARCH framework in which certain factors are responsible for the mean variations. The resultant GARCH output is reported in Table 1. In the inflation result, the variance equation shows that the ARCH term did not pass the z-test at the 5 percent level (with a critical value of 1.96). However, the GARCH term, with a negative coefficient is significant at the 5 percent. The significance of the term indicates that there is volatility in the system. The negative sign of the GARCH term suggests that volatility may be mitigated after sometime, although there may be a variance, indicating some level of volatility persistence.

Table 1: GARCH Output for Inflation.

Variable	**Coefficient**	**Z-Statistics**
C	40.22702	5.234105
Variance Equation		
C	1014.23	2.190322
ARCH	1.302182	2.133212
GARCH(1)	-0.823140	-12.170230
R-squared= 0.97; Adjusted R-squared=0.96	F-Statistic=14.79687	DW Statistic=

Source: Author's computation (2017).

4.2. Test of Endogeneity

In order to test for possible endogeneity between the inflation and the dependent variable gross fixed capital formation (GCF), the Hausman test of endogeneity is employed. As explained in the previous chapter, this test requires that the error terms or residuals from the GARCH estimation of the instruments of inflation be obtained and included in the baseline estimation of the investment equation. The result of the Hausman test for the inflation is reported in Table 2

below. The results report highly impressive goodness of fit, including the D.W statistic value of 1.83, which underscores the appropriateness of the estimation. Indeed, all the coefficients of the explanatory variables are significantly different from zero. In particular, the coefficient of the inflation rate variable and inflation volatility residual are significantly different from zero at the 5 percent level; implying the rejection of the hypothesis of non-endogeneity between GFC and inflation instability. This clearly shows that endogeneity bias exists between GFC and inflation volatility, thus necessitating the adoption of a dynamic estimation approach.

Table 2: Hauassman Test of Endogeneity Bias for Inflation Instability

Variable	**Coefficient**	**T-ratio**	**Probability**
C	-11010.150	-0.970	0.332
RINT	0.7034.262	2.983	0.003
REXR	-1.702.442	-3.142	0.002
INF	-0.0424	-2.240	0.033
VINF	-0.28202	-2.174	0.041
GRGDP	1.28824	4.431	0.000
R-squared=0.98 Adjusted R-squared=0.96	F-Value= 426.223	DW Statistic= 1.83	

Source: Author's computation (2017).

4.3. Gross Capital Formation Model

The final result for Gross Capital Formation (Gross fixed domestic investment) in Nigeria is reported in Table 3 below. Gross capital formation is instrumented by its first lag as well as inflation and real exchange rate.

In the results, the R-squared value of 0.984 and its adjusted counterpart clearly indicate that the model has a high explanatory power, as over 98 percent of the systematic variations in GFC is explained by its explanatory variables.

Table 3: 2SLS Estimation of Gross Capital Formation Model (GCF)

Variable	**Coefficient**	**t-Statistics**	Probability
RINT	0.0337	2.0112	0.044
REXR	-0.0493	-4.4803	0.000
INF	-0.1117	-2.3375	0.000
VINF	-1.9730	4.2133	0.000
GRGDP	1.1752	4.6025	0.000
R-squared=0.983 Adjusted R-squared=0.982	F-statistic=1014	DW Statistic=1.92	

Source: Author's computation (2017).

An examination of the 2SLS regression results show that the model explains over 98% of the systematic variation in gross domestic investment. This is an indication of high explanatory power of the model. The F-statistic of 1014 passes the significance test at the (less than) 1% level; a confirmation of the reliability of the explanatory power of the model, and validating the hypothesis of a significant linear relationship between gross capital formation and its explanatory variables. The D.W-statistic of 1.92 indicates the absence of autocorrelation in the model, making, the model reliable for policy analysis and forecasting purposes.

The estimated coefficients of the explanatory variables indicate the total effects of change in the explanatory variables on gross capital formation. Specifically, the sign of the coefficient of real interest rate (RINT) conforms to theoretical postulation and is statistically significant at the 5% and 1% level. The positive coefficient gives credence to the McKinnon-Shaw hypothesis in which rising interest rates stimulates savings, and the mobilization of savings for higher investment. Real exchange rate (REXR) has a negative coefficient and is significant at the 1 percent level. This implying that rising real exchange rate has a deleterious effect on investment in Nigeria, particularly given the fact that the country is highly dependent on imported capital goods. The coefficients of inflation (INF) and inflation volatility (VINF) are consistent with theoretical expectation; with that of inflation passing the significance test at the 5 percent level, while the volatility counterpart is significant at the 1 percent level. Thus, high inflation rate and its variability have detrimental effect on capital accumulation, particularly through their uncertainty syndrome in investment decisions. The adverse effect of inflation variability on investment is however seen to be higher, given the size of the coefficient and its statistical significance. The finding

corroborates the findings of Bleaney and Greenaway (2001), Patnaik and Joshi (2012) and Khan and Rana (2012).

Finally, the coefficient of growth rate in real economic output (GRGDP) conforms to apriori expectation and is statistically significant at the 1percent level. Thus, rising real output has a positive and significant effect on investment in Nigeria, giving credence to the acceleration theory of investment in which the level of current net investment is determined by the rate of change of national income (output growth).

5. CONCLUSION AND POLICY RECOMMENDATIONS

This study has empirically examined the impacts of inflation and inflation volatility on gross domestic capital formation in Nigeria, and in particular, whether the variability of inflation is more problematic and this respect, poses a more challenging policy issue, for the period 1986-2015. The choice of the estimation period was informed partly the accelerating rates of inflation and inflation variability during the period of study, particularly following the liberalization of exchange rates and interest rates, making it worth studying, and, partly by data availability. Employing the 2SLS Instrumental variable (IV) technique, having obtained the volatility of inflation using ARCH and GARCH process, the empirical findings reveal that high inflation rates, militates against capital formation in Nigeria. The destabilizing (adverse) effect of inflation variability is found to be higher, implying that the stability of inflation is much more important. Real exchange rate is also found to be negatively and significantly related to gross capital formation. Growth in real income on the other hand and real interest rate are both found to have positive and significant effects on investment. Given the empirical findings of this study, the basic conclusion is that low inflation rate, particularly its stability is critical to rapid and sustained investment growth, and hence, economic growth in Nigeria.

Against the backdrop of these findings, the following policy recommendations are advanced:

(i) Implementation of sound and stable macroeconomic policies that will promote investment, particularly with respect to low and stable inflation rates.

(ii) Adoption and implementation of realistic exchange rate and interest policies, as well as ensuring their stability in order to enhance their relevance for investment.

(iii) Real output enhancing policies, especially with respect to increase production and trade capacities.

(iv) Supplementary investment-enhancing fiscal incentives, such as tax holidays, tax concession, tax rebates.

(v) Provision of critical infrastructure such as stable and reliable power supply, ICT, and good road network, e.t.c.

(vi) Supporting sound institutional framework that would enhance investment

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NIGERIA'S SYSTEM WIDE LIQUIDITY CONDITIONS INDEX: ESTIMATION AND FORECAST

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Abstract

Liquidity management lies at the heart of the conduct of monetary policy and remains a sine-qua-non for delivering on central bank's price stability objective amongst others. However, the fluidity of the concept of liquidity and the fact that there is no single unambiguous and universally accepted definition of liquidity conditions across various segments of the financial market, suggests a need to synthesize various indicators of liquidity across financial market segments into a composite Liquidity Condition Index (LCI) that provides a snapshot guide for policy making towards mitigating the impact of adverse liquidity conditions on the functioning of the economy. The study is an attempt to create a systemic LCI for Nigeria, which incorporates the definitions of liquidity through variables that capture the cost of funding, efficacy of financial intermediation, funding through capital markets/international capital inflows and banking system liquidity. It utilises monthly data on interbank rate, banking system excess reserves, computed intermediation efficiency values and market capitalisation/capital inflow to construct the index. The data range (January 2000 to November 2015) covers significant events in the global and domestic economy as well as the Nigerian Banking landscape. The paper utilised the Johansen co-integration technique to estimate aggregate liquidity function, in which the long-run coefficients were applied to the deviations of the LCI drivers to produce the liquidity condition index. The developed LCI was validated as a functional systemic liquidity measuring metric when compared with banking system liquidity conditions and total system credit and thus is a viable instrument for the conduct of monetary policy.

Keywords: Money Demand, Lending, Financial Market, Liquidity Condition Index, Financial Crisis, Financial Intermediation

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1.0 Introduction

Efficient liquidity management process lies at the heart of the conduct of monetary policy, as the Central Bank's ability to optimally manage liquidity conditions in the economy remains a sine-qua-non for delivering on the price, exchange rate, growth and other macroeconomic objectives.

On the one hand, the presence of excess liquidity undermines the use of monetary policy for stabilisation purposes, as the required reserve ratio and the money multiplier lose their potency for controlling money supply, with the attendant inflationary risks. On the other hand, an unexpected tightening of liquidity surges money market rates, which drags investment spending, with attendant impact on growth performance and the credibility of monetary policy at large (see Saxegaard (2006), Agenor et.al (2004), Khemraj (2009); amongst others).

The efficient implementation of monetary policy operations and the stability of financial institutions and markets have necessitated Central banks' strong interest in systemic liquidity. These issues become very relevant for the Central Bank of Nigeria, given that despite the barrage of instruments in the CBN's monetary policy toolkit for tracking and controlling liquidity conditions in the economy, Nigeria remains one of the countries where excess liquidity control remains a challenge to monetary policy management.

This scenario is further exacerbated by the fact that the conduct of monetary policy in the Bank is often being accompanied by controversial debates on the adequacy or otherwise of monetary conditions. These inadvertently result from different concepts and understanding of excess liquidity, often from employing differing metrics of monetary conditions, such as interest rates, credit and money aggregates. Given the fluidity of the concept of liquidity and the fact that, in the words of Baker (1996), "….there is no single unambiguous and universally accepted definition of liquidity conditions across various segments of the financial market", there is therefore a pressing need to synthesize various indicators of liquidity across financial market segments into a composite liquidity index that provides a snapshot guide to inform policy making towards mitigating the impact of adverse liquidity conditions on the functioning of the economy. This is a broad departure from existing practice of gauging liquidity by focusing on different dimensions of the financial markets.

The foregoing considerations had informed the pioneering Systemic Liquidity Risk Index (SLRI) constructed by the IMF in the Global Financial Stability Report (April

2011). Subsequent to this, several Central Banks have developed variants of the systemic liquidity index (SLI) to monitor liquidity trends in the economy. This study thus represents a step in the same direction for the Nigerian economy. The paper is organized in seven sections; following the introduction is the review of country experiences in Section 2. Sections 3 and 4 discuss the theoretical foundation and methodology adopted, respectively. Section 5 focuses on model specification, estimation and interpretation of results while section 6 presents the forecast of SLI for the Nigerian economy. Section 7 concludes the paper.

2.0 Country Experiences in System-Wide Liquidity Index

India

Mishra et al (2012) attempted to develop a systemic liquidity index for the Indian financial market as well as validate its usefulness as an indicator for policy purpose. The study equated systemic liquidity in the financial system to liquidity scenario in the entire banking sector, non-banking financial services sector, the prevailing foreign currency liquidity and the corporate sector. Additionally, it took cognisance of the fact that present need for holding liquidity is subject to the expectation of fund availability and their future rates. The study utilised four liquidity indicators which were synthesised into a systemic liquidity indicator. The indicators are: (a) Weighted Average Call Rate – RBI Repo Rate, (b) 3 month CP Rate – 3 month CD Rate, (c) 3 month CD Rate – 3 month Implied Deposit Rate and (d) Weighted Average Call Rate - 3 Month OIS Rate.

In order to construct the index, the paper utilised four normalisation approaches which were then weighted and summed to arrive at the systemic liquidity indicator for India. The normalisation approaches include: (a) Relative distance, (b) Standard Normal or Variance-Equal, (c) Ranks – Percentile and (d) Principal Component Analysis (PCA). The paper opted for the variance-equal method for India based on its performance as it largely explained the episodes of liquidity excesses/shortages in the market. Further, the authors validated the performance of the index vis-à-vis developments in deposit and credit growth of the banking sector. The Systemic Liquidity Index (SLI) developed in India adequately tracked funding liquidity conditions relative to the price of liquidity (i.e. call rate which signals liquidity conditions of banks and primary dealers alone) and it adjusted for changes call rate owing to changes in policy rates rather than change in liquidity conditions.

The performance of the SLI was validated by analysing its relationship with the liquidity Adjustment facility which is used by the Reserve Bank of India to adjust daily liquidity conditions of the commercial banks and financial market dealers.

The result suggests that when SLI indicated tight liquidity conditions in the financial market, the quantum of funds availed by the RBI to banks would increase, while banks were engaged in reverse repo transactions with the RBI, when there was liquidity surfeit.

United States of America

M.D. Flood et al (2014) examined the Macroeconomic Patterns in System-Wide Liquidity Regimes in U.S. corporate equities. The study investigated statistical commonalities in liquidity across financial markets (stocks, bonds and commodity futures) to explain systemic patterns in aggregate or funding liquidity, that originate from broad patterns in market liquidity. The study applied Bayesian estimation of Hidden Markov Chain (HMC) to measure latent structure of liquidity. The HMC was applied to build up on granular liquidity measures across the markets in estimating the latent structure governing liquidity at the system-wide level. The paper leveraged on Kyle and Obizhaeva [2014] "invariant" Price-impact measures of responses to order flows that are readily comparable across a broad range of financial markets and conditions. Based on this approach, three latent regimes were discovered corresponding to high, medium and low price impact that described market liquidity conditions. By focusing on equities market, the study indicated that the latent state provided significant economic explanation to developments in liquidity levels in the markets studied.

Canada

The Bank of Canada, being the first central bank to build a monetary condition index (MCI) operationalized it towards setting its monetary policy target. The Bank's index is constructed by summing the weighted changes in the nominal 90-day commercial paper interest rate (R) and a nominal G-10 bilateral trade-weighted exchange rate index (E), in this case, the two variables are related to the values in a base year or period. The weight of exchange and interest rates shows the variables' estimated relative effects on Canadian output. In practice, the Bank uses a relative weight of 3 to 1, on interest rate to exchange rate. In order words, an increase of interest rate by one percentage point induces change in the Bank's MCI by three times, as it would lead to a one per cent appreciation of Canadian dollar.

Nigeria

The Central Bank of Nigeria recently developed its Monetary Condition Index (MCI) that informs the monetary authorities of the stance of monetary policy relative to a base year, in order to guide monetary policy decisions. It is a

weighted sum of the changes relative to a base year value in the following indicators:

- 91-day treasury bill rate(R),
- Real exchange rate index (E) and
- real private sector credit

The weights were derived by regressing the indicators on real Gross Domestic Product (GDP) using Vector Error Correction Model. The applicable weights were the coefficients derived from the long run equation in the Johansen framework. The weights reflect their estimated relative effects on Nigerian output.

A change in the index indicates the stance of monetary policy: how 'tight' or 'loose' monetary conditions in an economy are relative to the reference or base period. The Nigerian MCI aims to: (i) provide additional insights on monetary conditions; (ii) serve as potent indicator under a multiple indicator approach such that the contribution of each of the channels of monetary policy transmission to the general monetary condition (beyond the overnight interest rate and or exchange rate) can be evaluated; (iii) provide policy makers with necessary flexibility to respond more appropriately to local and foreign financial markets dynamics; (iv) allow monetary policy authorities the chance to continuously rebalance priorities between output growth and price stability in a flexible and time variant manner depending on the underlying macroeconomic and financial conditions evident in the MCI; (v) help to determine which of the variables (determinants) is more important in influencing monetary condition in a given period; (vi) serve as a leading indicator of price movement and economic activity; (vii) complement the money demand function which lacks precision; (viii) guide monetary policy decisions, using forecasts of MCI through the forecast of its determinants.

3.0 Theoretical Foundation

The context specific nature of the definitions of liquidity necessitates the development of an index which can holistically capture its context specific drivers. Literature identifies fours primary definitions of liquidity[2]; however three definitions were considered for the purpose of the study and they are:

Central Bank/system liquidity – This reflects the ability of the central bank to play its role as lender of last resort. It takes into consideration factors that are not in the

[2] The four definitions of liquidity identified in literature are Central Bank liquidity, Balance sheet liquidity, market liquidity and funding liquidity (Mitra, A.k and Abhilasha, 2012).

control of deposit money banks and directly impact their liquidity. In view of this definition a primary indicator of system wide liquidity is the Reserve money the central bank's monetary base comprising of DMBs deposits with the central bank and currency in circulation. The DMBs deposits comprises of required reserves which is sterilised, other reserves (i.e. excess reserves) and placement funds on the standing deposit window. Given that required reserves are sterilised, excess reserves (EXR) provides a functional indicator of the level of liquidity in the system in particular within the banking sector. In essence it represents additional non-income earning funds available to institutions in the banking system over and above their statutory requirements, to facilitate transactions and provide buffer in the event of unanticipated events (i.e. transactionary and precautionary). Consequently, the paper utilises excess reserves (EXR) as a key indicator of liquidity.

Market liquidity – it captures the ease of trade and conversion of financial assets to liquid cash, with minimal impact on asset prices. In essence the trading position (long or short) in exchange for cash should have an insignificant bearing on asset prices. Financial institutions which are the major players in the financial market trade in financial instruments whose prices are linked to their returns (i.e. interest rates). The most liquid of such markets is the interbank market where fixed and floating interest credit instruments are traded. The prevailing market clearing rate in the interbank market indicates its prevailing liquidity condition, as such the paper utilised the Interbank Rate (IBR) as a component indicator of the system wide liquidity.

Funding liquidity – this relates to the ease at which economic entities secure substantial funding of cash or near cash instruments either through the disposal of assets (fixed and variable assets including stocks) or borrowing. Based on the definition, a liquid economic entity is one that is capable of honouring all maturing and matured obligations as at when due from the maintenance of positive cash flows or possession of substantial cash stock. Private and public sector Corporations can fund their assets either through credit (i.e. loans and issuance of debt instruments) or equity (i.e. issuance of stocks on the stock market). In view of this, the study utilised two indicators for funding outside of banking sector credit namely capital market capitalisation (MCAP) and foreign capital inflow (TCI). A peculiarity of the capital inflow in the Nigerian stock market is such that portfolio flows are invested directly in the purchase of stock on the stock market, which has an impact on market capitalisation. This is evidenced by the high correlation coefficient between the two variables. The paper utilised the variable Intermediation Efficiency (i.e. INTEFF) to capture credit driver for liquidity

funding. INTEFF is the ratio of net domestic credit to total deposit and is measured in percentage (%).

$$INTEFF_t = \frac{NDC_t}{TD_t} \quad (1)$$

Where:

NDC_t = Net Domestic Credit and

TD_t = Total Deposit

In effect INTEFF shows the efficiency of DMBs in converting deposits into credit to create funding liquidity in the economy[3].

4.0 Methodology and Data

The paper borrows significantly from the literature on Monetary Condition Index (MCI) in the computation of the liquidity condition index for Nigeria. Based on earlier discussions, economy wide liquidity is driven by determinants of Central bank/ system liquidity, market liquidity and funding liquidity. These drivers could be proxied by:

1. Excess reserves –the additional non-income earning funds available to institutions in the banking system over and above their statutory requirements, to facilitate transactions and provide buffer in the event of unanticipated events (i.e. transactionary and precautionary).

2. Interbank Rate – which is a rate determined by market participants for the settlement of transactions amongst themselves.
3. Intermediation efficiency – the efficiency of the banking system to create liquidity through credit creation from their deposit base (total deposit base and loanable deposit base).

[3] In view of the fact that Banks are not able to loan out their total deposits due to statutory requirements, an alternative measure of intermediation efficiency (i.e. Actual intermediation efficiency) using Loanable total deposit (i.e. total deposit less statutory requirements) was computed. $AINTEFF_t = \frac{NDC_t}{(TD_t - RR_t)}$

4. Stock market capitalization/Total Capital Inflow – the funding of operations through the issuance and sale of equity or capital inflows from abroad in direct capital investment in a firm or for the purchase of shares in a firm.

Ultimately, the measure of liquidity within the system is the stock of money available in the system to facilitate transactions necessary to propel an economy on to a desired growth path[4]. Consequently, the stock of money is expected to be driven by excess reserves, settlement rate, efficiency in credit creation and inflows to fund production from the capital market. In line with the literature on MCI (Peng and Leung, 2005), the impact of the drivers on system liquidity represented by Stock of Broad money (M2) can be represented as follows:

$$M2_t = f(exr_t, mcap_t, \text{int}eff_t, ibr_t) \quad (1)$$

$$M2_t = f(exr_t, tci_t, \text{int}eff_t, ibr_t) \quad (1a)$$

$$M2_t = exr_t^{\beta_2} * mcap_t^{\beta_3} * \text{e}^{(\beta_1 + \beta_4 \text{int}eff_t + \beta_5 ibr_t + \varepsilon_t)} \quad (2)$$

$$M2_t = exr_t^{\beta_2} * \text{tci}_t^{\beta_3} * \text{e}^{(\beta_1 + \beta_4 \text{int}eff_t + \beta_5 ibr_t + \varepsilon_t)} \quad (2a)$$

Taking the log of equation (2) and (2q), we can derive the log-linear equation represented by equation (3) & (3a).

$$Log(M2_t) = \beta_1 + \beta_2 \log(exr_t) + \beta_3 \log(mcap_t) + \beta_4 \text{int}eff_t + \beta_5 ibr_t + \varepsilon_t \quad (3)$$

$$Log(M2_t) = \beta_1 + \beta_2 \log(exr_t) + \beta_3 \log(\text{tci}_t) + \beta_4 \text{int}eff_t + \beta_5 ibr_t + \varepsilon_t \quad (3a)$$

[4] Han, L and Lee, I.H. (2012) noted that the sum of the financial assets of the non-financial private sector is an effective liquidity measure that proxies the impact of money on the economy from the classical school. Consequently, the paper utilises broad money as a proxy for system wide liquidity in the absence of an accurate measure of the total financial assets of the non-financial private sector of the Nigerian economy. This is premised on the fact that Broad money captures both the liquid and near liquid assets as well as non-near liquid financial assets (e.g. fixed deposits and money market funds). Furthermore, it is the broadest measure of liquidity reported in the CBN's Monetary Survey.

The parameters β_2, β_3, β_4 and β_5 determine the weights of each driver on the liquidity condition index, while ε_t is the error term. The model for the determination of the System Wide Liquidity Condition Index (SWLCI) from the drivers of broad money (M2) is represented by equation (4) and (4a).

$$SWLCI_t = \beta_1 + \beta_2 exr_t + \beta_3 mcap_t + \beta_4 \text{int}eff_t + \beta_5 ibr_t \quad (4)$$

$$SWLCI_t = \beta_1 + \beta_2 exr_t + \beta_3 \text{tci}_t + \beta_4 \text{int}eff_t + \beta_5 ibr_t \quad (4a)$$

An increase in the SWLCI indicates a tightening of liquidity condition, while the opposite is true of a decrease in the SWLCI. However for simplicity of representation and interpretation, the SWLCI is inverted and charted (i.e. the inverse of equation [5] and [5a]), the inversion allows for the reverse interpretation (i.e. An increase indicates surfeit, while a decrease indicates tightness of liquidity in the system). A point increase on SWLCI is equal in impact to liquidity (i.e. broad money [M2]) originating from a percentage point increase in excess reserves, market capitalisation/total capital inflow, intermediation efficiency and interbank rates. Thus the weights are deemed to be elasticity of money supply (i.e. liquidity) with respect to excess reserves, market capitalisation/total capital inflow, intermediation efficiency and interbank rates. The System Wide Liquidity Condition Index $SWLCI_t$ is computed with reference to a base year and its value at a particular time (t) is the weighted sum of the change in excess reserve (exr), Market capitalisation or total capital inflow (mcap/tci), intermediation efficiency (inteff) and interbank rate (ibr) at time t relative to their values in the base year (t = 0).

$$SWLCI(v_{mcap})_t = \delta_{vexr}(exr_t - exr_0) + \delta_{vmcap}(\text{mcap}_t - mcap_0) + \delta_{v\text{int}eff}(\text{int}eff_t - \text{int}eff_0) + \delta_{vibr}(ibr_t - ibr_0) \quad (5)$$

$$SWLCI(v_{tci})_t = \delta_{vexr}(exr_t - exr_0) + \delta_{vtci}(\text{tci}_t - tci_0) + \delta_{v\text{int}eff}(\text{int}eff_t - \text{int}eff_0) + \delta_{vibr}(ibr_t - ibr_0) \quad (5a)$$

The weights attached to the individual drivers (i.e. δ_{vexr}, δ_{vmcap} / δ_{vtci}, $\delta_{v\text{int}eff}$, δ_{vibr}) and dispersion of the drivers from their base year values ultimately determine the SWLCI values. Estimating the weights is the major task in the computation of the SWLCI, as they reflect how changes in policy instruments impact a target policy variable. In the context of the SWLCI, liquidity which is the stock of Broad Money (M2) is the target variable in an effort to actualise the objective of price stability.

In line with the MCI literature, the SWLCI weights were estimated using Vector Error Correction Model (VECM), in which the stock of Broad Money (M2) supply was regressed against the values of the liquidity drivers/indicators (i.e. excess reserves, interbank rate, intermediation efficiency and market capitalization/total capital inflow).

The study utilized monthly Monetary Survey and Analytical Balance sheet data sourced entirely from the Central Bank of Nigeria (CBN) for the period January 2000 to November 2015. The data range covers periods of significant developments in the global and domestic economic as well as in the Nigerian Banking landscape – banking consolidation (2005), adoption of a new monetary policy implementation framework (2006), massive credit expansion (2007), severe liquidity challenges arising from the contagion effect of the Global Economic Crisis (GEC) (2008 – 2009), restructuring of the Banking Model, Quantitative Easing (QE) and considerable liquidity injection by Asset Management Company of Nigeria (AMCON) (2010), steady collapse of oil price (2014) and the operationalization of the Treasury Single Account (TSA) (2015).

The study utilized data on excess reserve and statutory reserves of the Banking system, Broad money supply (M2), Stock Market Capitalisation & Total Capital Inflow, which were transformed by taking the natural logs of their values to ensure that elasticity values were derived from them. In addition, the studies used data on interbank rate as well as construct an index of intermediation efficiency from data on Net domestic credit and total deposit. The choice of interbank rate as the primary cost indicator is on the premise that it is a true reflection of the cost of financial transactions amongst financial institutions, providing a strong indicator of market liquidity in which the key players are financial institutions.

In order to construct the SWLCI, the data was transformed using variance equal weight methodology, and the base year was 2004, in which the index was set at 100. The variance equal weights methodology normalizes the value of each observation relative to the mean and the variance of the sampled observations; this is represented by equation (6).

$$NV(\mathrm{X}_t) = \frac{(\mathrm{X}_t - \overline{X})}{\sigma_x} \qquad (6)$$

Where:

$NV(\mathrm{X}_t)$ = Normalised value of a variable (i.e. X) at time t

X_t = the observed value of a variable (i.e. X) at time t

$\overline{X}$ = the mean of variable X based on observed values in the sample and

σ_x = the variance of variable X based on the observed values in the sample.

Consequently, $NV(\mathrm{X}_{2004}) = 100$ for each of the variables (i.e. EXR, INTEFF, AINTEFF, MCAP, TCI and IBR) used in developing the LCI index.

5.0 Model Specification

The study recognises the fact that system liquidity should be a combination of banking system liquidity as well as other contributors to systemic liquidity. Being that the Banking sector is the primary player in the Nigerian financial market; the SWLCI should be able to isolate its impact and contribution to system wide liquidity. In essence, the SWLCI should allow for the derivation of a sub-index that reflects liquidity condition in the Banking system. In view of this the study produced two liquidity indices, one of which is a subset of the other (i.e. the Banking system liquidity index is a subset of the economy wide liquidity index).

The banking system liquidity index is defined as the weighted impact of deviations in interbank rate (ibr), Excess reserves (exr) and intermediation efficiency (inteff) from their base year levels (t=0) on liquidity. In addition to the determinant of banking system liquidity index, the system wide liquidity index includes capital market capitalization or Total capital inflow to capture how these channels influence liquidity levels (in particular funding liquidity) within the Nigerian economy.

Banking system LCI which is a measure of banking system liquidity is represented by equation (7) & (7a), while the system wide liquidity is represented by equation (5) and (5a).

$$BSLCI(v_{mcap})_t = \delta_{vexr}(exr_t - exr_0) + \delta_{v\mathrm{int}eff}(\mathrm{int}\,eff_t - \mathrm{int}\,eff_0) + \delta_{vibr}(ibr_t - ibr_0) \quad (7)$$

$$BSLCI(v_{tci})_t = \delta_{vexr}(exr_t - exr_0) + \delta_{v\mathrm{int}eff}(\mathrm{int}\,eff_t - \mathrm{int}\,eff_0) + \delta_{vibr}(ibr_t - ibr_0) \quad (7a)$$

The parameters δ_{vexr}, δ_{vmcap} / δ_{vtci}, $\delta_{v\text{int}eff}$, δ_{vibr} are the weights for excess reserves, market capitalization, total capital inflow, intermediation efficiency and interbank rate, respectively. The study derived the weights for the drivers of SWLCI, by estimating the Broad Money (M2) driver equation specified by equation (3) & (3a):

$$Log(M2_t) = \beta_1 + \beta_2 \log(exr_t) + \beta_3 \log(mcap_t) + \beta_4 \text{int}\, eff_t + \beta_5 ibr_t + \varepsilon_t \quad (3)$$

$$Log(M2_t) = \beta_1 + \beta_2 \log(exr_t) + \beta_3 \log(\text{tci}_t) + \beta_4 \text{int}\, eff_t + \beta_5 ibr_t + \varepsilon_t \quad (3a)$$

Where the a priori expectations of the coefficients are:

$\beta_2, \beta_3, \beta_4 > 0$ and $\beta_5 < 0$.

An increase in excess reserves in the banking system signifies that DMBs have liquidity surfeit, consequently a positive relationship exists between the volume of excess reserves and banking system liquidity. An increase in stock market capitalisation signifies that the economy is growing, fundamentally it connotes that firms in the economy are growing and are profitable. This translates into higher stock prices which is a reflection of increased future dividend pay-out to stockholders. The increased dividend pay-out and expectations of future increases in dividend pay-out are in themselves additional income and liquidity to investors and expectation of future increase in their income and liquidity levels. Consequently, the expectation is that there is a positive relationship between stock market capitalisation and system wide liquidity. Likewise, an increase in capital inflows into the economy in the form of direct or portfolio investments in the capital or shares of firms provides a source of funding for operations. This additional funds increase the balance sheet of the benefiting firms and their cash balances, translating to increased liquidity position. Consequently, a positive relationship exists between total capital inflow and system liquidity.

Intermediation efficiency represents the ability of DMBs to create credit using their deposit base. In view of the fact that what is practiced is fractional reserves banking, the higher the ratio, the more efficient the banking system is in creating credit. Furthermore, in creating additional credit DMBs increase money supply and thus liquidity. Fundamentally, this helps improve funding liquidity for both households and firms, as such a positive relationship exist between intermediation efficiency and liquidity. Interest rate represents the price of money or near cash financial instruments, in the event that there is a liquidity shortage, economic

agents would be willing to pay a higher price to obtain cash or near cash instruments. The reverse is the case for liquidity surfeit. In view of this, a negative relationship exists between system liquidity and interbank rates.

The study adopted the Johansen Co-integration technique to model the money supply driver equation (3) & (3a) and to estimate the long run coefficients of the liquidity indicators/drivers, which were used as a representation of their weights in the determination of system wide liquidity. The estimated parameters/weights we utilised in computing the system wide LCI.

Summary of the Descriptive Statistics of the Variables

Table 1: Descriptive Statistics

	LM2	LEXR	LMCAP	INTEFF	IBR
Mean	15.66777	11.49872	15.32465	0.872728	11.87042
Median	15.99078	11.79926	15.66481	0.914035	10.82500
Maximum	16.77394	13.62408	16.45655	1.275185	33.26000
Minimum	14.11359	1.098612	13.34695	-0.079529	1.130000
Std. Dev.	0.860884	1.395738	0.925269	0.273607	5.939235
Skewness	-0.367532	-2.730964	-0.747057	-1.209406	0.752924
Kurtosis	1.621573	20.03197	2.272532	4.188573	3.812937
Jarque-Bera	16.87930	2212.783	19.10099	50.23825	20.25507
Probability	0.000216	0.000000	0.000071	0.000000	0.000040
Sum	2600.850	1908.788	2543.892	144.8729	1970.490
Sum Sq. Dev.	122.2851	321.4341	141.2603	12.35203	5820.294
Observations	166	166	166	166	166

Table 1a: Descriptive Statistics

	LM2	LEXR	LMCAP	INTEFF_EX	IBR
Mean	15.66777	11.49872	15.32465	0.963019	11.87042
Median	15.99078	11.79926	15.66481	1.012182	10.82500
Maximum	16.77394	13.62408	16.45655	1.633114	33.26000
Minimum	14.11359	1.098612	13.34695	-0.082013	1.130000
Std. Dev.	0.860884	1.395738	0.925269	0.341622	5.939235
Skewness	-0.367532	-2.730964	-0.747057	-0.657864	0.752924
Kurtosis	1.621573	20.03197	2.272532	3.256306	3.812937
Jarque-Bera	16.87930	2212.783	19.10099	12.42810	20.25507
Probability	0.000216	0.000000	0.000071	0.002001	0.000040
Sum	2600.850	1908.788	2543.892	159.8612	1970.490
Sum Sq. Dev.	122.2851	321.4341	141.2603	19.25641	5820.294
Observations	166	166	166	166	166

Table 1b: Descriptive Statistic

	LM2	LEXR	LTCI	INTEFF_EX	IBR
Mean	15.88999	11.58811	8.852775	0.942490	10.55972
Median	16.15434	11.95015	8.944823	0.988387	10.50000
Maximum	16.77394	13.62408	9.679130	1.633114	33.26000
Minimum	14.46653	1.098612	7.675370	-0.082013	1.130000
Std. Dev.	0.720937	1.458443	0.464190	0.362732	5.089048
Skewness	-0.616621	-2.931166	-0.444458	-0.496546	0.972754
Kurtosis	2.007345	20.31661	2.457856	2.851758	5.889003
Jarque-Bera	14.82864	1977.539	6.414211	5.965224	71.77710
Probability	0.000603	0.000000	0.040474	0.050660	0.000000
Sum	2256.379	1645.512	1257.094	133.8335	1499.480
Sum Sq. Dev.	73.28481	299.9147	30.38164	18.55199	3651.676
Observations	142	142	142	142	142

Table 1c: Descriptive Statistics

	LM2	LEXR	LTCI	INTEFF	IBR
Mean	15.88999	11.58811	8.852775	0.854944	10.55972
Median	16.15434	11.95015	8.944823	0.909540	10.50000
Maximum	16.77394	13.62408	9.679130	1.275185	33.26000
Minimum	14.46653	1.098612	7.675370	-0.079529	1.130000
Std. Dev.	0.720937	1.458443	0.464190	0.289236	5.089048
Skewness	-0.616621	-2.931166	-0.444458	-1.046750	0.972754
Kurtosis	2.007345	20.31661	2.457856	3.620429	5.889003
Jarque-Bera	14.82864	1977.539	6.414211	28.20873	71.77710
Probability	0.000603	0.000000	0.040474	0.000001	0.000000
Sum	2256.379	1645.512	1257.094	121.4020	1499.480
Sum Sq. Dev.	73.28481	299.9147	30.38164	11.79568	3651.676
Observations	142	142	142	142	142

The Jarque-Bera statistics from Table 1 to 1c indicates that the variables are not normally distributed, Broad Money, excess reserves, market capitalization and intermediation efficiency are all negatively skewed (i.e. fat left tail), while IBR is positively skewed (i.e. fat right tail).

Figure 1 shows the trend in log(m2), Log(exr), log(mcap), log(tci), INTEFF, AINTEFF and IBR for the period January 2000 to November 2015. The series seemed to be

volatile. The ADF and PP tests indicate that the series are stationary at first difference except IBR, EXR and TCI.

Figure 1: Developments in LM2, LEXR, LMCAP, INTEFF, AINTEFF, IBR & LTCI

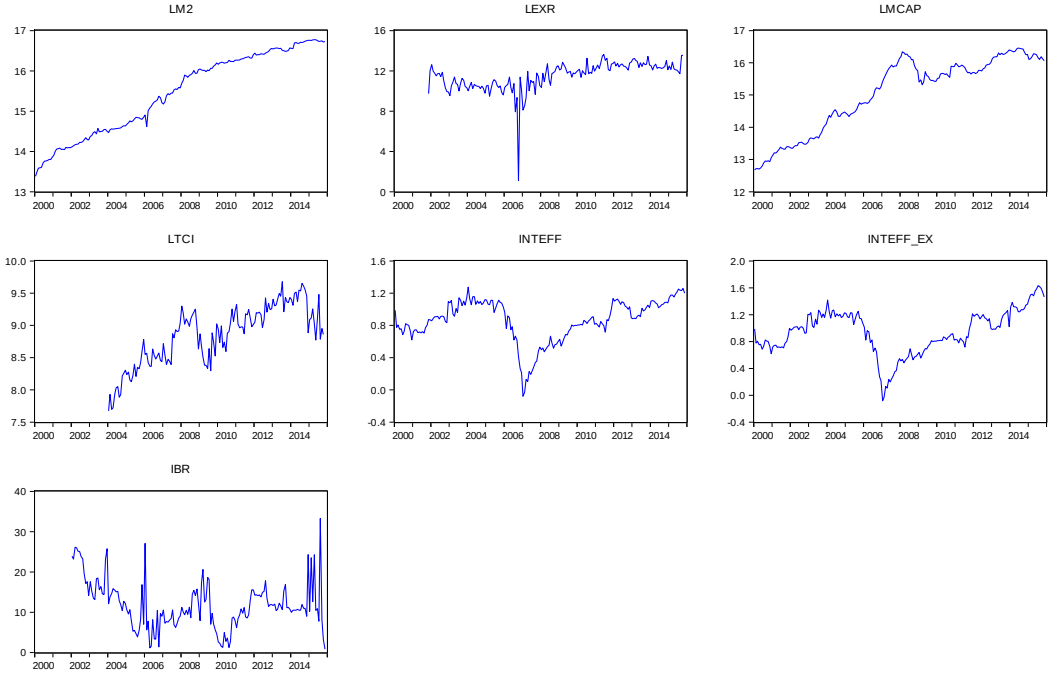


Table 2: Pairwise Correlation coefficient

	IBR	INTEFF	LEXR	LM2	LMCAP	LTCI
IBR	1.000000	0.251082	0.209670	0.150748	0.122487	0.069217
INTEFF	0.251082	1.000000	0.316454	0.172560	-0.117709	0.079411
LEXR	0.209670	0.316454	1.000000	0.673820	0.538137	0.533314
LM2	0.150748	0.172560	0.673820	1.000000	0.887934	0.846666
LMCAP	0.122487	-0.117709	0.538137	0.887934	1.000000	0.873952
LTCI	0.069217	0.079411	0.533314	0.846666	0.873952	1.000000

Table 2a: Pairwise Correlation coefficient

	IBR	AINTEFF	LEXR	LM2	LMCAP	LTCI
IBR	1.000000	0.292528	0.209670	0.150748	0.122487	0.069217
AINTEFF	0.292528	1.000000	0.315444	0.232672	-0.025452	0.131453
LEXR	0.209670	0.315444	1.000000	0.673820	0.538137	0.533314
LM2	0.150748	0.232672	0.673820	1.000000	0.887934	0.846666
LMCAP	0.122487	-0.025452	0.538137	0.887934	1.000000	0.873952

LTCI	0.069217	0.131453	0.533314	0.846666	0.873952	1.000000

The pairwise correlation coefficient indicates that the independent variables are loosely correlated, the highest correlation being between excess reserves (LEXR) and market capitalisation (LMCAP) (i.e. 53.81 per cent) and between excess reserves (LEXR) and total capital inflow (LTCI) (i.e. 53.33 per cent). Market capitalisation and total capital inflow are highly correlated (87.40 per cent), as previously discussed; a significant portion of capital flows is channelled through the capital market in the form of portfolio investments in stocks. Broad money (LM2) is highly correlated with market capitalisation (LMCAP) (i.e. 88.79 per cent) and total capital inflow (LTCI) (i.e. 84.67 per cent).

Presentation & Discussion of results

The results of the unit root tests indicated that all the variables were I(0) (i.e. integrated of order zero) except market capitalization, Broad Money (M2), Intermediation (INTEFF) and Actual Intermediation (AINTEFF) efficiency which were I(1) based on the superior Phillips-Peron test. The results are displayed in table 1. The relevant diagnostic tests were undertaken to validate the inferences on the parameters. The tests indicate that the variables are co-integrated in the long run and that the system was stable[5]. The paper presents the estimated long run coefficients of the drivers based on equation (3) (i.e. using market capitalization) and results using actual intermediation efficiency based on loanable total deposit in table 3 & 3a. The coefficients of the drivers are all significant at the 5 per cent critical levels. The corresponding results based on total capital inflow are presented in the appendix.

Table 3: Result of Unit root Tests

Variables	ADF		PP		Order of Integration
	Level	1st Difference	Level	1st Difference	
IBR	0.0179	0.0000	0.0000	0.0000	I(0)
LM2	0.1935	0.0000	0.0934	0.0000	I(1)
LEXR	0.2664	0.0000	0.0000	0.0001	I(0)
LMCAP	0.1522	0.0000	0.2186	0.0000	I(1)
LTCI	0.1189	0.0000	0.0477	0.0000	I(0)
INTEFF	0.4413	0.0000	0.4748	0.0000	I(1)
AINTEFF	0.6060	0.0000	0.6296	0.0000	I(1)

[5] The regression results and stability tests are available on request from the Authors.

Table 3: Johansen Long run Coefficients - Market Capitalisation & INTEFF

LM2	LEXR	LMCAP	INTEFF	IBR	Constant
	0.409421	0.638116	1.117425	-0.052867	0.822664
	(3.74996)**	(5.07488)**	(3.474364)**	(-2.94524)**	

Note: ** implies that the coefficient is statistically significant at the 5 per cent critical level

Table 3a: Johansen Long run Coefficients - Market Capitalisation & AINTEFF

LM2	LEXR	LTCI	AINTEFF	IBR	Constant
	0.465644	0.543197	0.675256	-0.052875	1.967424
	(5.03726)**	(5.15710)**	(3.21000)**	(-3.15860)**	

Note: ** implies that the coefficient is statistically significant at the 5 per cent critical level

The previous discussion attempts to illustrate the direct linkage between broad money supply (i.e. liquidity) and its drivers (excess reserves, market capitalization/total capital inflow, intermediation efficiency and interbank rate), to facilitate the computation of the SWLCI. This relationship is summarized in table 4 & 4a.

Table 4: Long run Coefficients/SWLCI weights based on Market Capitalisation & INTEFF

	Variables	Coefficients	LCI Weights	Apriori Expectations	Estimated Coefficient/LCI weights
1	Excess Reserves (LEXR)	β_2	δ_{vexr}	$\beta_2 > 0$	0.409421
2	Market Capital (LMCAP)	β_3	δ_{vmcap}	$\beta_3 > 0$	0.638116
2	Intermediation Efficiency (INTEFF)	β_4	$\delta_{vinteff}$	$\beta_4 > 0$	1.117425
4	Interbank Rate (IBR)	β_5	δ_{vibr}	$\beta_5 < 0$	-0.052867

Based on the estimated coefficients, a percentage increase in excess reserves, market capitalisation and intermediation efficiency would induce a 0.41, 0.64 and 1.12 percentage increases in broad money, in the following month. However, a percentage increase in interbank rate would result in a 0.05 per cent decrease in money supply in the following month.

Table 4a: Long run Coefficients/SWLCI weights based on Market Capitalisation & AINTEFF

	Variables	Coefficients	LCI Weights	Apriori Expectations	Estimated Coefficient/LCI weights
1	Excess Reserves (LEXR)	β_2	δ_{vexr}	$\beta_2 > 0$	0.465644
2	Market Capital (LMCAP)	β_3	δ_{vtci}	$\beta_3 > 0$	0.543197
2	Intermediation Efficiency (INTEFF)	β_4	$\delta_{v\text{int}eff}$	$\beta_4 > 0$	0.675256
4	Interbank Rate (IBR)	β_5	δ_{vibr}	$\beta_5 < 0$	-0.052875

Based on the estimated coefficients, a percentage increase in excess reserves, market capitalisation and actual intermediation efficiency would induce a 0.57, 0.54 and 0.68 percentage increase in broad money, in the following month. However, a percentage increase in interbank rate would result in a 0.05 per cent decrease in liquidity (money supply) in the following month.

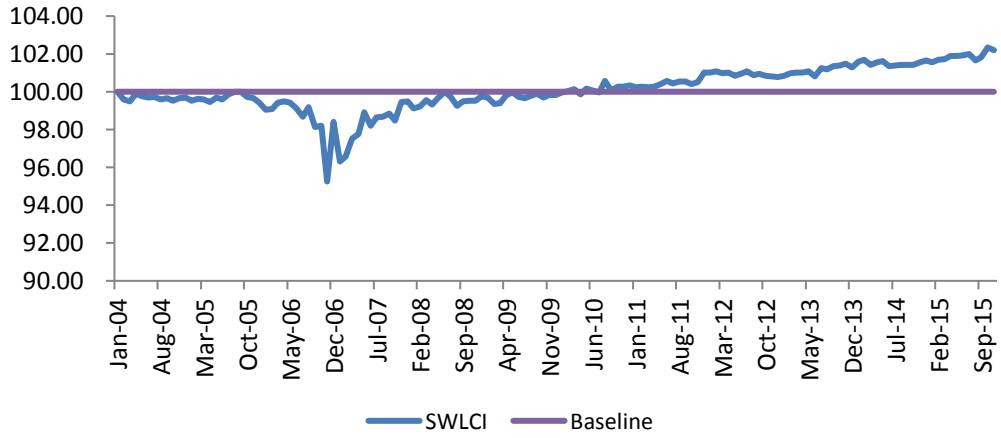
The most dominant driver of liquidity is intermediation efficiency which suggests that the credit channel has the greatest impact on driving liquidity in Nigeria. The impact of capital market/total capital inflow ranks second indicating that equity funding (either through new issuance or inflow of funds from abroad) has a significant impact on liquidity conditions in Nigeria. The result highlights the role of capital market funding of economic activities (outside of debt funding) in Nigeria. The diagnostic statistics validate the functional form, stability and model specification. The variables are all statistically significant at the 5 per cent critical level. The SWLCI is influenced by the combined impact of the interaction of the weights of the variables to their respective changes relative to the base year. In essence, deviations of the variables from the base year values are weighted using their estimated coefficients in the computation of the SWLCI.

Significantly, the results indicate that intermediation efficiency is reduced (i.e. from 1.117425 to 0.675256) once statutory reserves is accounted for, thus

suggesting that statutory requirements (i.e. Cash Reserves Ratio and Liquidity Ratio) are practical and effective instruments in moderating system liquidity in periods of liquidity surfeit. Additionally, it gives credence to the policy of utilizing sterilized statutory funds for the provision on loanable funds to the real sector. These additional funds would increase financial intermediation along the value chain of the targeted sectors of the real economy and help sustain overall growth of the economy.

The study used January 2004 as the Base year, due to the observation that the index was relatively stable between 2004 and 2005. Furthermore, it was a period of monetary policy stability, prior to the consolidation exercise in 2005.

Figure 2: System Wide Liquidity Condition Index (January 2004 - November 2015)



Note: January 2004 is the base year with an index value of 100

Figure 2 shows that system liquidity was relatively stable between 2004 and 2005, though liquidity condition was tight. Following the consolidation exercise, overall systemic liquidity became relatively tighter, though credit to private sector increased slowly and gradually between December 2005 and January 2007. The level of net domestic credit declined considerably as the government became a net creditor to the banking system, this situation was particularly severe between November 2006 and January 2007 (i.e. NDC took negative values, which in the context of the index signifies liquidity shortage. Figure 3 illustrates the developments in NDC, credit to government and private sector. It shows that post consolidation; there was an initial sluggish growth in credit to private sector, however government was a net creditor to the system and this moderated net

domestic credit in the period June 2006 – February 2007. This point is further highlighted in figure 3a.

Figure 3: Stock Market Capitalisation, Net Domesti Credit, Net Credit to Government & Private Sector (January 2000 - November 2015)

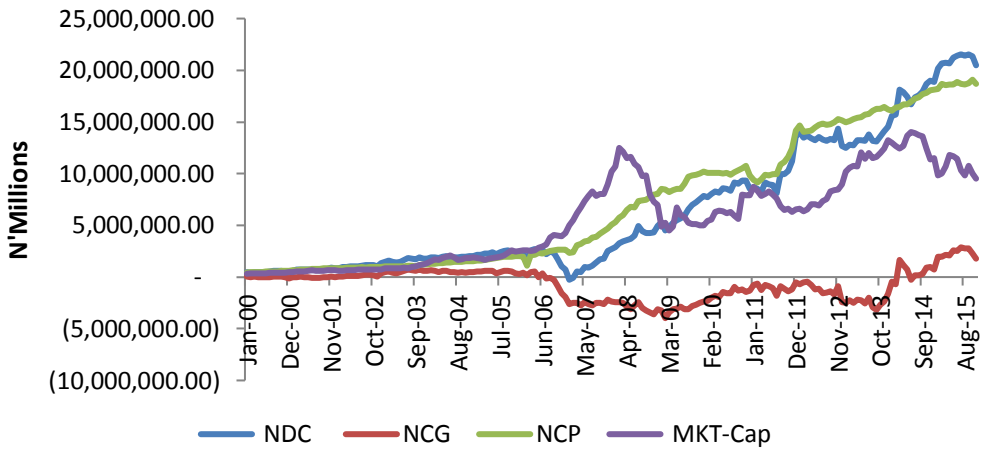
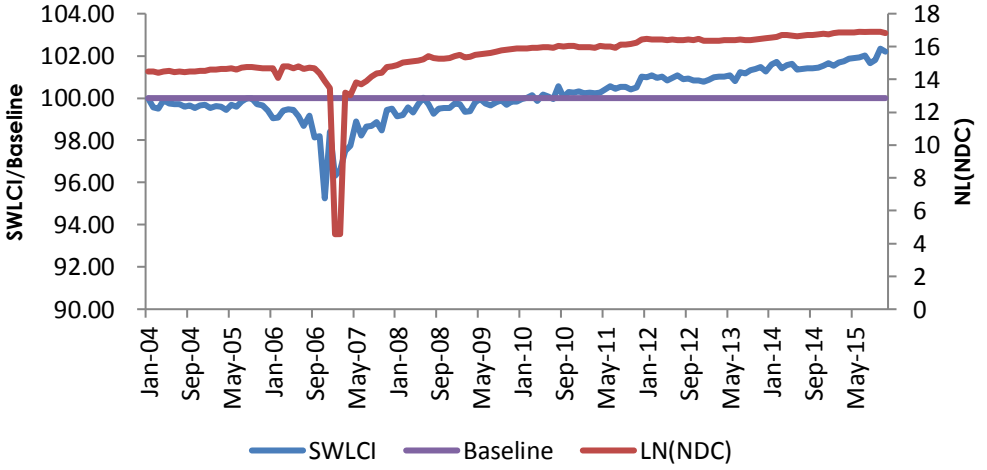


Figure 3a: Developments in Net Domestic Credit and System Wide Liquidity Condition Index (January 2004 - November 2015)



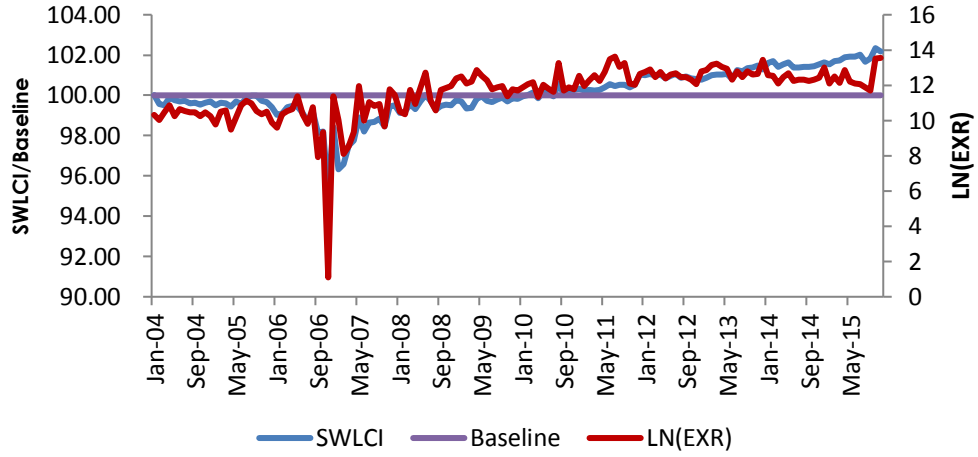
There was a subsequent explosion in credit to the private sector from mid-2007 up until the onset of the Global Economic Crisis (GEC) in late 2008. This culminated in a steady improvement in liquidity condition in the economy as the index steadily increased from mid-2007 to late 2008. There was also a significant explosion in stock market activities associated with margin lending facilities and improved profitability of listed firms particularly in the banking sector. Liquidity conditions

tightened in the early part of 2009 due to the initial impact of the GEC crisis and a significant plunge in market capitalisation, however this was eased due to quick intervention on the part of the CBN with measures to restructure the Banking sector, injection of funds to distressed DMBs, purchase of toxic assets and injection of liquidity into the system by AMCON as well as other real sector intervention programmes. The implication of this was that liquidity conditions changed significantly from being tight in 2009-2010, to being in surfeit by early 2012. In addition to this, there was a steady rise in market capitalisation between mid-2009 and third quarter of 2011, when it steadily dipped before recovering in early 2012. Liquidity conditions began tightening up by early 2012 until mid-2013, as NDC flattened, though this was moderated by the recovery in stock market capitalisation.

Credit conditions improved significantly from mid-2013 till the end of first quarter of 2014, largely driven by expansion of credit to government. Likewise, stock market capitalisation increased during the same period. The combined effect of increase in NDC and stock market capitalisation, helped improve liquidity conditions. There however was a slight dip in NDC owing to a decline in credit to government between April 2014 and June 2014, its impact on liquidity was moderated by the increase in market capitalisation up until July 2014. Though stock market capitalisation plunged from August 2014 till end of 2015, with a slight recovery in April 2015, its adverse impact on system liquidity was moderated by the steady rise in NDC occasioned by credit expansion to government. Credit expansion to government slowed down by mid-2015, this in conjunction with the decline in market capitalisation resulted in worsening liquidity conditions as the index began declining by end of 2015.

Figure 4 shows the developments of the system wide liquidity index and an indicator of liquidity conditions in the economy - banking system excess reserves. It can be observed that the indicator closely tracks the development in banking system liquidity in Nigeria for the study period, suggesting that the SWLCI is a good indicator of the direction of liquidity conditions in the economy.

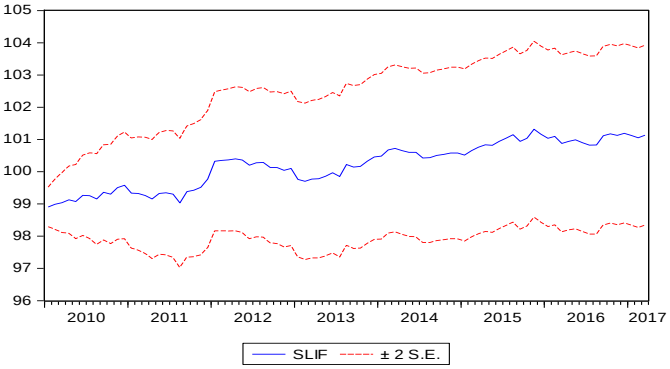
Figure 4: Developments in System Wide Liquidity Condition Index & Excess Reserves (January 2004 - November 2015)



6.0 SLI Forecast

A key motivation for the development of the system-wide liquidity index is to provide information on the future trajectory of liquidity in the country and therefore act as a guide to decision makers on policy stance. In pursuit of this goal a Box-Jenkin Autoregressive Integrated Moving Average (ARIMA) specification was set up to forecast the behavior of the system-wide liquidity index for the period 2015:12 – 2017:03. Figure 5 shows the forecast of the SLI from 2010:01 – 2017:03[6].

Figure 5: System Wide Liquidity Condition Index Forecast for January 2010 to March 2017.



Forecast: SLIF	
Actual: SLI	
Forecast sample: 2010M01 2017M03	
Included observations: 87	
Root Mean Squared Error	0.187112
Mean Absolute Error	0.139433
Mean Abs. Percent Error	0.139036
Theil Inequality Coefficient	0.000933
Bias Proportion	0.072000
Variance Proportion	0.006294
Covariance Proportion	0.921706

[6] The forecast models, forecasts evaluation and residual graph were not presented due to space limitation but are available on request.

From figure 5, the SWLCI is expected to be relatively loose in 2016 but tighten in the first three months of 2017 relative to the 2016:12 level if the excess reserves of DMBs, stock market capitalization, intermediation efficiency and interbank rate maintain their current levels over the forecast horizon.

The conventional forecast performance evaluation statistics are reported in figure 5. Theil inequality coefficient is approximately zero indicating that the forecast performance is relative high. Also, if the forecast is good, it is expected to have low bias proportion and variance proportion so that most of the bias is concentrated in covariance proportion. At a glance, the forecast evaluation table in figure 5 shows that the forecast is near perfect fit going by the bias, variance and covariance proportions. Other measure of prediction accuracy, namely, root mean squared error (RMSE), and mean absolute percent error (MAPE) are relatively low and closer to zero than one.

As robustness check, figures 6 and 7 present forecast of SWLCI for a longer and shorter time horizons. As can be observed, the forecast performance is relatively better in the shorter time horizon than the longer. Howbeit, the Theil coefficient and the covariance proportions in all the forecast are fairly satisfactory. The Fan-chart in figure 8 shows that the forecast lies within the bell.

Figure 6: System Wide Liquidity Condition Index Forecast for February 2002 to March 2017.

Forecast: SLIF_3	
Actual: SLI	
Forecast sample: 2002M02 2017M03	
Adjusted sample: 2002M04 2017M03	
Included observations: 180	
Root Mean Squared Error	0.303398
Mean Absolute Error	0.207873
Mean Abs. Percent Error	0.210496
Theil Inequality Coefficient	0.001528
Bias Proportion	0.004350
Variance Proportion	0.019735
Covariance Proportion	0.975915

Figure 7: System Wide Liquidity Condition Index Forecast for January 2014 to March 2017.

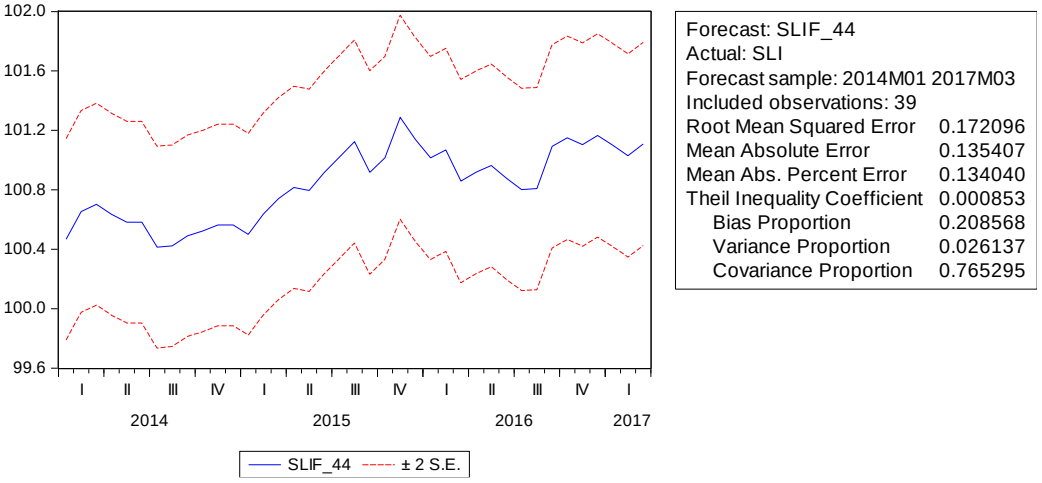
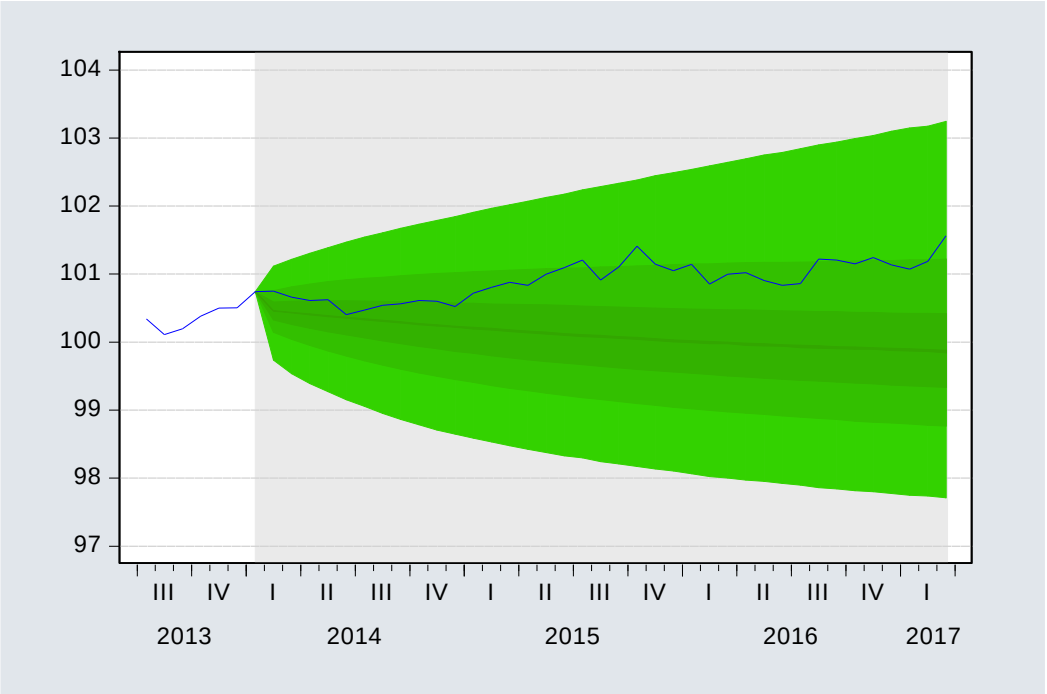


Figure 8: Fan-Chart of the Forecast of SWLCI



7.0 Conclusion

The lessons leant from financial crises all around the globe has highlighted the importance of timely and effective measures of systemic liquidity risk. In response to this, both the academics and financial institutions are devoting great deal of attention at developing tools and models which can be of help in measuring

systemic liquidity risk and system liquidity levels and trend. This paper borrows significantly from the literature on MCI to compute the system wide liquidity condition index for Nigeria and contributes to the strand of the literature on measuring metrics for system liquidity by introducing an indicator of systemic liquidity for the Nigerian economy.

The significant outcome of the paper is that the efficacy of financial intermediation by deposit money banks is the most important contributor to systemic liquidity in Nigeria. It also highlights the importance of capital market in the provision of funding and in driving systemic liquidity in Nigeria, which further validates the need to facilitate the development of an effective capital market as a functional funding source for economic activities outside of debt funding from the banking system. Importantly, the study suggest that the CRR and LR are effective prudential tools that moderate the ability of banks to create credit, as the results show a drop in the coefficient of intermediation efficiency in driving systemic liquidity from 1.12 per cent to 0.68 per cent, once required reserves are sterilized from total banking system deposit. It also suggests that the recent policy enabling DMBs to generate loanable funding for real sector activities using 5 per cent out of the 25 per cent of their sterilized CRR funds is expected to increase economic activities as well as system liquidity. The functional efficacy of the SWLCI metrics for a measurement of systemic liquidity in Nigeria was validated using data on excess reserves as well as net domestic credit of the banking system.

In concluding, the paper has shown that it is possible to generate an effective and functional metric for measuring system liquidity in Nigeria, which can be used to forecast systemic liquidity trend, therefore the SWLCI is recommended to management as an effective tool to facilitate efficient monetary policy formulation and implementation that would help the CBN deliver on its key objective of price stability.

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Appendix

Summary of results for regression based on TCI and INTEFF

LM2	LEXR	LTCI	INTEFF	IBR	Constant
	0.574241	1.111232	1.221296	-0.147584	-0.117910

	Variables	Coefficients	LCI Weights	A priori Expectations	Estimated Coefficient/LCI weights
1	Excess Reserves (LEXR)	β_2	δ_{vexr}	$\beta_2 > 0$	0.574241
2	Total Capital Inflow (LTCI)	β_3	δ_{vtci}	$\beta_3 > 0$	1.111232
2	Intermediation Efficiency (INTEFF)	β_4	$\delta_{vinteff}$	$\beta_4 > 0$	1.221296
4	Interbank Rate (IBR)	β_5	δ_{vibr}	$\beta_5 < 0$	-0.147584

Based on the estimated coefficients, a percentage increase in excess reserves, capital inflow and intermediation efficiency would induce a 0.57, 1.11 and 1.22 percentage increase in broad money, in the following month. However, a percentage increase in interbank rate would result in a 0.15 per cent decrease in money supply in the following month.

Summary of results for regression based on TCI and AINTEFF

LM2	LEXR	LTCI	AINTEFF	IBR	Constant
	0.702833	0.823816	0.858762	- 0.137457	1.070384

	Variables	Coefficients	LCI Weights	A priori Expectations	Estimated Coefficient/LCI weights
1	Excess Reserves (LEXR)	β_2	δ_{vexr}	$\beta_2 > 0$	0.702833
2	Total Capital Inflow (LTCI)	β_3	δ_{vtci}	$\beta_3 > 0$	0.823816
2	Actual Intermediation Efficiency (AINTEFF)	β_4	$\delta_{vinteff}$	$\beta_4 > 0$	0.858762
4	Interbank Rate (IBR)	β_5	δ_{vibr}	$\beta_5 < 0$	- 0.137457

POLICY REFORM AND TOTAL FACTOR PRODUCTIVITY GROWTH IN THE NIGERIAN BANKING SECTOR

Olele, Hilda Enoh

Abstract

The emphasis in this paper is to establish the existence or otherwise of (in)efficiency in the Nigerian banking sector which warranted the prescribed 2004 Soludo-led consolidation policy action using the non-parametric technique of data envelopment analysis. Employing data for ten of the consolidated banks spanning 1993-2013, Malmquist indices were computed for the sector. Findings revealed that inefficiencies actually existed in pre-consolidated Nigerian banks which however showed improvement after the implementation of the consolidation policy, thus strengthening the worthiness of the policy. Overall, the post consolidated banking sector in Nigeria was also found to be more efficient as far as total factor productivity and its components were concerned.

Keywords: Consolidation, Policy, Banks, Technological change, Total Factor Productivity.

JEL classification G18 G28 G21 O3 D24

1.0 Introduction

The financial liberalization program that was implemented from the mid 1980's, saw the Nigerian financial system undergo important structural, institutional and legal changes amongst which are the elimination of direct credit policies, liberalization of deposit and loan interest rates, deregulated exchange rate policies, relaxation of entry barriers, adoption of international best standard banking regulations, etc; which fostered competition in the financial services industry and created an accelerated global integration of the economy.

However, by the year 2004, the Nigerian banking industry was largely described as fragmented into fairly small, weakly capitalized banks with most banks posting paid up capital of US$10 million or less with the capitalized bank having US$240 million compared to a small developing economy like Malaysia where the least capitalized bank recorded US$526 million within the same period. Ebong (2006) further described the system as exhibiting other features like low capital base, high non-performing loans, over dependence on public sector deposits, insolvency and illiquidity, poor asset quality, a system with low depositors' confidence, weak corporate governance and a banking sector that is unable to support the real sector of the economy at 25% of GDP compared to African average of 78% and 272% for developed countries. Available evidence also

showed that there has been a consistent rise in the number of failed banks regardless of the several reforms undertaken since 1987.

Soludo (2004) observed that the system faced massive challenges which, if not urgently addressed, could snowball into a crisis in the not so distant future. In order to address these issues and to reposition the banking system to meet up with global standard, the monetary authority arrived at a 13-point reform agenda directed at consolidation and recapitalization of the banking system. In a bid to address the identified snags, the Central Bank of Nigeria (CBN) came up with a ten-year reform blueprint hinged on four cardinal reform programmes which includes establishment of financial stability, enhancing the quality of banks, enabling healthy financial sector and ensuring that the financial sector contributes significantly to the real economy. The achievement of these resulted in the 2004 Soludo-led consolidation policy reform which raised the required minimum capital base of money deposit banks from two billion naira (₦2 billion) to twenty-five billion naira (₦25 billion). This policy action led to the attenuation of banks from 89 to 25 in 2005 through mergers and acquisition. At end of 2012, the number of banks had further condensed to about 20 still within the reform agenda of the industry (International Monetary Fund (IMF), 2013 Country Report).

In the literature however, there seem to exist conflicting results on the impact of policy reform on efficiency of the banking sector. Some scholars reported a decline in efficiency after reform (Poloamina et al 2014, Okpara 2011, Hardy and Patti, 2001) and yet some others reported increase in efficiency after adoption of reform (Okorie and Agu 2015, Obafemi 2012, Iganiga, 2010 Ahmed et al. 2009 Olaosebikan 2009). However, very few studies analyzed efficiency using non-parametric tools in the Nigerian banking sector. An assessment of existing studies in Nigerian banking sector that has employed non-parametric approach of data envelopment analysis revealed that most of the studies merely computed efficiency score for the sector (Obafemi 2012, Okorie and Agu 2015) while Poloamina et al. (2014) decomposed productivity into its various components within the period 2001-2008 with a pooled observation of 120 sample points; a period considered too close to the reform era for effective evaluation.

The enactment and subsequent implementation of the consolidation policy is an obvious invitation to queries. It therefore became imperative for policy and research concerns to determine the existence or otherwise of inefficiency which would have imploded in the industry to warrant the prescribed policy measure, not only to avoid the perceived systemic failure but how efficiency or inefficiency would have promoted or undermined the soundness of such economic agents in the industry by way of technical progress. In other words, could there have been

(in)efficiency issues in the banking sector that could possibly be attributed to total factor productivity or any of its components to justify the worthiness of the prescribed policy? This study is therefore designed to resolve the identified gaps and provide answers to these questions. The paper is structured into six parts. Following the introduction is section two on stylized facts in the Nigerian banking sector and section three presents a survey of literature. Sections four and five describe the method of analysis adopted and analysis of results respectively while section six concludes the paper.

2.0 Stylized Facts on the Nigerian Banking Sector

The development of banking institutions in Nigeria started in 1894 with the opening of a branch of the African Banking Corporation which was later absorbed by the British Bank for West Africa (BBWA), now First Bank of Nigeria Plc in that same year. The thriving indigenous banking of the 1930s and 1940s presaged the emergence of Nigerian owned banks and interests of native entrepreneurs in bank ownership. There were however, massive failures of aboriginal banks towards the end of the 1940s and 1950s due basically to banks' liquidity. Banks then, had inadequate liquid assets to meet up with their obligation to customers, coupled with a financial system that was not well organized and it was also plagued with insufficient financial instruments to invest in. Hence, banks merely invested in real assets which could not be effortlessly converted to cash without loss of value when needed.

This development prompted the Federal Government then, backed by the World Bank Report to constitute the Loynes Commission in September 1958 which culminated in the promulgation of the Central Bank of Nigeria (CBN) Act of 1958, establishing the CBN which began business in July 1959 ushering in the first era of consolidation (1959 – 1969) in the Nigerian banking industry. 1959 was remarkably significant in the history of the Nigerian Banking sector not just because the Central Bank of Nigeria (CBN) was established, but the enactment of the Treasury Bill Ordinance which ultimately resulted in the issuance of the first treasure bill in April, 1960.

The period 1959 -1969, marked the establishment of formal money, capital markets and portfolio management and, the enactment of the 1968 Company Acts in Nigeria. This period is usually referred to as the beginning of serious banking regulation in Nigeria. The operation of the CBN during this period led to the pegging of the minimum paid-up capital at ₦400, 000 (USD$480,000) in 1958. The universal banking policy which was implemented in January 2001, brought the status of the banking sector in Nigeria to a fully deregulated one, merging the

operation of commercial and merchant banks in preparation towards the consolidation policy reform in 2004.

The proliferation of banks in the '90s gave rise to ailing and/or failure of many banks leading to another recapitalization exercise that led to the banks' capital being raised to ₦500 million (USD$5.88 million) and subsequently to ₦2 billion (US$0.0166 billion) in 2003-2004 when the universal banking policy was taken up and finally to ₦25 billion (US$ 0.2 billion) on 4th July 2004, accompanied by a 13-point reform agenda targeted at addressing the fragile nature of the banking system, stop the boom and burst cycle that had become a distinctive feature of the sector and evolving a banking system that not only could serve the Nigerian economy, but also the regional and global economy. The Nigerian monetary authorities' agenda was that which will consolidate the Nigerian banks and make them competent to play in the international financial system with international best practice. However, there appears to be divergence between the state of the Nigerian banking industry vis-à-vis the vision of the government and regulatory authorities for the industry. This in essence, was the aim of the mandatory consolidation policy, which was closed to dialogue with components that see solidly cast in concrete.

In terms of number of banks and minimum paid-up-capital, between 1952- 1978, the banking sector recorded forty-five (45) banks with changeable minimum paid-up capital for commercial and merchant banks while 1979-1987 recorded fifty-four (54) banks. The number of banks rose to 112 during the period 1988-1996 with substantial varying increase in the minimum capital and 110 between 1997-2002 with yet another increase in minimum paid-up capital and finally to twenty-five (25) in 2004 with a whooping increase in minimum paid-up capital from ₦2 billion (US$0.0166 billion) in January 2004, to ₦25 billion (USD$0.2 billion) in July 2004.

Table 1: Minimum Capital Requirement and Number of Banks in Nigeria (1952 – 2013)

Years	Minimum Capital Requirement	Minimum Capital *US$	Cumulative No of Banks
1952 – 1978	£200,000 – Foreign £25,000 – Nigerian £400,000 Foreign £25,000 Nigerian ₦1,500,000 – foreign ₦600,000 – Nigerian	235,295 29,412 470,588 29,412 1,764706 705882	45
1979 – 1987	₦1,500,000 – foreign ₦600,000 – Nigerian ₦2,000,000 – Merchant Bank	1,500,000 600,000 2,000,000	54
1988 – Feb.	₦ million – Commercial Bank ₦3million – Merchant Bank	250,000 150,000	66
1988 Oct.	₦10million – Commercial Bank ₦6million- Merchant Bank	500,000 300,000	66
11989-1990	₦10million –Commercial Bank ₦12million– Merchant Bank	235,294 141,176	107
1991 – 1996	₦50million –Commercial Bank ₦40million– Merchant Bank	586.235 470,588	110
1997 – 2002	₦500million –Comm. Bank ₦500million–Merchant Bank	5.88 million 5.88 million	110
2003 – 2004	₦2billion–Universal Banking	0.0166billion	89
July 2004-2005	₦25billion – Universal Banking	0.2 billion	25
2005	₦25billion – Universal Banking	0.2 billion	25
2006	₦25billion – Universal Banking	0.2 billion	25
2007-2011	₦25billion – Universal Banking	0.2 billion	24
2012	₦25billion – Universal Banking	0.2 billion	21
2013	₦25billion – Universal Banking	0.2 billion	24

£= British Pound Sterling; $ = US Dollar; ₦ =Nigerian Naira
Source: Central Bank of Nigeria Publication. (2013)

3.0 Review of Empirical Literature

One of the foremost studies to investigate productivity change in the banking industry was by Berg, Forsund and Jansen (1992). Employing Malmquist indices for

productivity growth in the Norwegian banking industry during the years 1980-89, they recorded a decline in productivity prior to the period of deregulation but eventually grew rapidly after deregulation.

Kumar and Gulati (2008) used the analytical technique of data envelopment analysis (DEA) in combination with logistic regression analysis in 17 public sector banks (PSBs) operating in India to measure the extent of technical, scale and pure technical inefficiencies during the period 2004/05. The empirical results reveal that Public Sector Banks operate at 88.5 % of overall technical efficiency. In other words, 11.5 percent reduction in inputs would lead to a non-attendant reduction in output if all banks were efficient as identified by 7 benchmark banks using DEA. Furthermore, the study identified that the contribution of scale inefficiency to overall technical inefficiency is lesser than that due to managerial inefficiency (i.e., pure technical inefficiency). The principal form of scale inefficiency pertaining to returns-to-scale in the public sector banking industry in India is decreasing returns-to-scale. The logistic regression analysis result provides that the introduction of the banks to off-balance sheet or non-traditional activities exerts a strong and positive impact on the overall technical efficiency of banks.

Sharma and Gupta (2010) analyzed efficiency growth pattern and productivity of Indian banking industry during the post-liberalization era. Malmquist data envelopment analysis (DEA) was employed in estimating the different performance measures viz., technological change, scale efficiency, productivity growth and technical efficiency for the period 1996-2006. Results indicate that within the period 1996-2006, the industry exhibited regress in technological progress alongside stagnation in technical efficiency. Some progress was recorded in scale economies however, there was pervasive productivity decline resulting from the dominating technological regress. From the group wise analysis, nationalized sector came out to be the leader in the case of scale economies whereas private sector emerged as the best performer in technical efficiency and of all the groups, none could experience positive growth in productivity over the study period.

With the aim of assessing the effects of the financial sector reform on the profitability and efficiency of the Pakistani banking system, Hardy and Patti (2001) carried out a study on bank reform and efficiency in Pakistan. In order to assess these effects, profitability, cost and revenue efficiency frontiers were estimated using the Distribution Free Approach, from which can be derived certain measures of the efficiency of banking system relative to the best available practice. The results revealed that revenue performance of all banks, and especially the privatized banks, improved significantly, although costs also rose

and relative performance across banks did not converge. Also, the reform did not lead to a rise in overall profitability and it led to increase in both costs and revenue.

Ahmed et al.(2009) carried out a research on efficiency dynamics and financial reform of Pakistani banks. The study used data sets of 20 domestic commercial banks to measure banking efficiency using data envelopment analysis (DEA) to compute malmquist index total factor productivity (TFP) from 1990 to 2005. The result showed that financial sector reforms were successful in improving the efficiency of the domestic commercial banks role of intermediation in Pakistan.

Some empirical attempts to assess the performance of the financial sector reforms have been recorded in Nigeria (Ikhide and Alawode, 1994; Ikhide, 1998; Nyong, 2005). Some of the earlier studies carried out in the Nigerian banking sector merely focused on the effect of liberalization on interest rate spread and transaction costs in assessing whether financial liberalization has an impact on the banking system. [Onwioduokit and Adamu (2005), Adeoye and Adewuyi (2005)]. These studies didn't include the generation of efficiency scores, which can be used as a more appropriate measure of efficiency or at best, as dependent variable against a set of explanatory variables. Nyong (2005) however, went beyond these traditional efficiency approaches in the banking sector. Employing data for 18 Nigerian banks, efficiency scores were generated for the period 2002/2003. However, the study looked at only one period which fell within the period of financial liberalization in Nigeria and used few banks (89 banks were in operation during this period).

Okpara (2011) in a study, empirically evaluated banking sector reforms and the performance of the Nigerian banking sector using a single sample t-statistics and the population mean as the test value. Results showed that the 2004 consolidation policy didn't have any significant impact on performance indicators in the banking sector. The paper suggests that the merger and acquisition connected with the recapitalization reform was a compelling requirement which was unable to significantly improve the efficiency and performance of the participant banks.

Iganiga (2010), adopted the classical least square technique to evaluate the Nigerian financial sector reforms with a focus on the banking sub-sector of the Nigeria financial system. The results show an improvement in the performance of the financial sector. In a similar fashion, Olajide et al. (2011), examined the impact of financial reforms on banks' organizational performance in Nigeria between 1995 and 2004. It specifically determined the effects of policies of interest rates

deregulation, exchange rate reforms and bank recapitalization on banks performance, and analyzed how banks internal characteristics and industry structure affect the performance of Nigeria banks. The study utilized panel data econometrics in a pooled regression and the result confirmed that the effects of government policy reforms, bank specific characteristics and industry structure has mixed effects on banks profitability level and net interest margin of Nigerian banks. Bank specific characteristics appear to have a significant positive influence on banks profitability and efficiency performance of banks in Nigeria.

Olaosebikan (2009) appraised the efficiency of Nigerian banks pre- and post-2004 minimum capital requirement increase between 1999 -2005 using data envelopment analysis and a Tobit model to evaluate the main determinants of efficiency. The findings from the study indicate that earlier reforms (late 1990s) led to a reduction in the number of distressed banks with high volatility inefficiency while the 2004 consolidation policy resulted in a strengthening of the banking sector and improved efficiency.

Obafemi (2012) employed data from 67 Nigerian banks comprising of commercial and merchant banks cutting across four decades embedded within the periods 1984/1985, 1994/1995, 1999/2000, and 2003/2004 to investigate the efficiency of pre- and post- liberalization banks by deriving efficiency scores for the banks using the technique of data envelopment analysis. A comparison of these results with post consolidation evidences revealed that on the average, Nigerian banks were not efficient within the period of study. However, liberalization resulted in improvement in the technical efficiency of banks in Nigeria; nevertheless, the improvement did not last long as some of the banks started sliding in efficiency with continued liberalization. Thus, supporting the timeliness and worthiness of the consolidation exercises which actions were taken along with the liberalization exercise to save the banks. Furthermore, the study also showed that some of the collapsed banks during the 2006 consolidation exercise recorded continuous decline in their efficiencies.

Poloamina et al (2014) examined the total factor productivity change (TFPC) of fifteen major deposit money banks in Nigeria over the period 2002 – 2008 using the Malmquist Data Envelopment Analysis. The results showed a similar productivity change in the pre- and during consolidation era but showed a slight decrease in productivity afterward. Hence the consolidation policy reform was found not to have positively influenced productivity change in the Nigerian banking sector.

Okorie and Agu (2015) in a study evaluated the impact of the 2004 reform on banking sector performance and efficiency in the pre- and post-consolidation period in Nigeria using the non-parametric technique of Data Envelopment Analysis. Findings from this study revealed a general improvement in efficiency in the post-consolidation Nigerian banks. However, the two immediate years following the consolidation period recorded poor levels of efficiency among many of the banks studied. The study however failed to provide explanation for this trend.

4.0 Methodology of Study

Data envelopment analysis as suggest by Charnes et al (1978) and following Färe *et al.* (1994) construct which assumes a constant return to scale (CRS) and an output orientation, was employed in computing Malmquist TFP index,
The Malmquist TFP index between the base period, *s* and period *t* is given by:

$$M_0(y_s,x_s,y_t,x_t)= \left[\frac{D_0^s(x_t,y_t)}{D_0^s(x_s,y_s)} \times \frac{D_0^t(x_t,y_t)}{D_0^t(x_s,y_s)}\right]^{1/2} \quad (1)$$

where the notation $[D_0^s(x_t,y_t)]$ denotes the distance from period *t* observation to period *s* technology or efficiency frontier. Equation (1) is actually a geometric mean of two total factor productivity indices. The first is evaluated relative to period *s* technology while the second with respect to period *t* technology. When the value of M_o is greater than one it indicates a growth/increase/progress in productivity from periods *s* to *t*, a value less than one signifies a decline/decrease/regress in productivity while a value equal to one is indicative of a stagnation.

The Malmquist index productivity growth formulation can further be broken down into the following components:

$$M_0(y_s,x_s,y_t,x_t) = \left[\frac{D_0^t(x_t,y_t)}{D_0^s(x_s,y_s)}\right] \times \left[\frac{D_0^s(x_t,y_t)}{D_0^t(x_t,\ y_t)} \times \frac{D_0^s(x_s,\ y_s)}{D_0^t(x_s\ ,\ y_s)}\right]^{1/2} \quad (2)$$

The first component of productivity change is termed technical efficiency change and measures the change in the efficiency of a Decision Making Unit (DMU) with respect to the best practice frontier, that is, the change in the DMU's distance to the production frontier. Färe *et al.*, (1997) proposed a further decomposition of the 'technical efficiency change' component to take into account variable returns to scale (VRS) technology, which differentiates between 'scale efficiency' and 'pure technical efficiency change'. In this regard, there is

a consensus that the Malmquist index is accurately measured by the ratio of the constant returns to scale (CRS) distance function even when a VRS technology seems to exist (Casu *et al.,* 2004). Thus, a Malmquist index value greater than 1 denotes an increase in that efficiency component relative to the frontier whereas a value less than 1 shows a decline in efficiency relative to the frontier. The second component, referred to as *technological change*, results from variation of the production frontier between two periods, and thus reflects the improvement or worsening of best practice DMUs. A value greater than 1 signifies technological progress whilst a value less than 1 means technological regress. Thus, total factor productivity is decomposed into technical efficiency change (EFFCH), pure efficiency change (PECH), scale efficiency change (SECH) and technological change (TECH), using DEAP 2.1 software.

The analysis was carried out in two phases. The first phase was done without isolating the consolidation period giving rise to two periods; pre-consolidation (1993-2003) and post-consolidation (2004 – 2013). While in the second phase, the consolidation period was carefully isolated breaking the data into three periods; pre-consolidation period (1993-2002), consolidation period (2003-2005) and post-consolidation period (2006-2013). The purpose of this is to determine if the consolidation policy has any effect on total factor productivity in the banking sector thus highlighting the worthiness or otherwise of the policy.

4.1 Data

Panel data were obtained from Published Annual Reports of the banks which constitute the sample, the Nigerian Stock Exchange website, various issues of the Nigerian Stock Exchange Factbooks and from the web sites of ten (10) consolidated banks within the period 1993-2013; a total of 21 years covering the period of pre-consolidation and post-consolidation of the sector. The variables of interest were categorized into inputs and outputs as defined by the intermediation approach to variable selection. Thus, the input variables are total deposits, total share capital, and number of employees as proxy for labour while the output variables are total loans & advances, investment securities and property & equipment.

5.0 Analysis of DEA Result

The results from the data analyzed using DEAP 2.1 software are presented in this sub-section. The data were analyzed in phases. The first phase of the analysis was undertaken without isolating the consolidation period from the data; instead the data was divided into two. The first part which is simply referred to as pre-

consolidation period spans 1993-2003 while the second set of data is from 2004-2013 termed post-consolidation period. In the second phase of the analysis, the data was divided into three parts, taking care to isolate the consolidation period to give pre-consolidation period (1993-2002), consolidation period (2003-2005) and the post-consolidation period (2006-2013). The pre-consolidation result from the first-phase of the analysis is presented in table 2. In both phases, an output orientated Malmquist DEA outlook with constant returns to scale outlook was adopted.

Pre-consolidation Result (1993-2003)

Employing data spanning 1993-2003, a decomposition of total factor productivity into its various components was done. Considering the Malmquist index summary of annual means presented in table 2, it was observed that total factor productivity exhibited an improvement with technological change contributing the most to the improvement in total factor productivity change. Efficiency change and scale efficiency change recorded regresses within the period under consideration.

Table 2: Malmquist Index Summary of Annual Means (Pre-consolidation, 1993-2003)

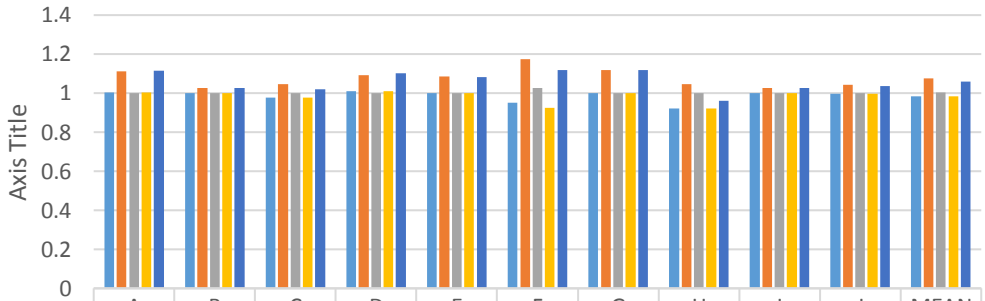
Year	Effch	Tech	Pech	Sech	Tfpch
1994	0.947	1.054	1.008	0.940	0.998
1995	1.082	1.069	1.020	1.061	1.157
1996	0.932	1.194	1.000	0.932	1.113
1997	0.940	1.244	0.969	0.969	1.169
1998	1.040	0.889	1.020	1.019	0.925
1999	1.014	1,110	1,011	1.003	1.125
2000	0.827	0.981	0.979	0.845	0.811
2001	1.272	1.264	1.022	1.245	1.609
2002	0.874	0.992	0.986	0.887	0.868
2003	0.989	1.018	1.014	0.975	1.007
Mean	**0.985**	**1.075**	**1.003**	**0.983**	**1.059**

Source: Author's computation (2018)

Note: t-1 in year 1 and t+1 in the final year are not defined. Also all Malmquist index averages are geometric means.

A critical analysis of table 2 shows that in over half of the period under consideration, both efficiency change and scale efficiency change components exhibited regresses thus resulting in overall regress of -0.15 and -0.17 respectively while technological change and pure efficiency change components recorded improvements (7.5 and 0.3 percent respectively). In four out of the ten years

reported, total factor productivity change showed regress. Overall, the study period recorded a 5.9 percent increase in total factor productivity change. On the side of the firms, the Malmquist index summary of firms mean presented in Fig. 1, revealed that forty percent of the firms recorded inefficiency in both technical and scale efficiency.



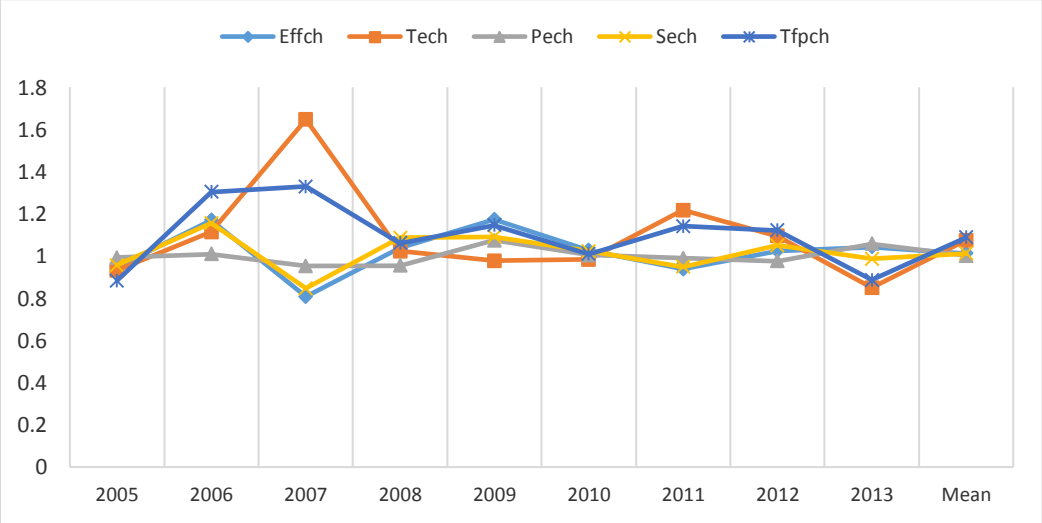
	A	B	C	D	E	F	G	H	I	J	MEAN
Effch	1.003	1	0.977	1.01	1	0.95	1	0.92	1	0.996	0.985
Tech	1.113	1.025	1.046	1.093	1.085	1.175	1.12	1.045	1.025	1.042	1.075
Pech	1	1	1	1	1	1.028	1	1	1	1	1.003
Sech	1.003	1	0.977	1.01	1	0.925	1	0.92	1	0.996	0.983
Tfpch	1.116	1.025	1.021	1.103	1.082	1.117	1.12	0.961	1.025	1.038	1.059

Fig 1: Malmquist Index Summary of Firms Means (Pre-consolidation)
Source: Author's computation (2018)

This is not unexpected because a firm that exhibits technical inefficiency issues when the scale of operation is small will definitely experience exacerbated efficiency problems with increase in the scale of operation. This also points to the fact that, technical inefficiencies in the banking sector is more of scale inefficiency and not directly from management error since pure efficiency component which is a measure of management's efficiency lies on an efficient margin (growing marginally by 0.03 percent). All the firms considered experienced increasing growth in technological change making them best practice banking institutions while in terms of pure efficiency change, the firms operated within the neighbourhood of full pure efficiency. Again, this buttresses the fact that technical inefficiency in the banking sector is more from scale expansion (which could be attributable to branch network) rather than from management inefficiency. In other words, management efficiency (PECH) contributes more to technical efficiency in the banking sector than does the scale of operation (SECH). Overall, total factor productivity change for all except one of the firms exhibited increases. Moreover, the means for the components of

TFPCH suggests that even in period before the consolidation policy was implemented in the Nigerian banking sector, technological change with the mean of 1.075, was the main driver of total factor productivity change. Post-consolidation (2004-2013)

The result of the post consolidation analysis using data collected from 2004-2013 which was classified as post-consolidation period (without isolating the consolidation era) in the Nigeria bank sector is presented in Fig. 2 and Table 3.



Source: Author's computation (2018)

Fig 2: Malmquist Index Summary of Annual Mean (Post-consolidation 2004-2013)

Table 3: Malmquist Index Summary of Annual Mean (Post-consolidation 2004-2013)

Year	Effch	Tech	Pech	Sech	Tfpch
2005	0.948	0.932	0.992	0.956	0.884
2006	1.170	1.114	1.010	1.156	1.304
2007	0.808	1.647	0.953	0.847	1.330
2008	1.038	1.023	0.955	1.086	1.061
2009	1.173	0.977	1.075	1.091	1.146
2010	1.028	0.983	1.005	1.023	1.010
2011	0.938	1.217	0.989	0.948	1.141
2012	1.025	1.094	0.976	1.050	1.122
2013	1.043	0.850	1.058	0.986	0.887
Mean	**1.013**	**1.074**	**1.001**	**1.012**	**1.088**

Source: Author's composition (2018)

(Note: t-1 in year 1 and t+1 in the final year are not defined)

The mean values of the components of the Malmquist total factor productivity change index showed very impressive results with a rise in all its components. This is an improvement over the pre-consolidation result. This could be one of the obvious gains from the consolidation exercise embarked upon in the Nigerian banking sector. One major benefit accruing from mergers and acquisition which is a fall-out of the consolidation exercise is the economics of scale. This obviously, is typified in the increase in efficiency change as shown in Table 3. With the increase in efficiency change, came increase in scale efficiency change as against what obtains in the pre-consolidation era.

On the firm side, all components of total factor productivity change also exhibited increases with technological change taking the lead (Table 3A). The inefficiencies in terms of technical and scale efficiency exhibited by the banks in the pre-consolidated era, improved significantly in the post-consolidation period. The consolidation exercise that resulted in the attenuation of Nigerian banks from a superfluous 89 banks to 21 gave birth to fewer but stronger, reliable and more efficient banks. The increase in the efficiency may have been spurned by a number of factors which includes but not limited to product or process innovation- which enabled banking firms in Nigeria to figure out more efficient ways of making existing products, allowing output to grow at a more rapid rate than economic inputs thus engendering a reduction in the cost of production over time; the obvious effect of mergers and acquisition which nullified the impact of weak and ailing banks on the efficiency of such banks; streamlining banking operations in line with best banking practices by elimination of inefficient banks. On the other hand, the growth in total factor productivity change of post-consolidated banks could also be as a result of the banks making better use of existing labour and other economic inputs to produce more of the output. For example, as management take advantage of research and development (R∝ D), it results in labour finding newer or better ways of doing things so that relatively minor modifications to plant, equipments and procedures contributes to higher levels of productivity. Also, increase in skills that results from learning by doing and training and re-training is another way of increasing efficiency change thus leading to a rise in total factor productivity change.

Table 3A: Malmquist Index Summary of Firm's Mean (Post-consolidation 2004-2013)

	A	B	C	D	E	F	G	H	I	J	Mean
Effch	1.000	0.989	1.009	0.983	1.019	1.077	1.000	1.057	1.000	1.000	1.013
Tech	1.099	1.005	1.084	1.038	1.035	1.168	1.142	1.120	1.062	1.001	1.074
Pech	1.000	1.000	1.007	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.001
Sech	1.000	0.989	1.002	0.983	1.019	1.077	1.000	1.057	1.000	1.000	1.012
Tfpch	1.099	0.994	1.094	1.020	1.055	1.258	1.142	1.184	1.062	1.001	1.088

Source: Author's composition (2018)

The second phase of the analysis had the data divided into three (3) parts viz; 1993-2002 (pre-consolidation phase), 2003-2005 (consolidation phase) and 2006-2013 (post-consolidation)

Table 4: Malmquist Index Summary of Annual Means (Pre-consolidation, 1993-2002)

Year	Effch	Tech	Pech	Sech	Tfpch
1994	0.944	1.046	1.008	0.937	0.987
1995	1.100	1.077	1.020	1.079	1.184
1996	0.877	1.317	0.995	0.882	1.156
1997	0.982	1.061	0.974	1.008	1.043
1998	1.040	0.890	1.020	1.019	0.926
1999	1.014	1.110	1.011	1.003	1.125
2000	0.827	0.981	0.979	0.845	0.811
2001	1.272	1.264	1.022	1.245	1.609
22002	0.874	0.992	0.986	0.887	0.869
Mean	**0.992**	**1.082**	**1.002**	**0.989**	**1.079**

Source: Author's computation (2018)

Considering the pre-consolidation result from the second phase analysis presented in Table 4, the Malmquist index of annual means showed the existence of technical inefficiency in the Nigerian banking sector. 55 percent of the sampled banks exhibited inefficiencies technically and scale wise while 45 percent operated with improvement in both indices. 2001 witnessed the highest rate of improvement in technical efficiency with a 27 percent increase which unfortunately was not sustained as the succeeding year (2002) recorded the lowest regress (-12.6 percent) in technical efficiency. The pre-consolidation result showed that the period ended with -0.8 percent regress (inefficiency) in technical efficiency change.

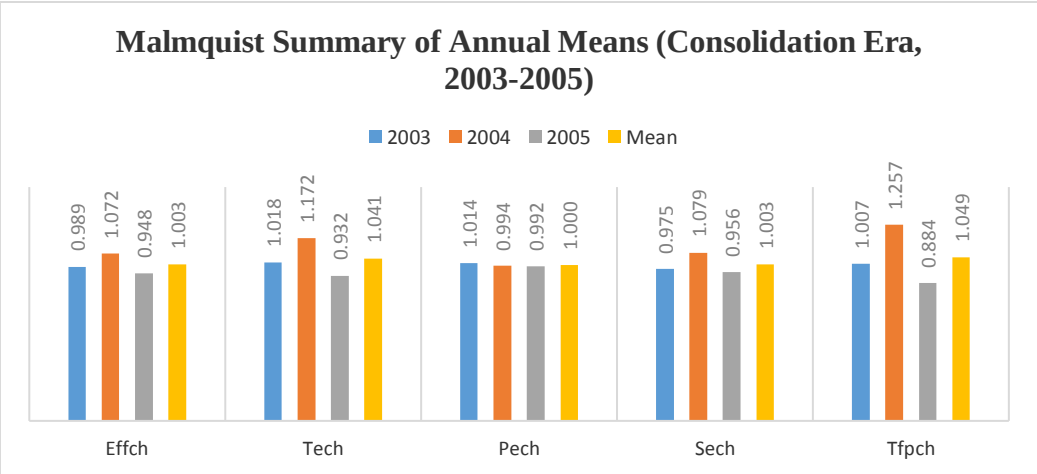
Table 5: Malmquist index summary of annual mean (Post-consolidation, 2006-2013)

Year	Effch	Tech	Pech	Sech	Tfpch
2006	1.170	1.114	1.010	1.159	1.304
2007	0.808	1.647	0.953	0.847	1.304
2008	1.038	1.023	0.953	0.847	1.330
2009	1.173	0.977	1.075	1.091	1.146
2010	1.028	0.983	1.005	1.023	1.010
2011	0.938	1.217	0.989	0.948	1.141
2012	1.025	1.094	0.976	1.050	1.122
2013	1.043	0.850	1.058	0.986	0.889
Mean	**1.028**	**1.113**	**1.003**	**1.024**	**1.125**

Source: Author's computation, 2018

The post-consolidation result shows improvement in total factor productivity change and its components. A comparison of Table 3 and 5 revealed a significant improvement in Table 5 as against the situation in table 3. The increase in efficiency change, technological change, pure efficiency change, scale efficiency change and total factor productivity change are 1.5, 3.9, 0.2, 1.2 and 3.7 percent respectively. This is an indication that post-consolidated Nigerian banks are indeed more efficient both in terms of available resource use as well as in the scale of operation and in other components of total factor productivity. Also, total factor productivity in the banking sector has increased and technology plays a major role in the growth of total factor productivity in the Nigerian banking sector.

Fig 3: Malmquist Summary of Annual mean (Consolidation era, 2003-2005)



Source: Author's computation,2018

The result of the consolidation period (2003-2005) is presented in Fig 3. Efficiency change and scale efficiency change both exhibited regresses in 2003; a period where the imperative for policy must have been so heightened such that any further delay could spell doom for the economy. However, the commercial banks may have been privy to a purported policy enactment in 2004 and perhaps engaged in some temporary remedial actions to boost their efficiency which may have resulted in increase in technical and scale efficiency in 2004 but with the policy action taking effect in 2004, the temporal effect of whatever action that raised efficiency in 2003 obviously became unsustainable in 2005 which resulted in the observed regresses posted by technical and scale efficiency. Another reason that could be attributed to the observed trend is the lagged effect of the policy. Overall, technical and scale efficiency recorded marginal progress in their means (0.3 percent in both cases). Technological progress recorded impressive increases in 2003 and 2004 and regress in 2005 strengthening the assumption of a lagged policy effect. Overall, the era closed with a 4.1 percent increase in technological change. Pure scale efficiency recorded increase in 2003 and then regresses in 2004 and 2005 closing the period with stagnation. Total factor productivity recorded progresses in 2003 and 2004 (0.7 and 25.7 percent respectively) and a regress in 2005 (11.6 percent) but managed to close the period with a increase of 4.9 percent.

It is noteworthy to report that total factor productivity and all its components recorded regresses in 2005- the year the consolidation policy actually commenced. The reason for this regress is not far-fetched because banks in the Nigerian economy were struggling to satisfy the Central Bank of Nigeria consolidation policy of twenty-five billion naira (₦25 billion) minimum capital reserve which resulted in weak banks having to merge or be acquired by stronger banks. Also, while this was going on, customer's confidence in the banking sector was seriously eroded which resulted in massive withdrawal of deposits from the banking system as a result of perceived systemic distress which they thought could emanate from the consolidation exercise. This behavior on the customer's side is in consonance with Goldfield and Chandler (1981) and Somoye (2006) cultural lag effects of policy change which measures the responsiveness of the banking public to policy changes in a predominantly poor banking habit population.

Summary of Findings

The findings from this study showed that technological change is the main driver of total factor productivity in the Nigerian banking sector. The separation of the analysis into two distinct phases helped to alienate and identify the existence of (in) efficiency as far as total factor productivity and its components is concerned

in the Nigerian banking sector. It was observed that inefficiency issues actually existed in the banking sector prior to the implementation of the consolidation policy thus revealing the worthiness and timeliness of the policy. Furthermore, inefficiency in the banking sector was found to come mainly from technical and scale inefficiency. Also, total factor productivity and all its components were found to have grown significantly upon implementation of the consolidation policy.

6.0 Conclusion and Recommendations

The consolidation policy initiated by the Soludo-led administration in the Nigerian banking sector was found to be timely and worthwhile from the results in this study. The banking sector prior to the policy intervention had some underlying technical and scale efficiency issues constraining productivity in the sector as revealed by the pre-consolidation and post-consolidation results. Importantly, the sector recorded very impressive results in total factor productivity and its components in the post-consolidation analysis when compared with pre-consolidation. It is hoped that the observed growth in total factor productivity and its components will be sustained in the long run. Consequently, it is recommended that effective monitoring of the banking sector should be done with special focus on efficiency enhancing factors which if left to self-regulate, could lead to systemic failure in the sector.

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THE EFFECT OF FOREIGN EXCHANGE INTERVENTION ON THE MONEY SUPPLY OF THE LIBERIAN DOLLAR (2006-2015): AN AUTOREGRESSIVE DISTRIBUTED LAG (ARDL) MODELING APPROACH

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Abstract

The paper examines the impact of the Central Bank of Liberia's (CBL) foreign exchange intervention on the growth of money supply of the Liberian dollar and whether the intervention is sterilized. We estimate these effects using Autoregressive Distributed Lag (ARDL) modeling approach employing monthly time series data spanning the period 2006 to 2015. To determine the stationarity of the data, an Augmented Dickey-Fuller and Phillips-Perron tests were conducted at level and 1st difference. Next, we perform co-integration test using Bound Test technique. The existence of co-integration allows us to estimate the error correction model for broad money.

This paper finds evidence that the CBL's intervention in the foreign exchange market is sterilized and that the intervention variable is rightly signed but statistically insignificant, reflecting the low levels of intervention through the CBL's auction. Thus, we proffer the following recommendations: First, in the short run, the CBL's foreign exchange intervention strategy should be directed to major actors such as importers, businesses, and forex bureaus. The level of foreign exchange intervention should be informed by the level of CBL's international reserves. Second, the CBL should institute measures that would deter speculation and rent seeking behavior in the foreign exchange market and ensure that its intervention strategies are properly targeted at enhancing appropriate monetary policy stance, inflation control and exchange rate stability, among others. Third, there is a need to convert portion of the remittance inflows to Liberian dollar to promote Liberian dollar monetary growth, thereby reducing the current level of dollarization of the economy.

JEL Classification: *E58, F31*

Keywords: Foreign Exchange Intervention, Money Supply, Exchange Rate, Autoregressive Distributed Lag, Co-Integration.

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††††The findings, interpretations, and conclusions expressed are entirely that of the authors. They do not represent the view of the Central Bank of Liberia.

1. Introduction

From 2006-2015, the Liberian monetary authority, the Central Bank of Liberia (CBL), used foreign exchange intervention as a monetary policy instrument to help smooth exchange rate volatility. The importance of this approach cannot be understated as its pass-through has significant effects on inflation, a primary objective of the CBL.

Since 2009, the Central Bank of Liberia (CBL) has intervened in the foreign exchange market to support and stabilize the value of the Liberian dollar. In 2012, the CBL's intervention in the forex market was further strengthened as the Government of Liberia (GoL) through the Ministry of Finance signed on the International Monetary Fund Extended Credit Facility (ECF) program. As part of the ECF program, the CBL purchased foreign exchange from the Government to intervene in the foreign exchange market as well as use a targeted amount for reserve accretion. However, the existing dual currency regime[2] characterized by the high level of dollarization[3] presents a major challenge to the CBL in the conduct of effective monetary policy. Moreover, Liberia's economic growth which has been largely driven over the years by the extractive industry, particularly iron ore and rubber, was marred by high importation of staple commodities and this exposed the economy to exogenous shocks. This condition led to a large reduction in Government retained revenue that was denominated in foreign currency, thereby placing enormous pressure on the CBL to intervene more frequently to meet the foreign exchange demand of importers.

Although foreign exchange intervention as a monetary instrument has been used to mitigate exchange rate volatility in various countries, its effectiveness has been a subject of debate amongst central banks, policymakers and researchers (Simatele, 2003; Guimarães, and Karacadağ, 2004; Bank of International Settlement, 2005, 2013; Menkhoff's, 2010; Alder and Tovar, 2011; Newman et al, 2011; Omojolaibi and Gbadebo, 2014). In relation to the above in the extant literature, the need to distinguish between sterilized and non-sterilized interventions has often arisen as there no consensus on how non-sterilized intervention impacts exchange rate via money supply (Danker et al., 1996; Lewis, 1988b; Humpage, 1989; and Dominguez, 1998).

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[2] The Liberian and United States (US) dollars are both legal tenders in Liberia.

[3] The US dollar share of broad money at end-August 2016 stood at 70.2 percent, an indication of the high degree of dollarization of the Liberian economy.

The purpose of this paper is to determine the impact of foreign exchange intervention on the growth of money supply and whether the intervention is sterilized. Liberia's dual currency regime and the nature of foreign exchange intervention through which the CBL purchases US dollar from Government and in turn provide Liberian dollar equivalent does have implication on the growth of money supply. Thus, if the intervention is not sterilized, then it would impact the growth of money supply which affects the exchange rate and by extension inflation and the economy at large (Adebiyi, 2007; Chipili, 2010; Dayyabu, Adnan, and Sulong, 2016).

The remainder of this paper is organized as follows. In Section 2 we discuss Liberia's dual currency regime and its history of foreign exchange market. Section 3 provides the theoretical framework on foreign exchange market intervention; while Section 4 presents the data and model specification. In Section 5 we report and discuss the parameter estimates and the last Section concludes.

2. History of Liberia's Dual Currency Regime

The dual currency regime in Liberia can be traced from the country's historical ties with the United States of America (USA) and its proximity to British West African colonies. Since its emergence as an independent country in 1847, the economy of Liberia has been either fully or partially dollarized (Erasmus, Leichter, and Menkulasi, 2009). During the periods 1839-1847 and 1847-1904, representing the eras of both a Commonwealth and a young Republic, the US dollar and the Liberia dollar coins circulated side-by-side in the country as medium of exchange and unit of account. However, the legality of the US dollar as legal tender currency was unclear with a conspicuous absence of a monetary authority. Liberia introduced its first notes which circulated alongside the Liberian dollar coins and US dollar between 1850s-1880s. The period between 1913 and 1942, Liberia adopted the British-West African pound, mainly used in neighboring Sierra Leone and other nearby British West African colonies. The period between 1943 and 1962, Liberia adopted the US dollar as the official and the sole legal tender currency (Erasmus, Leichter, and Menkulasi, 2009). It is also important to note that, beyond 1962 up to date, the US dollar remains legal tender of Liberia.

However, the dominance of the US dollar (though beneficial) was not without disadvantages. One of such disadvantages was massive capital outflows from the economy especially after the 1980 coup d'état. The Liberian government, therefore, introduced the five-dollar coin in 1982 to curb the capital outflows.

The coin was faced with the challenge of portability. In 1989, the first Liberian bank notes, "J.J. Roberts", five-dollar banknote was introduced to replace the five-dollar coin. The "Liberty" notes were issued in 1991 to invalidate the J.J. Roberts five-dollar banknotes looted from the National Bank of Liberia during the civil war, effectively creating two currency zones. Thus, the J.J. Roberts and Liberty banknotes were concurrently used as medium of exchange until 1999 when they were both withdrawn and replaced by the multidenominational banknotes in five, ten, twenty, fifty and hundred-dollar bills alongside the US dollar (Erasmus, Leichter, and Menkulasi, 2009). It is also important to note that during these periods mentioned above and now the US dollar continues to be legal tender in Liberia and can be used side by side for transactions purposes.

2.1 Brief History of the Liberia Foreign Exchange Market Exchange Rates

The current exchange rate regime of Liberia evolved over the years shifting from fixed exchange rate system to a managed floating regime. Liberia practiced a fixed exchange rate regime with the Liberian dollar and US dollar officially trading on one-to-one parity for 37 years (1962-1999). The period between 1962 and 1982, the parallel market rate and the official rate remained almost the same. However, beyond 1982, the parallel rate deviated from the official rate. The difference widened incrementally as the political crisis escalated with attendant slowdown in economic activities, especially in the major exports of the country (rubber, Timber and iron ore). In 1998 the exchange rate peg was abandoned and the exchange with the US dollar was devalued from LD1/USD1 to LD43/USD1. Since the 1998 devaluation, the Liberian dollar has depreciated on average by five percent a year. The CBL Act of 1999 expunged the one-to-one parity and adopted a floating exchange rate regime between the Liberian dollar and US dollar. However, it maintains the legal tender status of the US dollar.

3. Theoretical Framework on Foreign Exchange Market Intervention

Exchange rate is affected by reversible factors, namely: fundamental and transitory. Volatility in the exchange rate is triggered by volatility in market fundamentals, such as the growth of money supply, income, and interest rate. In addition, the formulation of market expectation due to new information and speculative bandwagons further impact exchange rate volatility (Bonsear-Neal and Tanner, 1996). Thus, exchange rate volatility would depend on the extent to which the causes underlying the latter is influenced by the former (Chipili, 2014).

Dominguez (1998) argues that to model exchange rate as a forward-looking process is efficient with respect to public information. Thus, the current spot exchange rate can be represented as:

$$s_{t=}(1-\delta)\sum_{k=0}^{\infty}\delta^{k}E_{t}(z_{t+k}|\Omega_{t}), \qquad (1)$$

where s_t is the logarithm of the current exchange rate; δ is the discount factor such that $\delta = \frac{\beta}{1+\beta}$ where β is the interest semi-elasticity of money demand in the monetary model; z_t is a vector of exogenous driving variables; E_t is the expectations operator; and Ω_t is the information set in period t. If intervention operations, denoted I_t, provide relevant information to the market, the market information set will enlarge such that (Ω_t <Ω_t+I_t) and the spot exchange rate will be influenced. For instance, if the central bank intervention in the market intended to support the domestic currency signals future contractionary domestic monetary policy, the domestic currency is expected to appreciate relative to the foreign currency such that:

$$s_t = (1-\delta)\sum_{k=0}^{\infty}\delta^{k}E_{t}(z_{t+k}|\Omega_{t}) > \; s_t = (1-\delta)\sum_{k=0}^{\infty}\delta^{k}\,E_{t}((z_{t}|\Omega_{t}+I_{t}), \qquad (2)$$

where I_t represents an official purchase of domestic assets[4]. In general, foreign exchange market intervention is any transaction or announcement by an official agent of the government intended to influence the value of the exchange rate (Dominguez, 1998). The intervention can be classified as sterilized or unsterilized. Sterilized intervention occurs when the monetary authority offsets the domestic asset such that the monetary base is unchanged, and prices or interest rates are not affected directly. On the other hand, unsterilized interventions lead to a change in the monetary base where the interest rates differentials as well as the exchange rate are affected. As related by the monetary model of exchange rate determination, unsterilized intervention impacts the exchange rate in a manner that the impact is proportional to change in the relative supplies of domestic and foreign currencies.

According to Neil and Fillion (1999), sterilized intervention affects exchange rate at least through four mechanisms, namely: signaling, portfolio-balance, noise-

[4] Empirical evidences in support of the hypothesis that intervention serves as a signal for future monetary policy are found in studies such as Dominguez (1993); Ghosh (1992), Lewis (1995) and Kaminsky and Lewis (1996).

trading and liquidity approaches. Aguilar and Nydahl (1998) explained that intervention can affect the exchange rate through these various channels such that the exchange rate can be specified as follow:

$$s_{t=} f_t + \alpha[E_t(s_{t+1}|\Omega_t) - s_t] \quad (3)$$

where f_t is current period fundamentals; other variables in equation (3) were previously defined. Thus, equation (3) indicates that the exchange rate at time *t* is determined by the current period fundamental factors as well as the expected capital gain of holding the currency until the next period.

Equation (3) can further be expanded to:

$$s_{t=}\frac{1}{1+\alpha}\sum_{j=0}^{\infty}\left[\frac{1}{1+\alpha}\right]^j E\left(f_{t+j}\,|\Omega_t\right) + \left[\frac{1}{1+\alpha}\right]E(b_{t+1}|\Omega_t) \quad (4)$$

where b_{t+1} represents a rational bubble. The expected present value of future fundamentals are expressed as $\frac{1}{1+\alpha}\sum_{j=0}^{\infty}\left[\frac{1}{1+\alpha}\right]^j E\left(f_{t+j}\,|\Omega_t\right)$ while a bubble is expressed as $\left[\frac{1}{1+\alpha}\right]E(b_{t+1}|\Omega_t)$. Therefore, the intervention affects the exchange rate through various channels as follows.

3.1 Signaling Approach

Under the signaling approach, the assumption is that there is information asymmetry in that the central bank has more information than the market agents regarding future monetary policy. By intervening in the foreign exchange market, the central bank changes the expectation of market agents about future monetary policy fundamentals. The signal of future monetary policy is observed because of central bank purchase of domestic currency which leads to contractionary money supply, thereby revising the market agents' expectations which result in an appreciation of the domestic currency (Kaminsky and Lewis, 1996). The signaling theory thus posits that exchange rate will depreciate if the central bank purchase of foreign currency is assumed to signal a more expansionary domestic money supply. The resulting depreciation effect is attributed to the action of the central bank if it does not alter the domestic monetary base to avoid the agents misinterpreting it as a change in the monetary policy position. The only way that this action by the central bank in terms of its intervention in the foreign exchange market becomes effective is when the signal about future monetary policy is credible. Over the years, some

studies have found that intervention has been effective through this channel (Galati and Melick, 1999; Neely, 2000, Neely 2005, Broto 2012).

3.2 Portfolio-Balance Approach

The basic premise of this approach is that investors would balance their portfolio between domestic and foreign assets based on their expected returns and the risk associated with those returns (Sarno and Taylor, 2001). The important feature of this approach is that investors are assumed to be rational and risk-averse. Therefore, intervention would affect the level of exchange rate through the portfolio-balance channel by altering the relative supply of foreign and domestic securities, thus compensating investors by a risk premium for holding securities that are imperfect substitutes. Such action creates a portfolio disequilibrium in investors' portfolio and equilibrium can be restored through a change in risk premium. But, if the securities are perfect substitutes, then intervention would not have any effect on the exchange rate (Chipili, 2014; Dayyabu, Adnan, and Sulong, 2016). Several studies also allude to the effectiveness of this intervention (Dominguez and Frankel, 1993; Catte et al., 1994; Neely, 2000).

3.3 Noise-Trading Approach

This approach allows for the movement of the exchange rate from its fundamental value due to the rational bubble assumption which considers the behavior of "noise traders." The actions of the noise-traders in terms of the movement of asset prices away from the fundamental equilibrium is captured through the buying and selling of currency because of the central bank intervention. Thus, the noise-traders actions affect their perception of the trend in the exchange rate. Therefore, central bank intervention can either increase or decrease exchange rate volatility when the noise-traders move the exchange rate away or toward the fundamental value. Hence, it is important to note that the theory regarding the effectiveness of central bank intervention on exchange rate volatility is ambiguous (Chipili, 2014).

3.4 Liquidity Approach

Under this approach, the assumption is that intervention does impact exchange rate volatility but not its levels. Short-term effect on exchange rate is determined by the size of the central bank intervention in the foreign exchange market. The size of the intervention influences behavior of the market and by extension impact the current exchange rate. This creates additional liquidity to dealers

and reduce market risk. Overall, the size of the intervention affects market fundamentals and provides a window in which the impact on the exchange rate is realized because of the size of the intervention relative to the market turnover within a given period (Chipili, 2014). However, there have been little empirical evidence to support this approach since the size of intervention by the central bank is usually smaller relative to the total market liquidity (Rogoff, 1984; Humpage, 1988; Obstfeld, 1989; Klein and Rosengren, 1991; Ghosh, 1992).

4. Data and Model Specification

4.1 Data

For the empirical analyses, we employed monthly secondary time series data spanning from January 2006 to December 2015[5]. The variables used in this analysis include: broad money (M2) in Liberian dollar, exchange rate, Liberia price index, remittance inflows, and U.S. interest rate. In this paper, we created a dummy variable to represent the intervention time series which assigns a value of one when the central bank intervenes and zero otherwise. The data were mainly sourced from the Central Bank of Liberia Quarterly Economic Bulletin, Liberia Financial Statistics and the International Financial Statistics of the International Monetary Fund. Broad money is defined as currency outside bank plus demand deposits and quasi money (saving and time deposits). Exchange rate is the price of one US dollar in terms of Liberian dollar in nominal term. Liberia price index measures Liberia's consumer price index which comprises 235 items. Remittance inflows are migrant remittances into Liberia. US interest rate is the Federal Funds Rate which banks charge each other for overnight lending.

Variables and Sources

Variable	Definition	Source
Liberian dollar M2	The component of Money Supply exclusively in Liberia dollar	The Central Bank of Liberia Monetary Survey
Liberia Price Index	Consumer Price Index with based period 2005=100	Central Bank of Liberia (Liberia Financial Statistics)
Exchange Rate	Liberian dollar per US dollar nominal exchange Rate	Central Bank of Liberia
Remittance Inflows	Migrant remittance	Central Bank of Liberia

[5] Intermittent civil wars between 1990 and 2003 led to the use of monthly data.

	inflows into Liberia	(Quarterly Economic Bulletin)
US Interest Rate	Federal Funds Rate	International Monetary Fund
Intervention	Central Bank of Liberia Foreign Exchange Auction	Central Bank of Liberia (Quarterly Economic Bulletin)

Variable and a priori Signs

Variable	A Priori
Liberian dollar M2	
Liberia Price Index	+/-
Exchange Rate	+/-
Remittance Inflows	+/-
US Interest Rate	+/-
Intervention	-

4.2 Model Specification

Similar to Adebiyi (2007), this paper seeks to determine the extent to which the CBL foreign exchange intervention is sterilized through its effect on the growth of broad money. We employed the Auto-regressive Distributed Lag (ARDL) approach that was popularized by Pesaran and Pesaran (1997), Pesaran and Smith (1998), Pesaran and Shin (1999), and Pesaran et al. (2001) given its numerous advantages. One of the main advantages of the ARDL approach is that it can be applied irrespective of whether the variables are I(0) or I(1) (Pesaran and Pesaran (1997) . Also, the ARDL approach allows for sufficient number of lags to capture the data generated in a general to specific modeling framework (Laurenceson and Chai, 2003). Additionally, a dynamic error correction model (ECM) can be derived from ARDL approach through a simple linear transformation (Banerjee et al., 1993). Finally, the ARDL approach avoids problems resulting from non-stationary time series data (Laurenceson and Chai, 2003). Thus, we illustrate the ARDL modeling approach as follows:

$$M_{2(t)=}\gamma_0 + \gamma_1 M_{2(t-1)} + \gamma_2 ER_t + \gamma_3 LPI_t + \gamma_4 INF_t + \gamma_5 USR_t + \gamma_6 INV_t + \varepsilon_t \quad (5)$$

where $M_{2(t)}$ represents Liberian dollar broad money at time *t*; ER_t is the nominal exchange rate at time *t*; LPI_t represents Liberia price index at time *t*; INF_t is the remittance inflow at time *t*; USR_t is the U.S. interest rate at time *t*; INV_t is a dummy variable representing the intervention time series which assigns a value

of one when the central bank intervenes and zero otherwise; ε_t is a vector of stochastic error terms; and γ_0 , γ_1 , γ_2 , γ_3 , γ_4 , γ_5, γ_6 are the parameters. Using equation (5), the ARDL error correction model can be expressed as:

$$\Delta M_{2(t)=}\varphi_0 + \sum_{i=0}^{p} \varphi_{1i}\,\Delta ER_{t-i} + \sum_{i=0}^{p} \varphi_{2i}\,\Delta LPI_{2t-i} + \sum_{i=0}^{p} \varphi_{3i}\,\Delta INF_{3t-i} + \sum_{i=0}^{p} \varphi_{4i}\,\Delta USR_{4t-i} + \sum_{i=0}^{p} \varphi_{5i}\,\Delta INV_{5t-i} + \varphi_6 ER_{t-1} + \varphi_7 LPI_{t-1} + \varphi_8 INF_{t-1} + \varphi_9 USR_{t-1} + \varphi_{10} INV_{t-1} + \varphi_{11} ECM_{t-1} + \varepsilon_t \quad (6)$$

where in equation (6), $\varphi_1, \varphi_2, \varphi_3$, φ_4, φ_5 represents the short-run dynamics of the model while φ_6 , φ_7 , φ_8 , φ_9 , φ_{10} represents the long-run relationship. The null hypothesis is $\varphi_6 = \varphi_7 = \varphi_8 = \varphi_9 = \varphi_{10} = 0$, that is there is no long-run relationship that exist amongst these variables. ECM_{t-1} is the error correction model in time *t -1* which represents the speed of adjustment in the growth of money supply.

4.3 ARDL Model Testing Procedure

Under this approach, the first step is to conduct a bound test with a null hypothesis that there is no co-integration. To verify the null hypothesis, the F-statistic is compared with the critical value (Pesaran and Pesaran, 1997; Pesaran et al., 2001). The null hypothesis states that no long-run relationship is rejected if the test statistic exceeds the upper bound or if the test statistic falls below the lower bound regarding the order of integration. Also, if the test statistic is within the upper and lower bounds, then the results are inconclusive. However, if the variables are I(1), then the test statistic is compared to upper bound critical value while if the variables are I(0), then the test statistic is compared to the lower bound critical value.

To obtain the optimal lag length for each variable, we used the automatic selection in EViews 9.5. The second step is to estimate the long-run relationship using the selected ARDL model. When there exists a long-run relationship between variables, an error correction model is estimated, and the results indicate the extent to which the long-run equilibrium is adjusted after a short-run shock. The third step is to conduct the goodness of fit of the ARDL model. This is done through a diagnostic and stability tests, respectively. The diagnostic test includes: serial correlation, normality test, and heteroscedasticity while the structural stability test is conducted using the cumulative sum of recursive residuals (CUSUM) (Chipili, 2014).

5. Results

To evaluate whether the variables under consideration are stationary at levels, 1st difference or mixed, we applied the Augmented Dickey-Fuller (ADF) test and Phillips-Perron (PP) test. We verify the co-integration relationship amongst the variables by employing the bound test. Next, we estimate the short and long run relationship of the model. Finally, we conduct a diagnostic and stability tests to ensure that the ARDL model is robust and stable over time.
To test for unit root, we assume that:

$$\varphi_{\mathrm{p}}(\lambda) = (1-\lambda)\varphi_{\mathrm{p}-1}(\lambda) \tag{7}$$

where $\varphi_{p-1}\ (\lambda) = 1 - \varphi_1\lambda - \ldots - \varphi_{p-1}\lambda^{p-1}$ has root lying outside the unit cycle.
Therefore, the Augmented Dickey-Fuller test equation is given as:

$$\Delta Y_t = \sigma Y_{t-1} + \sum_{j=1}^{p-1} \varphi_j \Delta Y_{tj} + \theta_0 + \varepsilon_t \tag{8}$$

With the null hypothesis given as H_0:$\varphi = 1$ and H_1:$\varphi = 0$.

In order to use the ARDL approach, the data should be stationary purely at level I(0) or purely at first difference I(1) or mixture of level and first difference. For this reason, the ARDL model incorporated the logged and first difference of each variable. The results of the unit root tests are broadly in line with the existence of unit root at level but the first difference is stationary.

All the variables are I(1) (Table1).

Table 1: Unit Root Test

		Augmented Dickey-Fuller		
Variable	**Levels**	**1st Difference**	**Critical Value**	**Integration Order**
ER	-0.76	-11.09*	-2.89	I(1)
M2	-0.81	-12.98*	-2.89	I(1)
INF	-1.52	-11.63*	-2.89	I(1)
LPI	-1.15	-10.60*	-2.89	I(1)
USRATE	-1.70	-4.87*	-2.89	I(1)
		Phillips-Perron		
Variable	**Levels**	**1st Difference**	**Critical value**	**Integration Order**
ER	-0.61	-11.48*	-2.89	I(1)
M2	-0.82	-12.92*	-2.89	I(1)
INF	-2.41	-26.08*	-2.89	I(1)
LPI	-1.23	-10.60*	-2.89	I(1)
USRATE	-1.70	-10.09*	-2.89	I(1)

Note: Parameter estimates are statistically different from zero at * 5% significance level.

5.1 Bound Test

We conduct the Bound Test to determine the long-run relationship between the independent variables and the dependent variable as stated above. According to Pesaran et. al. (2001), the Bound Test is represented as follow:

$$\Delta M_{2(t)=} - \sum_{i=1}^{p-1} \gamma_i^* \, \Delta M_{(2)t-1} + \sum_{j=1}^{k} \sum_{i=0}^{q_{j-1}} \Delta X_{j,\,t-i'}, \varphi_j, i^* - \rho M_{(2)(t-1)} - \alpha - \sum_{j=1}^{k} X_{j,\,t-1'}, \delta_j + \varepsilon_t \quad (9)$$

where $X_{j,\,t-i'}$ represent all independent variables. Thus, the test for the existence of long-run relationship is:

H_0: $\rho = 0$ and $\delta_1 = \delta_2 = ...\delta_k = 0$.

H_1: $\rho \neq 0$ and $\delta_1 = \delta_2 = ...\delta_k \neq 0$.

Table 2 reports the co-integrating relationships of the variables. The bound test was used to determine this relationship. The F-statistic value tells us about the co-integration among the variables. If the F-value comes less than the critical bound values then we can conclude that there is no co-integration among

variables. Our F-value is above the upper and lower bound test at the different critical levels. So, we can conclude that there is co-integration among variables.

Table 2: ARDL Bounds Test

Test Statistic	Value	K
F-statistic	25.064	4
Critical Value Bounds		
Significance	I0 Bound	I1 Bound
10%	2.45	3.52
5%	2.86	4.01
2.5%	3.25	4.49
1%	3.74	5.06

5.2 Model Selection

To determine the extent to which the CBL foreign exchange intervention is sterilized or not, we regressed growth in broad money supply (M2) on nominal exchange rate (ER), Liberia Consumer Price Index (LCPI), remittance inflows (INF), US interest rate (USRATE), and a dummy variable for intervention (INV). The model was selected based on the ARDL estimator whose lag length was selected automatically by EViews 9.5. The maximum lag of 4 was selected based on the Akaike Information Criteria (AIC). Table 3 showed that remittance inflows at first difference zero lagged and first difference fourth lagged were found to be statistically significant in explaining growth in money supply at 5 percent levels. However, exchange rate at first difference zero lagged was found to be statistically significant in explaining growth at the 10 percent level (See the automatic selection of the twenty best models in the appendix). The first of those was chosen for this paper.

Table 3: Model Selection

Dependent Variable: D(M2)
Method: ARDL
Sample (adjusted): 2006M06:2015M12
Included Observations: 115 after adjustments
Fixed Regressors: INTERVENTION C
Selected Model: ARDL(1, 0, 0, 4, 0)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(M2(-1))	-0.096	0.095	-1.010	0.315
D(ER)	-0.437	0.234	-1.865	0.065**
D(LPI)	-0.040	0.068	-0.583	0.561
D(INF)	0.042	0.019	2.184	0.031*
D(INF(-1))	0.012	0.022	0.560	0.577
D(INF(-2))	-0.006	0.022	-0.282	0.778
D(I NF(-3))	0.017	0.022	0.789	0.432
D(INF(-4))	-0.041	0.019	-2.115	0.036*
D(USRATE)	-0.004	0.017	-0.230	0.819
INTERVENTION	-0.005	0.009	-0.526	0.600
C	0.022	0.008	2.891	0.004*

Note: P-values and any subsequent tests do not account for model selection.
Parameter estimates are statistically different from zero at * 5% and ** 10% significance levels.

5.3 Short and Long Run Regression on Broad Money Supply

The co-integrating equation (ECM) is both negative and significant, so there exists a short-run relationship. For the long-run, there is a significant and negative relationship between Liberian dollar broad money growth (M2) and nominal exchange rate (ER) (Table 4). In the short-run, the two variables exchange rate and remittance inflows explain growth in money supply. The coefficient of the error correction model is statistically significant and high in magnitude. It confirms a long-run relationship between the variables. The coefficient of ECM (CointEq(-1)) term is -1.096, which suggests a fast adjustment process, nearly 110 percent of the disequilibria of the previous month's shock adjust back to the long-run equilibrium in the current month. This fast adjustment speed is largely due to the dual currency nature of the Liberian economy.

As shown in Table 4, exchange rate appreciation is inversely related to Liberian dollar money supply (M2) in the short run, precisely, a 1 percent appreciation of the Liberian dollar reduces money supply (M2) by 44 percent. Conversely, remittance inflow is positively related to increases in money supply. The results also suggest that growth in remittance inflows by 1 percent increases Liberian dollar money supply by 4.1 percent. This is evidenced by the demand for Liberian dollar mainly from households outside of Monrovia who receive huge inflows of remittances, especially during the second half of each year as a result of the festive seasons (both Christmas and independent days). Most households outside of Monrovia and its environs expenditure are mainly in Liberian dollar. The injection of Liberian dollar as a result of this demand leads to increased Liberian dollar in circulation, depreciation of the domestic currency and higher inflation in the economy.

Table 4: Short and Long Run Regressions on Broad Money Supply

Dependent Variable: D(M2)
Method: ARDL Co-integrating and Long Run Form
Sample: 2006M01:2015M12
Included Observations: 115
Selected Model: ARDL(1, 0, 0, 4, 0)

Co-integrating Form				
Variable	**Coefficient**	**Std. Error**	**t-Statistic**	**Prob.**
D(ER, 2)	-0.437	0.234	-1.865	0.065**
D(LPI, 2)	-0.040	0.068	-0.583	0.561
D(INF, 2)	0.042	0.019	2.184	0.031*
D(INF, 2)	0.006	0.022	0.282	0.778
D(INF, 2)	-0.017	0.022	-0.789	0.432
D(INF, 2)	0.041	0.019	2.115	0.037*
D(USRATE, 2)	-0.004	0.017	-0.230	0.819
D(INTERVENTION)	-0.005	0.009	-0.526	0.600
CointEq(-1)	-1.096	0.095	-11.546	0.000*
Long Run Coefficients				
Variable	**Coefficient**	**Std. Error**	**t-Statistic**	**Prob.**
D(ER)	-0.399	0.220	-1.810	0.073**
D(LPI)	-0.036	0.062	-0.584	0.561
D(INF)	0.022	0.068	0.319	0.750
D(USRATE)	-0.004	0.016	-0.230	0.818
INTERVENTION	-0.004	0.008	-0.526	0.600
C	0.020	0.007	2.933	0.004*

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

5.4 Diagnostic Tests

The results in Table 5 indicate that there is no serial correlation and the data is homoscedastic. The normality property of the residuals was rejected, that is, the error terms are not normally distributed. The ARDL model has been shown to be robust against residuals auto-correlation.

Table 5 : Diagnostics Tests

	Breusch-Godfrey LM Test	Jarque-Bera Test	Breusch-Pagan-Godfrey Test
1. Serial Correlation	F(2,102)=0.086(0.958)		
2. Normality		268.787 (0.000)	
3. Heteroscedasticity			F(10,104)=0.539 (0.859)

Note: The parentheses represent the p-values for each test. 1) Null hypothesis: no serial correlation; 2) Null hypothesis: residuals are normally distributed; and 3) Null hypothesis: no heteroscedasticity in the data.

5.5 Plot of Stability Test (CUSUM)

The plots of the stability test result (CUSUM) of the ARDL model is given in Figure 1. The CUSUM plotted against the critical bound of the 5 percent significance level shows that the model is stable over time (see Appendix).

6. Conclusion and Policy Recommendations

In the short run, exchange rate and remittance inflows variables explain growth in money supply. Exchange rate at first difference was found to be negatively signed and statistically significant at 10 percent. This implies that a percentage point appreciation of Liberian dollar will result into a 43.7 percent decline in Liberian dollar money supply. Similarly, remittance inflows at second lagged was found to be statistically significant and positively signed. A 1 percent increase in remittance inflows leads to 4.2 percent rise in Liberian dollar money supply. This is partly attributed to the supply of Liberian dollar especially during the last half of each year. It is important to note that the rising Liberian dollar money supply that is not supported by strong real and external sectors has implication for exchange rate depreciation as evidence by the rising depreciation reported at end-2015.

Moreover, macroeconomic fundamentals are essential determinants of exchange rate. The central bank of any country cannot easily stop the depreciation of its domestic currency against other currencies. However, the central bank can mitigate the depreciation of its domestic currency by putting

in place policies aimed at increasing supply of foreign exchange to the domestic economy by widening its exports base through a sustained process and reducing its import payments, thus significantly improving its current account position. The current demand (proxy by the intervention variable, although not significant) control measure adopted by the CBL is not sustainable as it may negatively impact the country's international reserves, especially, in the face of declining net inflows of foreign exchange into the domestic economy. It is important to note that Central Bank of Liberia policy to intervene in the foreign exchange market to prevent the rapid fall of the Liberian dollar cannot only be a standalone decision, it requires both monetary and fiscal efforts. Although, the exchange rate for the reported period was found to be rightly signed and statistically significant at the 10.0 percent level, the level of significance is not robust enough. This is partly due to fiscal dominance. It is important to note that the exchange rate usually mirrors an economy: a weak economy produces a weak or depreciated currency. A central bank's decisions alone cannot cause the exchange rate to be stable or appreciate; such decisions should be complemented by prudent fiscal policy including investment in infrastructure, and the productive sectors of the economy.

This paper finds evidence, among others that the CBL's intervention in the foreign exchange market is sterilized. Moreover, the intervention variable is rightly signed but statistically insignificant, reflecting the low levels of intervention through the CBL's auction. The paper concludes that with a strong and negative relationship between broad money supply and exchange rate, the CBL should continue its intervention in the foreign exchange market to mitigate exchange rate pass through into inflation.

Based on the results of the analysis, we proffer the following recommendations: First, given the low levels of foreign exchange intervention, in the short run, the CBL's foreign exchange intervention strategy should be directed to major actors such as importers, businesses, and forex bureaus. The level of foreign exchange intervention should be informed by the level of CBL's international reserves . Second, the CBL should institute measures that would deter speculation and rent seeking behavior in the foreign exchange market and ensure that its intervention strategies are properly targeted at enhancing appropriate monetary policy stance, inflation control and exchange rate stability. Third, there is a need to convert portion of the remittance inflows to Liberian dollar to promote Liberian dollar monetary growth.

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Appendix
CUSUM Test Result