An Empirical Analysis of the Effect of Monetary Policy on the Manufacturing Sector in Nigeria

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Abstract

This study examined the effect of monetary policy on the manufacturing sector in Nigeria from 1970 to 2012 using Autoregressive Distributed Lag (ARDL) bound testing approach. Exchange rate was found as the only channel of monetary policy transmission with significantly negative effect on the manufacturing sector. This implies that manufacturing firms largely rely on foreign inputs for production and do not depend on the banking system for funding. The study, therefore, recommends indigenous technology and financial system development to reduce dependence on imported inputs and facilitate access to more funds.

Keywords: Monetary policy, manufacturing sector, and Nigeria.
JEL Classification: E52, L60

I. Introduction

The issue of monetary policy transmission has always been of key interest to economists and policy makers, though most analyses in this area have concentrated on the aggregate level of the economy (e.g. Cambazoglu and Karaalp, 2012; Hameed, 2011; Adefeso and Mobolaji, 2010; Okoro, 2013; David, 2010). Hayo and Uhlenbrock (1999), however, pointed out that this approach ignores possible asymmetries, at more disaggregated levels, of the effects of monetary policy across economic entities such as sectors or regions of the economy. Consequently, recent analyses of monetary policy have shifted focus from the question of whether monetary policy exercises significant effect on real aggregate variables to emphasising other aspects. One of such aspects that has received considerable attention of late is the sectoral effects of monetary policy shocks. Recent studies on the subject made it quite clear that different sectors of the economy respond differently to changes in monetary policy (Alam and Waheed, 2006; Saibu and Nwosa, 2012; Arnold and Vrugt, 2002). This observation has far reaching implications for macroeconomic management as the monetary authority would have to assess the differential effects of its actions on various sectors of the economy as the tightening of monetary policy might be considered mild from the aggregate perspective but it could be excessive for

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certain sectors. If this is true, then monetary policy should have strong distributional effects within the economy (Alam and Waheed, 2006). For this reason, monetary economists have called for a disaggregated analysis of monetary transmission mechanism (e.g. Carlino and Defina, 1998; Ganley and Salmon, 1997; Dedola and Lippi, 2005).

This study, therefore, is a disaggregated approach that focuses on the effect of monetary policy on the manufacturing sector. The sector is chosen because, according to Tkalec and Vizek (2009), it is one of the important and most tradable sectors of every economy, which in turn suggest that it is often the most competitive sector. Tkalec and Vizek (2009) further asserts that the importance of the manufacturing sector also stems from the fact that it is the carrier of innovation, research and development activities that eventually spill over to other sectors and result in increased productivity. The manufacturing sector reflects the extent to which an economy is developed especially as one of the ingredients of economic development is the composition of output or the degree to which an economy is able to transform primary products into manufactured goods (Todaro and Smith, 2005). Sanusi (2010) also pointed out that the sector is dynamic as it offers opportunities for capital accumulation, employment generation and economies of scale.

Ibrahim and Amin (2005), asserted that monetary policy (and the exchange rate in particular) is often considered to be the main reason for the weak performance of the manufacturing sector, and monetary disturbances may amplify fluctuations in manufacturing output at a magnitude greater than aggregate fluctuations. Given the key role of the manufacturing sector, the presence of this amplified effect on it needs to be verified empirically. Accordingly, this study examines the effect of monetary policy on manufacturing output because an understanding of the specific responses of the manufacturing sector would aid policy makers in their consideration of the sector in the formulation of monetary policy.

Most of the previous empirical studies in Nigeria (e,g. Adefeso and Mobolaji, 2010; Okoro, 2013; David 2010; Chimobi and Uche, 2010; Onyeiwu, 2013) focused on the effects of monetary policy on aggregate real output, neglecting sector specific analysis. This neglect of sectoral effect of monetary policy in the existing literature creates an empirical gap, which could undermine the policy relevance of inferences from the empirical evidence in previous studies in Nigeria. Monetary policy shock according to Alam and Waheed (2006) and Hayo Uhlenbrock (1999), have differential effect on disaggregated output. Also, sectoral effect differs as some sectors are more sensitive to certain monetary variables (Dale and Haldane, 1995). Hence, this research differs from all these earlier ones as it

investigates the sectoral effects with emphasis on the manufacturing sector. It is also different from the disaggregated studies by Saibu and Nwosa (2011 and 2012), Ubi et al. (2011) and Ubi et. al., (2012) because it examines broad money supply channel (M_2) which is absent in those previous studies, and uses more valid technique and updated data to capture recent trend and relationship between monetary policy variables and the manufacturing output. Thus, the objective of the study is to examine the relationship between monetary policy and the manufacturing output, and the channel through which monetary policy transmits its impulse on the manufacturing sector.

The paper is structured into five sections. The first section is the introduction, followed by literature review. This is then followed by the explanation of the methodology adopted in Section 3; data analysis, result discussion and policy implications are considered in Section 4 while Section 5 concludes the paper and proffer recommendations based on the findings of the study.

II. Literature Review

This section is presented in three sub-sections. The first dwells on review of major concepts. The second explains the theoretical underpinning of the study. In the last sub-section, a review of related empirical studies is presented.

II.1 Conceptual Issues

Two key concepts are used in this study. These are monetary policy and manufacturing sector, and are defined as follows:

According to Uchendu (2009) monetary policy is the use of the instruments at the disposal of the monetary authority to influence the availability and cost of credit or money with the ultimate objective of achieving price stability and sustainable growth. He further added that monetary policy influences the level of money stock and or interest rate i.e. availability, value and cost of credit in consonance with the level of economic activity. In the Nigerian context, monetary policy encompasses actions of the Central Bank of Nigeria that affect the availability and cost of commercial and merchant banks' reserve balances and thereby the overall monetary and credit conditions in the economy with the main objective being to ensure that overtime, the expansion of money and credit will be adequate enough for the long-run needs of the growing economy at stable prices (Akatu, 1993).

The manufacturing sector in Nigeria consists largely of a handful of factories engaged in the production of construction materials, clothing, textiles, footwear

and processed foods using simple assembly process (Kayode and Teriba, 1977). Mike (2010) asserts that the sector is a part of the real sector reputed to be an important engine of growth, an antidote for unemployment, a creator of wealth and the threshold for sustainable development. The art of manufacturing, according to Mustapha (2011), adds value to commodities and eventually creates more wealth. He further added that the ability of a nation to manufacture depends, to some extent, on their level of technological development.

II.2 Theoretical Framework

The study is based on the IS-LM framework, which was developed in 1937 by John R. Hicks to show theoretically how the product and money markets attain equilibrium simultaneously at the same level of income and interest rate (Anyanwu, 1995; Dwivedi, 2006). It has become the basis for understanding the adjustment process and the interaction of money and product markets (Anyanwu, 1995). According to Olweny and Chiluwe (2012), the IS-LM model offers a convenient model to analyse the effect of monetary policy on real macroeconomic variables. The IS curve shows the combinations of interest rates and levels of output at the equality between savings and investment while the LM schedule or money market equilibrium schedule represents combinations of interest rates and levels of income where demand for real money balances is equal to the supply (Olweny and Chiluwe, 2012; Dwivedi, 2006). Thus, the IS curve represents product market and LM curve represents money market (Dwivedi, 2006). Along the LM schedule the money market is in equilibrium, and along the IS curve the product market is in equilibrium (Dornbusch *et. al.,* 2002).

The adoption of the IS-LM framework follows the works of Olweny and Chiluwe (2012) and Saibu and Nwosa (2012). Olweny and Chiluwe (2012) explained that the IS-LM model offers a convenient model to analyse the effects of monetary policy while capturing the interplay of variables where private sector investment is determined by variables such as money supply, gross domestic debt, gross domestic savings and interest rates. According to Saibu and Nwosa (2012), in the Keynesian IS-LM approach, a discretionary change in monetary policy affects the real economy through the two sides of market forces – the demand and supply sides. Monetary policy from the aggregate demand side is transmitted either directly through the three channels; the exchange rate, the interest rate and the wealth channel or indirectly through the bank credit, which is transmitted through two channels; the bank-lending channel and the balance sheet channel. From the supply side, monetary policy impulse affects real variables through changes in the cost of inventory.

Though, Saibu and Nwosa (2012) acknowledged the supply side channel, they however adopted aggregate demand side channels for two reasons; first in the Keynesian framework, the aggregate supply is relatively fixed due to stickiness of price at least in the short-run. Second, the Nigerian economy is structurally weak and not well developed in a way that will allow the necessary adjustment to take place if the inventory cost approach is to be relevant, hence the adoption of the demand channel.

The channel of monetary policy transmission to the real sector is represented schematically as follows and as explained by the ISLM theory.

MS↑→INT↓→PSC↑→EXR↓→I↑→MO↑

In the above framework, **MS**↑ indicates expansionary monetary policy where there is government purchase of securities in the open market, resulting in decline in real interest rate, which in turn leads to increase in the amount of credit by Deposit Money Banks (DMBs) to the private sector; and decrease in exchange rate due to reduction in interest rate. These effects stimulate investment and consequently manufacturing output (Saibu and Nwosa, 2012). This could either result in increase or decrease in inflation level depending on the effect of money supply (MS) on price level and output.

II.3 Review of Empirical Studies

It is imperative to point out the major findings reported in the literature from both outside and within Nigeria on the effect of monetary policy on the manufacturing sector. Among the empirical studies conducted outside Nigeria, was the one by Carlino and Defina (1998). They examined whether monetary policy has symmetric effects across U.S during the period 1958:1 to 1992:4. Impulse response function from the estimated Structural Vector Auto Regression models (SVARs) revealed differences in policy response and the state of Michigan being the most responsive state to unanticipated changes in federal funds rate. The study further revealed that the size of state's long-run response to a monetary policy shock was positively related to the share of manufacturing with evidence of interest rate channel for monetary policy. The study found no evidence for the credit channel. A state's concentration of small firms has no significant effect on the size of the state's policy response and a greater concentration of small bank decrease states' sensitivity to monetary policy shocks.

Tkalec and Vizek (2009) examined the impact of macroeconomic policies on manufacturing production in Croatia. The analysis was conducted using quarterly

data from 1998:1 to 2008:2. The study modelled changes in the output of 22 manufacturing industries as a function of changes in macroeconomic conditions of monetary and fiscal policies as well as real effective exchange rate using ordinary least squares (OLS) approach. The results showed that restrictive monetary policy led to the contraction of manufacturing output. The results for exchange rate revealed that exchange rate depreciation boosts output in industries characterised by low and medium technological intensity but the opposite was true for industries requiring a high or medium level of technological intensity.

Yusof (2009) ascertained the relative effect of monetary indicators on sectoral output in Malaysia using quarterly data covering 1970:1 to 2008:3. The econometric appraisal of the monetary indicators was based on the Johansen-Juselius co-integration techniques, vector error correction model (VECM) and parsimonious error correction model (PECM). To take account of the effect of the mid-1977 financial crisis, a dummy variable was introduced in the model. The findings on Johansen-Juselius co-integration test revealed long-run relationship among the variables. The results on short-run relationship showed that broad money (M_2), interest rate and exchange rate were significantly linked to agricultural real output; while liquid money (M_1), interest rate and exchange rate were variables that affect manufacturing activity in the short run. Thus, credit and broad money do not affect manufacturing output. Construction and services output were not responsive to all the monetary indicators in the short-run.

A similar study on Pakistan by Alam and Waheed (2006) examined whether monetary policy shocks have different sectoral effects or not. The study adopted a reduced form Vector Autoregressive (VAR) approach to estimate the statistical relationship among the set of variables. The analysis estimated VAR for each sector as well as for aggregate production. The result for the real output (GDP) revealed that monetary policy, proxied by call money rate, has significant impact on the GDP i.e. real output declines in response to monetary tightening. On the sectoral output, the findings indicated that mining and quarrying; manufacturing; wholesale and retail trade; and finance and insurance sectors were more responsive to monetary shocks. Agriculture and construction sectors were weakly interrelated with interest rate.

Ibrahim and Amin (2005) investigated the dynamic effects of exchange rate and monetary policy shocks on manufacturing output in Malaysia using quarterly data spanning from 1978:1 to 1999:4. The study used Vector Autoregressive (VAR) approach and co-integration technique based on Johansen (1988) and Johansen-Juselius (1990). The co-integration test revealed that the variables were

co-integrated. The findings generally showed that shocks in the interest and exchange rates had significant negative effect on manufacturing output and output of other sectors.

Sukmana (2011) investigated the sensitivity of the economic sectors to changes in the Islamic and conventional monetary policy. The study covers the period from June 2006 to February 2011 using monthly data. The researcher carried out co-integration test based on Johansen and Juselius procedure and also estimated the Impulse Response Function (IRF). The study used Industrial Production Index (IPI) as the dependent variable while overnight interbank rate for conventional bank was adopted as a proxy for the conventional monetary instrument (CONOMIST) and the Islamic overnight interbank rate was used as a proxy for the Islamic monetary policy (ISMONINST). The findings revealed that real output was not influenced by conventional rate but it responded negatively to Islamic monetary instrument. Only the manufacturing sector responded positively to the shock of the conventional monetary rate.

Having examined evidence from other countries on disaggregated impact of monetary policy, we now report studies within Nigeria on the topic. The study by Saibu et al. (2011), studied the relative effect of monetary policy in stimulating sectoral output growth using quarterly data over the period 1986:1 to 2008:4. The model used was Autoregressive Distributed Lag (ARDL) bound testing to co-integration and the error correction model. Six sectors were analysed and the findings revealed that all the sectors were sensitive to varying monetary policy indicators but the manufacturing sector was not sensitive to any of the monetary policy variables both in the short-run and long-run.

Saibu et. al., (2012) in another related research, investigated the monetary transmission mechanism on six sectors of the Nigerian economy. The study employed quarterly data spanning from 1986:1 to 2009:4 and the sectors included were agriculture, mining, manufacturing, building and construction, wholesale and retail trade and the service sectors. Six unrestricted VAR systems for the six sectors were estimated as well as variance decomposition. The result revealed that there were differences in the channels through which monetary policy was transmitted to the various sectors and that only two channels were outstanding i.e. the interest rate channel and the exchange rate channel. Thus the credit and the asset price were weak channels of transmitting monetary policy impulse. The interest rate channel was responsible for transmitting monetary policy to the manufacturing sector.

Ubi et. al., (2011) looked at the relationship between monetary policy and industrialisation in Nigeria with data covering the period 1970-2008. The authors

adopted a Vector Autoregressive (VAR) model and the Forecast Error Variance Decomposition (FEVD) estimates. They found that the predominant sources of fluctuations in industrialisation in Nigeria were largely own shocks and to a lesser extent monetary policy i.e. linkage between industrialisation and monetary policy in Nigeria is weak and unpredictable in both the short-run and long-run.

In a similar research by Ubi et. al., (2012), an empirical assessment of the impact of monetary policy on industrialisation in Nigeria as an open economy was carried out with a sample period of 1970-2009. The study adopted the Johansen co-integration approach, error correction model (ECM) and the parsimonious model as estimation techniques. The findings revealed that monetary policy has statistically significant impact on industrialisation in both the short-run and long-run in Nigeria.

Ehinomen and Oladipo (2012) investigated the impact of exchange rate management on the growth of the manufacturing sector in Nigeria with data covering the periods 1986-2010 using Ordinary Least Square (OLS) analysis. The study found inverse relationship between exchange rate depreciation and manufacturing production in Nigeria, and significantly positive effect of inflation on manufacturing output.

In a similar study, David et. al., (2010) investigated the effects of exchange rate fluctuations on the Nigerian manufacturing sector from 1986-2005. The study used Ordinary Least Square (OLS) regression technique and the results revealed statistically significant adverse effect of exchange rate fluctuations on the manufacturing output.

The review of empirical studies suggests that studies on the effect of monetary policy on the manufacturing sector are few in Nigeria and the findings are inconclusive hence the need for further empirical investigation. This research, therefore, adds to the existing literature by including more data, relevant variables and employing more adequate econometric model in order to arrive at a robust outcome that would provide valuable information to the monetary authority in the design of appropriate monetary policy for the development of the manufacturing sector in Nigeria.

III. Research Methodology

III.1 Data

This research, in view of its nature, made use of secondary data. Annual data were employed and were sourced from the Central Bank of Nigeria (CBN) Statistical Bulletin and National Bureau of Statistics (NBS) financial and external

sector statistics for the period 1970-2012. The 43-year period is selected to meet the requirement of the Central Limit Theorem that sample size must not be less than thirty years for normality purpose, and the fact that the larger the sample, the greater the reliability or validity of time series research findings (Gujarati, 2005).

III.2 Variables Measurement

The dependent variable is real manufacturing output and is used as a proxy for the manufacturing sector following the works of Saibu *et al.* (2011 and 2012). The independent variables are measured as follows: Broad money (M_2) stands as a proxy for money supply as applied by Ubi et. al.,(2011) and Onyeiwu (2013). We used prime lending rate as a proxy for interest rate. Anthony and Mustapha (2011) also used this as a proxy. Official exchange rate of the naira to the US dollar was used as a proxy for exchange rate following David (2010), Anthony and Mustapha (2011), Saibu *et al.* (2011 and 2012), and David *et al.* (2010). Private sector credit is used to represent the credit channel following Sabiu et. al., (2011 and 2012). Consumer Price Index (CPI) is incorporated into the model as a proxy for inflation rate following the works of David (2010), Saibu et. al.,(2011 and 2012).

III.3 Model Specification

The econometric model used for the study is adapted from Saibu and Nwosa (2011) and is specified as follows:

$$InRMO = \beta_o + \beta_1 InMS_t + \beta_2 InINT_t + \beta_3 InEXR_t + \beta_4 InPSC_t + \beta_5 InCPI_t + U_t \quad (1)$$

Where:

lnRMO	=	log of real manufacturing output
β_o	=	Constant parameter
β_1- β_5	=	Coefficients of the explanatory variables
U_t	=	Stochastic disturbance term
$lnMS_t$	=	log of money supply
$lnINT_t$	=	log of interest rate
$lnEXR_t$	=	log of exchange rate
$lnPSC_t$	=	log of credit to the private sector
$lnCPI_t$	=	log of consumer price index
t	=	Time Subscript

Therefore, equation 1 was employed as a model for this research.

III.4 Method of Data Analysis

The data collected for this research were analysed using Autoregressive Distributed Lag (ARDL) model along with error correction model following the

works of Saibu and Nwosa (2011); Aliero *et al.* (2013); Khosravi and Karimi (2010). The ARDL model is a recent innovation in time series econometrics developed by Pesaran and Shin (1996); Pesaran and Pesaran (2001); for testing the existence of co-integration. One of the advantages of using the ARDL approach to testing for the existence of a long-run relationship between variables is that it is applicable irrespective of whether the underlying variables are purely I(0) or I(1), or a mixture of both (Khosravi and Karimi, 2010). However, in the presence of I(2) variables, the computed F-statistics provided by Pesaran *et al.*(2001) will become invalid.

Therefore, the use of unit root tests in the ARDL approach is inevitable to ensure that none of the variable is integrated of order I(2) or beyond. To detect the presence or otherwise of unit root, we consider a variable that has a unit root represented by a first order autoregressive AR (1) as follows:

$$Y_t = \beta Y_{t-1} - U_t. \quad (2)$$

Where Y_t is the level variable, Y_{t-1} is the first lag of the dependent variable (Y_t), β is the parameter and U_t is the white noise error term assumed to be normally distributed with zero mean and constant variance and also assumed to be serially uncorrelated. If the absolute value of the coefficient β is less than 1 (i.e. $|\beta|<1$), then Y_t is stationary. If, on the other hand, the absolute values of the coefficient β is statistically equal to or greater than 1 (i.e $|\beta| \geq 1$) then Y_t is non stationary and unit root exists (Gujarati, 2005). To identify stationarity or non-stationarity of the variables used in this research, we adopted the Phillips-Peron (PP) unit root test and the conventional Augmented Dickey – Fuller (ADF) unit root test based on the model expressed below:

$$\triangle Y_t = \beta_0 + \beta_1 Y_{t-1} + a_i \sum \triangle Y_{t-I} + u_t \quad (3)$$

Where:

$\triangle Y_t$ = Differenced value of a given time series variable
β_0 = Constant Parameter
β_1 = Coefficient of the first lag value of the series variable
Y_{t-1} = First lag value of a series variable
a_i = Coefficient of the lag values of the differenced time series variable
$\triangle Y_{t-i}$ = Lag values of the differenced series variable
u_t = Error term

The Autoregressive Distributed Lag (ARDL) model used in this study is expressed as follows:

$$\triangle \ln RMO = \delta_0 + \delta_1 \ln RMO_{t-1} + \delta_2 \ln MS_{t-1} + \delta_3 \ln INT_{t-1} + \delta_4 \ln EXR_{t-1} + \delta_5 \ln PSC_{t-1} + \delta_6 \ln CPI_{t-1} + \sum \lambda_1 \Delta \ln RMO_{t-i} + \sum \lambda_2 \Delta \ln MS_{t-i} + \sum \lambda_3 \Delta \ln INT_{t-i} + \sum \lambda_4 \Delta \ln EXR_{t-i} + \sum \lambda_5 \Delta \ln PSC_{t-i} + \sum \lambda_6 \Delta \ln CPI_{t-i} + \upsilon_t \quad (4)$$

Where δ_0= Constant Parameter

Δ = First difference operator

δ_i, λ_i = Vector of the parameter of the lagged values of the natural logarithmic values of the explanatory variables.

υ_t = Error term

The terms with the summation signs ($\sum$) in equation 4 above represent the error correction dynamics while the second part of the equation with δ_i correspond to the long-run relationship. The null hypothesis in the equation is $H_0 = a_1 = a_2 = a_3 = 0$. This denotes the absence of long-run relationship while the alternative hypothesis is H_1: $a_1 \neq a_2 \neq a_3 = 0$. The calculated F-statistic is compared with two sets of critical values. One set assumes that all the variables are I(0) and the other assumes they are I(1). If the calculated F – statistic exceed the upper critical value, the null hypothesis of no co-integration will be rejected irrespective of whether the variables are I(0) or I(1). If it is below the lower bound value, the test is inconclusive (Ali, 2015).

Once a co-integration relationship has been ascertained the long-run and short run parameters of the co-integration equation are then estimated. The long run co-integration relationship was estimated using the following specification:

$$\ln RMO = \delta_0 + \delta_1 \ln RMO_{t-1} + \delta_2 \ln MS_{t-1} + \delta_3 \ln INT_{t-1} + \delta_4 \ln EXR_{t-1} + \delta_5 \ln PSC_{t-1} + \delta_6 \ln CPI_{t-1} + U_t \quad (5)$$

In order to estimate the short-run relationship between the variables and the speed of adjustment of the model to equilibrium, the corresponding error correction equation was estimated as expressed below:

$$\ln RMO = \lambda_0 + \sum \lambda_1 \Delta \ln RMO_{t-i} + \sum \lambda_2 \Delta \ln MS_{t-i} + \sum \lambda_3 \Delta \ln INT_{t-i} + \sum \lambda_4 \Delta \ln EXR_{t-i} + \sum \lambda_5 \Delta \ln PSC_{t-i} + \sum \lambda_6 \Delta \ln CPI_{t-i} + \lambda_7 ECM_{t-1} + U_t \quad (6)$$

Where, ECM is the Error correction term of one period lag estimated from equation (6), the coefficient λ_7 measures the speed of adjustment of the model's convergence to equilibrium.

IV. Data Analysis and Results Discussions

In this section, the results of the study are presented, analysed and discussed.

IV.1 Unit Root Test Results

The results of our unit root tests using the Augmented Dickey Fuller (ADF) and Phillips Perron (PP) tests are presented in table 1.

Table 1: Unit Root Tests Results

	ADF Unit root test			PP unit root test		
Variables	**At Level I(0)**	**At First Diff. I(1)**	**Status**	**At Level I(0)**	**At First Diff. I(1)1)**	**Status**
lnRMO	-2.669*		I(0)	-2.857*		I(0)
lnMS	-0.35	-4.609***	I(1)	-0.348	-4.603***	I(1)
lnINT	-1.68	-9.148***	I(1)	-1.535	-9.139***	I(1)
lnEXR	-0.129	-5.211***	I(1)	-0.244	-5.228***	I(1)
lnPSC	-0.275	-4.923***	I(1)	-0.283	-4.905***	I(1)
lnCPI	-3.922***		I(0)	-3.82***		I(0)
Note: significant at 1 per cent (***) and 10 per cent (*). The values presented are test statistic values.						

Source: Stata 10.0.

As a first step in the analysis, the series were transformed into natural logarithm form and tests for unit roots in the variables at both level and first difference values were conducted.

Considering the manufacturing output (lnRMO) and lnCPI in Table 1, it was found that the null hypothesis of a unit root at level is rejected in both the ADF and PP tests. Hence, manufacturing output and CPI are stationary at level values I(0). This is because in absolute term, their test statistic values are greater than the critical values at 10 per cent and 1 per cent respectively. The results of data on money supply (lnMS), interest rate (lnINT), exchange rate (lnEXR) and private sector credit (lnPSC) indicate that the variables are not stationary at level. But taking their first difference, the variables became stationary at first order I(1) as their test statistic values in absolute term are greater than their respective critical values at 1 per cent. In summary, the unit root test has indicated that our independent variable (i.e. manufacturing output) and one of the explanatory variables (inflation rate) are stationary at level i.e. I(0) while the remaining variables are integrated of the first order i.e. I(1) (see Table 1). This implies that none of the series is I(2) and can all be included in the ARDL estimation.

IV.2 Optimum Lag Selection Criteria

Optimum lag selection was carried out in order to determine the number of lag(s) to be included in the model prior to the bound test. The results are presented in Table 2.

Table 2: Optimum Lag Selection Criteria

Lag	LL	LR	Df	P	FPE	AIC	HQIC	SBIC
0	-11.629				0.141635	0.88094	0.97269	1.13443
1	3.83822	30.92*	1	0.000	0.06883*	0.15809*	0.26495*	0.45364*
2	4.02341	0.37038	1	0.543	0.071821	0.19883	0.320959	0.536605
3	4.87008	1.6933	1	0.193	0.072545	0.206496	0.343891	0.586494

Source: Stata 10.0.

From Table 2, the Sequential Modified Likelihood Ratio (LR), Final Prediction Error (FPE), Akaike Information Criteria (AIC), Hanna-Quinn Information Criteria (HQIC) and Schwarz-Bayesian Information Criteria (SBIC) indicate one maximum lag selection at 1 per cent level of significance.

IV.3 Bound Test for Cointegration Analysis

Having conducted the unit root test and the optimum lag selection, F-statistic test for cointegration is required to determine whether there is cointegration among the variables captured in the unrestricted error correction version of the ARDL model. This has been estimated using the bound testing approach and the results presented in Table 3.

From table 3, the bound test results reveal the existence of six co-integrating equations among the variables. When manufacturing output is the dependent variable, i.e. in the function F_{lnRMO} (lnRMO/lnMS, lnINT, lnEXR, lnPSC, lnCPI), the null hypothesis that there is no co-integration between monetary policy variables and the manufacturing output is rejected at both 5 per cent and 10 per cent as the F-statistic, 4.0494 is greater than the critical value, 3.7583 and 3.1892 at the upper bound indicating there is co-integration between monetary policy and the output of the manufacturing sector. When money supply, interest rate and exchange rate were each captured as the dependent variable, their respective F-statistics (2.7839, 2.6404 and 3.0698) are less than the upper bound critical values (i.e. 3.7583 and 3.1892) at 5 and 10 per cent; but greater than the lower bound critical values, 2.3675 and 1.9666, at 5 per cent, which also indicate the rejection of the null hypotheses of no co-integration at 5 per cent level.

Table 3: Bound Test Results

Dependent Variable	Function	F-Statistics
$\ln RMO$	$F_{\ln RMO}(\ln RMO \mid \ln MS, \ln INT, \ln EXR, \ln PSC, \ln CPI)$	4.0494**
$\ln MS$	$F_{\ln MS}(\ln MS \mid \ln RMO, \ln INT, \ln EXR, \ln PSC, \ln CPI)$	2.7839**
$\ln INT$	$F_{\ln INT}(\ln INT \mid \ln MS, \ln RMO, \ln EXR, \ln PSC, \ln CPI)$	2.6404**
$\ln EXR$	$F_{\ln EXR}(\ln EXR \mid \ln INT, \ln MS, \ln RMO, \ln PSC, \ln CPI)$	3.0698**
$\ln PSC$	$F_{\ln PSC}(\ln PSC \mid \ln EXR, \ln INT, \ln MS, \ln RMO, \ln CPI)$	39.2623**
$\ln CPI$	$F_{\ln CPI}(\ln CPI \mid \ln PSC, \ln EXR, \ln INT, \ln MS, \ln RMO)$	3.8404**
Asymptotic Critical Value for Rejecting Null Hypothesis		
Critical value	At 5 per cent	At 10 per cent
Lower bound	2.3675	1.9666
Upper bound	3.7583	3.1892

Note: Significant at 5 per cent (**).
Source: Microfit 5.0.

Also, for the functions where private sector credit and inflation were each used as the dependent variable, the F-statistics (39.2623 and 3.8404) fall above the critical value at the upper bound (i.e. 3.7583 and 3.1892) indicating the existence of co-integration at 5 per cent level. In a nutshell, the bound testing has indicated the existence of strong co-integrating equations among the series as revealed by the F-statistic and the critical values; meaning that there is long-run relationship among the variables.

IV.4 Results of Estimated Long-run Coefficients Based on ARDL Approach

Owing to the fact that the existence of co-integration among the variables has been established, the long-run relationship between manufacturing output and monetary policy variables has also been estimated using the ARDL approach with ARDL (1,0,0,0,0,0) specification selected based on Akaike Information Criterion. The results are presented in Table 4.

The results reported in Table 4 reveal that the null hypothesis of no co-integration between money supply channel and manufacturing output in Nigeria cannot be

rejected as can be seen from the P-value 0.78770. Furthermore, on interest rate and the manufacturing sector, the p-value (0.185) implies rejection of the alternative hypothesis indicating absence of significant long-run relationship between the manufacturing sector and interest rate in Nigeria though the coefficient, 0.91002, is positive. On the other hand, a negative and significant long-run relationship is found between exchange rate channel and the manufacturing sector in Nigeria. This is because the p-value (0.000) signifies rejection of the null hypothesis at 1 per cent level of significance. While the estimated coefficient which is -0.76270 indicates that a 10 per cent increase in exchange rate in Nigeria leads to approximately 7.63 per cent decrease in manufacturing output in the long-run (see Table 4).

Table 4: Result of Estimated Long-run Coefficients Based on ARDL Approach: ARDL (1,0,0,0,0,0) Selected Based on Akaike Information Criterion (AIC)

(Dependent Variable: lnRMO)

Independent Variables	Coefficients	Standard Error	Test –Ratio
LnMS	0.97189	1.2338	0.7877
			(0.436)
LnINT	0.91002	0.67317	1.3518
			(0.185)
LnEXR	-0.7627***	0.19642	3.8829
			(0.000)
LnPSC	-0.21071	1.1764	0.17912
			(0.859)
LnCPI	-0.10913	0.27396	0.39834
			(0.693)

Note: Significant at 1 per cent (***). The values in parenthesis are probability values.
Source: Microfit 5.0.

From the results of private sector credit and inflation, they reveal the acceptance of the null hypothesis, which states that no co-integration between each of private sector credit on one hand, inflation on the other hand, and the manufacturing sector. This is because their p-values, 0.859 and 0.693, respectively, are not statistically significant though their coefficient estimates (-0.21071 and -0.10913) imply negative relationship.

Therefore, the results indicate the existence of long-run relationship between monetary policy and the manufacturing sector in Nigeria; and that monetary

policy shock is transmitted with negative effect on the manufacturing sector through the exchange rate channel of monetary transmission mechanism.

IV.5 Results of Estimated Short-run Relationship Between Monetary Policy and the Manufacturing Sector

The short-run relationship between monetary policy and the manufacturing sector is estimated using the error correction model and the results are presented in Table 5 as follows.

From Table 5, the error correction coefficient (ecm), which is approximately -0.22 not only has the expected negative sign but it is also statistically significant at 5 per cent considering the probability value which is 0.028. The value of the ecm implies a fairly slow speed of adjustment to equilibrium after a shock. Approximately 22 per cent of disequilibria from the previous year's shock converge back to the long-run equilibrium in the current year. For the respective explanatory variables, as in the case of the long-run estimation, the short-run results only show the existence of significant negative relationship between exchange rate and the manufacturing sector at 5 per cent level. The result indicates that a 10 per cent increase in exchange rate will approximately result in 0.5 per cent decline in the manufacturing output. The coefficients of other monetary/explanatory variables are not significant.

Table 5: Results of Error Correction Version of the ARDL Model

(Dependent Variable: ΔlnRMO)			
Independent Variables	**Coefficients**	**Standard Error**	**Test –Ratio**
ΔlnMS	0.20896	0.23286	0.89805
			(0.375)
ΔlnINT	0.19565	0.20283	0.96459
			(0.341)
ΔlnEXR	-0.045303**	0.062097	2.6407
			(0.012)
ΔlnPSC	-0.045303	0.24482	0.18505
			(0.845)
ΔlnCPI	-0.023463	0.057596	0.40737
			(0.686)
ecm(-1)	-0.21500**	0.094185	2.2827 (0.028)

Note: Significant at 5 per cent (**). The values in parenthesis are probability values.
Source: Microfit 5.0.

In summary, the short-run results indicate that monetary policy is transmitted with negative effects on the manufacturing sector in Nigeria through the exchange rate channel, which is the same as the long-run effects earlier explained.

IV.6 Results of the Diagnostic Test of the ARDL Approach

To justify the adequacy of the selected ARDL model, post-estimation diagnostic tests for serial correlation and heteroscedasticity were carried out and the outcome is presented in Table 6.

Table 6: Results of the Diagnostic Test of the selected ARDL Model

Test of Serial Correlation of Residuals		
L M Version	CHSQ(1)	0.0087245 (0.926)
F Version	F(1,35)	0.0072719 (0.933)
Autoregressive Conditional Heteroscedasticity Test of Residuals		
L M Version	CHSQ(1)	0.0545521 (0.815)
F Version	F(1,35)	0.045519 (0.832)

Note: The values in parenthesis are probability values.
Source: Microfit 5.0.

From Table 6, the Langrange Multiplier (LM) test was adopted and the p-value is 0.926, which is not significant and indicating that the null hypothesis of no serial correlation is accepted. This is indeed a desirable result proving the adequacy of the selected ARDL model. Also, on the test for heteroscedasticity, autoregressive conditional heteroscedasticity test was carried out and the null hypothesis, which says that the model is homoscedastic, could not be rejected going by the p-value (0.815). This indicates that the model is not heteroscedastic. In a nutshell, the two post-estimation tests have complemented each other in justifying the adequacy of the adopted ARDL model.

IV.7 Discussion of Results

This paper has empirically examined the effects of monetary policy on the manufacturing sector in Nigeria from 1970 to 2012 using time series analysis. Firstly, the data were transformed into natural logarithm as suggested by Ibrahim and Amin (2005), Khosravi and Karimi (2010) and Aliero *et al*. (2013); and ADF and PP tests were used in testing for the stationarity of the variables. Due to the outcome of our unit root tests which reveal a mixture of integration order, i.e. I(0) and I(1) among our variables, bound testing approach to co-integration with an

autoregressive distributed lagged (ARDL) model became an unavoidable estimation procedure; being a technique capable of providing consistent estimation when variables are integrated of different orders. The discussion of the outcome examines how the results of this research, earlier explained are in line with or different from similar studies previously conducted; and it takes the form of three dimensions: firstly on the long-run effects of monetary policy on the manufacturing sector; secondly on the short-run relationship among the variables. and lastly, the policy implications of the findings.

IV.7.1 Discussion of Results on the Long-run Relationship Between Monetary Policy and the Manufacturing Sector in Nigeria

To start with, the bound testing approach confirmed the existence of cointegration between monetary policy variables and the output of the manufacturing sector. This is in line with the findings of Yusof (2009), Sukmana (2011), Ibrahim and Amin (2005), and Carlino and Defina (1998). The result is, however, in contrast with the work of Saibu and Nwosa (2011), which revealed no cointegration among the variables.

On the long-run relationship among the variables, our ARDL results reveals a positive but statistically insignificant long-run relationship between broad money supply (M_2) and manufacturing output in Nigeria, which is in conformity with the work of Yusof (2009); but partially contradicts the work of Khosravi and Karimi (2010), which revealed a negative but insignificant relationship. This means that the broad money supply channel does not transmit long-run monetary policy impulse to the manufacturing output in Nigeria. The result is also in conformity with the Keynesian argument that money is neutral and has no real effect in the long-run due to liquidity trap as explained in the works of Alam and Waheed (2006), Yusof (2009), and Taylor (1995).

The interest rate channel on the other hand, reveals positive but statistically insignificant long-run relationship with the manufacturing output. The positive sign of the coefficient of interest rate is not in line with the economic theoretical proposition that rising interest rate crowd out real investment (Olweny and Chiluwe, 2012). However, the result is not statistically significant. This evidence of no long-run effect of interest rate channel on the manufacturing sector is inconsistent with the findings of Sukmana (2011), which revealed positive and significant long-run relationship; and contradicts the work of Ibrahim and Amin (2005), Tkalec and Vizek (2009), Carlino and Defina (1998), which showed negative and statistically significant long-run relationship. The result which reveals no interest rate channel aligns with what is obtainable in money supply above as

money supply transmits its impulse on the real sector through the interest rate channel of monetary transmission mechanism (Saibu and Nwosa, 2012). Hence, since there is no evidence of money supply channel, it is consistent with economic theory that there should be no evidence of interest rate channel of monetary policy transmission on real manufacturing output.

The findings on exchange rate channel, which reveal negative and statistically significant effect on the manufacturing output conforms with the research conducted by Ibrahim and Amin (2005) and Ubi et al. (2012). It is, however, in contrast with the works of Yusof (2009) and Saibu and Nwosa (2011) that found no evidence of exchange rate channel. Our result implies that exchange rate changes affect the growth of the manufacturing sector in the long-run. Lastly, the results of private sector credit and inflation that reveal no statistically significant effects are in line with the findings on both variables by Saibu and Nwosa (2011), Yusof (2009); and the findings of Carlino and Defina (1998) on the credit channel. The results buttress the findings on broad money supply channel explained above that reveals insignificant long-run relationship with the manufacturing sector.

4.7.2 Discussion of Results on Short-run Relationship Between Monetary Policy and the Manufacturing Sector in Nigeria

On the short-run relationship, it has been discovered that the error correction term is negative and statistically significant. This is in conformity with earlier studies by Saibu and Nwosa (2011), and Yusof (2009). On the short-run broad money channel, which this study found no evidence of relationship with the manufacturing sector in Nigeria, the result conforms to that of Yusof (2009) but contradicts Ubi et al. (2012) that indicated significantly positive relationship.

The findings on interest rate, which shows no significant short-run negative relationship with the output of the manufacturing sector is in line with Ubi *et al.* (2012), and Saibu and Nwosa (2011). The result is, however, in contrast with the studies conducted by Alam and Waheed (2006), Yusof (2009), Tkalek and Vizek (2009) and Saibu and Nwosa (2012) which revealed short-run negative relationship. The results of broad money supply and interest rate contradict Keynesian propositions that monetary policy is effective in the short-run as elucidated by Agba (1994) and Afolabi (1998).

On the exchange rate channel, the findings of this study reveal negative and statistically significant effect on the manufacturing sector in the short-run which, is in conformity with the works of Yusof (2009), Ehinomen and Oladipo (2012), David *et al.* (2010) and Ubi (2012). It is, however, not in line with the findings of Saibu and

Nwosa (2011 and 2012) that found no evidence of exchange rate channel on the sector in the short-run. These findings imply that changes in exchange rate adversely affect the growth of the manufacturing sector in the short-run.

While the result on private sector credit, which is positive but insignificant in the short-run, aligns with the works of Yusof (2009) and Saibu and Nwosa (2011 and 2012); the negative but statistically insignificant short-run relationship as revealed by inflation result is partially in contrast with the study by Saibu and Nwosa (2011), which revealed inflation to have negative and statistically significant short-run relationship with the sectoral output. The inflation result is, however, in conformity with the work of Alam and Waheed (2006); and partially in line with the work of Ehinomen and Oladipo (2012) that revealed positive and significant relationship.

The results of the study were also found largely not to be in conformity with the previous studies (e.g. David, 2010; Okoro, 2013; Adefeso and Mobolaji, 2010; Onyeiwu, 2013) that focus on aggregate output hence the need for sector-specific monetary policy design with regards to the manufacturing sector.

IV.7.4 Policy Implications of Findings

The findings of the study indicate that broad money supply, interest rate, private sector credit and inflation do not explain changes in the output of the manufacturing sector. It is found that exchange rate is the only effective channel of monetary policy transmission on the manufacturing sector, and increase in exchange rate have negative effect on the growth of the sector in Nigeria.

On the money supply channel, the reason why no evidence from both short-run and long-run is traceable to the manufacturing sector could be because firms in the sector are more of small and medium scale holding large and highly liquid money due to the underdeveloped nature of the Nigerian financial system and the need to safeguard against the uncertainties of the system. According to Gbandi and Amissah (2014), small and medium enterprises represent about 90 per cent of total manufacturing establishments in Nigeria.

The result which also reveals that the sector is not interest rate sensitive implies that manufacturing firms are not heavily dependent on bank loans. In addition, the credit channel is not important in both long-run and short-run, and this could be because firms in the sector largely rely on their own sources of funding such as personal savings and retained earnings; as such, interest rate, broad money and credit are not important channels. Hence, narrow/liquid money (M_1) may be having greater role in the manufacturing sector. However, this needs empirical verification. More so, the rapid technological and communications development

in banking facilities could result in a fundamental increase in M_1 given the increased demand for internet banking, telephone banking, automated teller machines (ATM), debit cards and credit cards, which allow for greater access to highly liquid money in the banking system (Yusof, 2009).

The evidence on exchange rate channel, which indicates a significant negative long-run and short-run relationship with the manufacturing sector, could be because the sector largely depends on foreign technology and inputs as explained by David *et al*. (2010). Fluctuating and high exchange rate causes instability or reduction in the purchasing power of manufacturing firms for importation of inputs, which results in reduction in the output of the sector. The finding is also in line with the theoretical argument by Yusof (2009) that in an increasingly globalising world economies, exchange rate channel of monetary transmission is one of the most dominant determinant of real output. The findings on inflation reveal no significant effect on the manufacturing sector. This implies that inflation does not explain changes in the output of the manufacturing sector. This could be because consumer price index (CPI) is used in measuring inflation. With empirical investigation, producer price index (PPI) may be having a significant impact on the sector.

In addition, our findings on the sector reveal that its reaction to changes in monetary indicators largely differs from the results on aggregate output in previous studies examined in the literature (David 2010; Okoro 2013; Adefeso and Mobolaji 2010; and Onyeiwu 2013). This, therefore, suggests that the use of monetary policy instruments to stimulate output of the manufacturing sector based on the findings on aggregate output could result in policy ineffectiveness. Hence, the need to adopt sector-specific policy measures on the basis of sectoral empirical investigations. Monetary policy aimed at improving the manufacturing sector should be designed on the basis of empirical evidences on how the transmission channels specifically affect the sector, and not from evidences from studies on aggregate output.

V. Recommendations and Conclusions

From the findings above, conclusions are drawn that broad money supply, interest rate and private sector credit do not cause changes to the growth of the manufacturing sector in Nigeria. This could mean that firms in the sector hold more of liquid money and do not depend on the financial system to finance their economic activities probably due to the underdeveloped nature of the financial system, insufficiency of funds and high rate of interest on borrowing from banks. Hence, they rely on personal or other sources of funding outside the banking

system. This calls for the need to adopt policies to further strengthen the financial system as a catalyst for economic development.

The findings on exchange rate indicated that it is the only channel responsible for transmitting monetary policy impulse with significantly negative effect on the manufacturing sector. This could be as a result of the sector depending largely on external sources of technology and other inputs. This suggests the need for policies that will encourage the development and the use of domestic technology and raw materials in manufacturing activities to reduce dependence on imported ones. The result on inflation revealed no significant long-run and short-run effects on the manufacturing sector, which implies that inflation does not explain changes in the output of the sector.

Generally, the findings of this study have demonstrated that the potential benefits of promoting growth in the output of the manufacturing sector by the Central Bank of Nigeria (CBN) can be fully realised when the sector's specific responses to monetary transmission mechanism, through empirical verifications, are taken into consideration in the design of monetary stabilisation policies.

Based on the results of this research, which revealed that broad money supply channel is not significant in influencing manufacturing output in Nigeria due to the underdeveloped nature of the financial system, we recommend development of the system through mobilisation of more savings from the public and linking resources from the informal or traditional financial sector to the banking system. This is expected to increase broad money supply (M_2) as a percentage of GDP, reduce interest rate, and increase access to funds and investment in the manufacturing sector.

It is also empirically discovered that interest rate channel does not transmit monetary policy impulse to the manufacturing sector as firms in the sector do not depend on bank loans. Based on this, it is recommended that interest rate should be reduced to a level that would facilitate access to funds in the banking system by manufacturing firms in order to enhance investment in the sector.

The findings of the study revealed that exchange rate is the only channel with significant adverse effect on the growth of the manufacturing firms due to their high dependence on imported input. Hence, development of indigenous technology and encouragement of firms in the sector to use locally sourced raw materials is recommended. These, the government could achieve by making adequate funding available to indigenous science and technology research centres, and encouragement of science and technology-based knowledge acquisition through provision of the needed facilities in schools and higher

institutions. There is also the need for more research grants to higher institutions and scholarships to science and engineering students with strict guidelines and monitoring to prevent diversion of funds. Local content laws should be adequately enforced through monitoring of firms' compliance with the relevant regulations. In relation to this finding on exchange rate, fiscal policy with regards to high customs duty should be placed on imported inputs that have local substitutes, and domestic patronage of the products of manufacturing firms should be enhanced through embargo or quota on competitive foreign products.

In addition, it is found that output of the manufacturing sector is not responsive to changes in private sector credit. This has been explained to be as a result of the sector depending largely on retained earnings, private savings and other sources of funds due to high interest rate on bank loans. It is, therefore, suggested that credit to the private sector be enhanced, monitored and a reasonable percentage be directed to the manufacturing firms in order to protect the sector from undue competition for loans, and commercial banks' credit rationing which could be in favour of other more developed and competitive sector or few firms within the manufacturing sector.

Furthermore, the monetary authority should maintain low and steady inflation rate that would enhance investors' confidence in the economy. This is expected to bring stability in the economy and higher investment in the manufacturing sector.

There is also need for sustained reform of the banking sector and strengthening of the monetary policy design and implementation by adopting sector specific policy with regards to the efficacy of the monetary transmission channels based on their relative strength and significance in influencing sectoral output. This is because the findings of this study revealed that the effects of monetary policy on the manufacturing output differ from its impact on aggregate output as revealed by previous empirical literature on the Nigerian economy.

Lastly, since broad money supply (M_2) channel is found not to have significant effect on the output of the manufacturing sector, there is need for empirical investigations to determine whether narrow money supply (M_1) explains changes in the output of the sector. There is also need to investigate domestic credit, credit to manufacturing sector, and liquidity ratio to determine their effects on the manufacturing sector. The Nigerian manufacturing sector is categorised into three – oil and gas, cement, and other manufacturing – hence, empirical investigations should be conducted to determine the possible asymmetrical effect of monetary policy on the various components of the manufacturing sector. In addition, this study could be further enriched if fiscal variables such as government expenditure

were included to examine the combined effects of both monetary and fiscal policies on sectoral output.

V.1 Suggestions for Further Study

In view of the scope of the study, the following areas for further study are suggested:

- Since broad money supply (M_2) channel was found not to have significant effect on the output of the manufacturing sector, there is need for empirical investigations to determine whether narrow money supply (M_1) explains changes in the output of the sector. There is also need to investigate domestic credit, credit to manufacturing sector, and liquidity ratio to determine their effects on the manufacturing sector as these monetary variables were not included in this study.

- The Nigerian manufacturing sector is categorised into three with respect to data availability – oil and gas, cement, and other manufacturing – hence, empirical investigations should be conducted to determine the possible asymmetrical effect of monetary policy on the various components of the manufacturing sector.

- Lastly, this study could be further enriched if fiscal variables such as government expenditure and taxation were included to examine the effects of both monetary and fiscal policies on the sector.

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