MONETARY POLICY AND MANUFACTURING OUTPUT IN NIGERIA: A STRUCTURAL EQUATION MODELLING APPROACH

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ABSTRACT

This study examines the impact of key monetary policy variables money supply, interest rate, inflation, and exchange rate on manufacturing output in Nigeria from 1986 to 2023 using a Structural Equation Modeling (SEM) approach. Annual time-series data were sourced from the Central Bank of Nigeria (CBN) and the National Bureau of Statistics (NBS). The findings reveal that money supply has a positive and statistically significant impact on manufacturing output, with a unit increase leading to a 177.5-unit rise, highlighting the importance of liquidity in supporting manufacturing sector growth. In contrast, interest rate, inflation, and exchange rate exert negative impacts, with inflation and exchange rate showing statistical significance. Specifically, a one-unit rise in interest rate, inflation, and exchange rate reduces manufacturing output by approximately 79.34, 50.56, and 16.94 units, respectively. These outcomes align with Monetarist and Keynesian theories, which emphasize the role of monetary expansion and macroeconomic stability in enhancing productive capacity. The study recommends an expansionary monetary policy through targeted credit interventions, a strengthened inflation-targeting framework, a unified and rules-based foreign exchange regime, and improved access to affordable credit for manufacturers. These strategies are crucial for promoting sustainable growth in Nigeria's manufacturing sector and achieving broader macroeconomic stability.

***Keywords*:** *Money Supply, interest rates, inflation, exchange rates, structural equation modeling.*

JEL Code: E52, L60, C51, F31.

Introduction

Monetary policy remains a pivotal mechanism for regulating economic activities, influencing key macroeconomic variables such as interest rates, exchange rates, inflation, and money supply. By strategically manipulating these variables, central banks aim to achieve critical economic objectives, including price stability, full employment, and sustained economic growth. For instance, during periods of heightened inflation, central banks may increase interest rates to curb borrowing, reduce liquidity, and temper inflationary pressures (Alfa, 2024). Conversely, lower interest rates can stimulate investment and consumption, fostering business expansion and economic development.

In Nigeria, monetary policy variables have historically played a significant role in shaping macroeconomic outcomes. Ogundipe et al. (2017) underscore that fluctuations in these variables critically impact price stability, exchange rate dynamics, and overall economic performance. The manufacturing sector, representing a vital component of Nigeria's industrial base, is particularly sensitive to monetary conditions due to its dependence on capital investment and access to foreign exchange. According to the Savers-Spenders theory, an expansion in the money supply not only boosts savings but also stimulates consumption, thereby potentially driving manufacturing sector output (Mankiw, 2000).

Despite a growing body of research, the nexus between monetary policy and manufacturing output in Nigeria remains insufficiently explored, particularly regarding the simultaneous interaction of multiple policy variables over an extended period. While previous studies have primarily focused on isolated effects or short-term impacts, few have employed a holistic modeling approach to capture the complex interrelationships at play. (Adewale, 2020). Moreover, the structural vulnerabilities of Nigeria's manufacturing sector—including inconsistent policy implementation, endemic corruption, limited access to credit, and infrastructural deficits— have further complicated the effectiveness of monetary interventions. Government initiatives such as the Small and Medium Enterprises Development Agency of Nigeria (SMEDAN) and the Economic Recovery and Growth Plan (ERGP) have achieved limited success due to operational inefficiencies and policy inconsistencies (CBN, 2021).

Historical analysis further highlights these challenges. The collapse of the crude oil market in the 1980s severely constrained Nigeria's ability to finance critical manufacturing imports, leading to sectoral stagnation. Although the Structural Adjustment Program (SAP), introduced in 1986, sought to liberalize the economy, manufacturing output remained subdued, averaging a growth rate of 2.6% between 1986 and 1993. Subsequent years witnessed moderate improvement, with manufacturing growth reaching 9.06% in 2020. Nevertheless, the sector's contribution to GDP remained low—6.6% in 2016 and 8.98% in 2021—while employing only about 12% of the labor force (National Bureau of Statistics [NBS], 2022; Central Bank of Nigeria [CBN], 2021; World Bank, 2022).

Against this backdrop, this study aims to empirically investigate the impact of monetary policy variables—specifically, interest rates, exchange rates, money supply, and inflation—on Nigeria's manufacturing sector output from 1986 to 2023. Using a structural equation modeling (SEM) approach, the study offers a comprehensive analysis of both direct and indirect impacts of monetary policy variables on manufacturing output in Nigeria. The findings aim to fill existing research gaps and provide actionable policy recommendations for enhancing the resilience and productivity of Nigeria's manufacturing sector.

Literature Review

Theoretical Review

The Monetarist theory, championed by Milton Friedman, underscores the central role of money supply in influencing economic activity. According to the Quantity Theory of Money (MV = PY), changes in money supply directly affect price levels and output, particularly in the short run (Friedman, 1968). In the manufacturing context, increased money supply enhances liquidity, reduces borrowing costs, and expands credit availability—facilitating investment in capital projects, raw material procurement, and production capacity expansion (Mishkin, 2007). However, Monetarists warn that excessive monetary growth can trigger inflation, which erodes purchasing power and raises production costs, potentially undermining long-term manufacturing stability (Friedman & Schwartz, 1963).

In contrast, the Keynesian theory emphasizes aggregate demand as the primary determinant of output, with monetary policy influencing the economy through adjustments in interest rates (Keynes, 1936). Lower interest rates reduce borrowing costs, encouraging manufacturing firms to invest and expand, while also stimulating consumer demand for manufactured goods (Blinder, 2008). Nonetheless, Keynesians emphasize the adverse effects of inflation—such as rising input costs, compression of profit margins, and investment uncertainty—on manufacturing performance (Snowdon & Vane, 2005). Additionally, exchange rate volatility, often driven by inflation or speculative pressures, can disrupt production reliant on imported inputs. However, a stable or moderately depreciated exchange rate may enhance export competitiveness, supporting manufacturing growth (Dornbusch et al., 1996).

Keynesians also acknowledge structural limitations to monetary policy effectiveness, including liquidity traps and weak transmission mechanisms, which are particularly relevant in developing economies like Nigeria (Iyoha & Oriakhi, 2002). Thus, both theoretical frameworks offer valuable insights into the monetary dynamics influencing manufacturing output, while also highlighting the potential risks and constraints in policy implementation.

Theoretical Framework

The Structural Equation Model (SEM) is an econometric framework used to analyze complex systems where multiple endogenous variables interact simultaneously. Unlike single-equation models that assume unidirectional causality, SEM allows for feedback loops and reciprocal relationships, capturing the dynamic and interdependent nature of macroeconomic systems (Greene, 2018; Bollen, 1989).

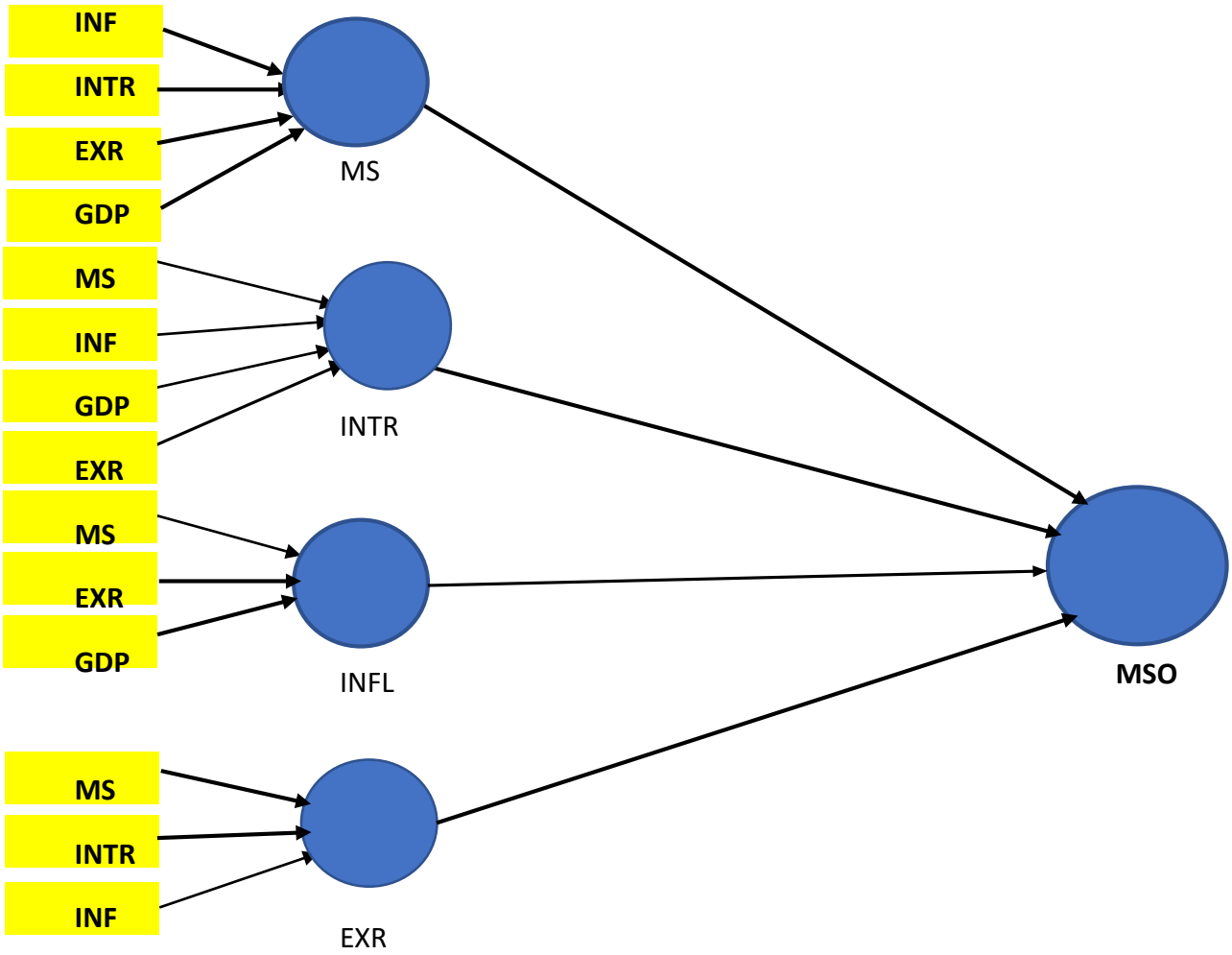

Figure 1: The Structural Equation Model diagram

The Structural Equation Model diagram reflects the multidirectional relationships among money supply, interest rate, inflation, exchange rate, and manufacturing output. The model recognizes that monetary policy variables do not operate in isolation but interact to determine economic performance jointly.

This study adopts the Structural Equation Model (SEM) to analyze the intricate interdependencies among monetary policy variables—money supply, interest rate, inflation, and exchange rate—and their joint influence on manufacturing output in Nigeria. SEM is particularly suited for this investigation due to its capacity to account for simultaneous and reciprocal relationships among endogenous variables, offering a more realistic representation of macroeconomic systems compared to traditional single-equation models (Greene, 2018; Bollen, 1989).

This study draws on Monetarist and Keynesian theories to examine the effects of monetary policy on manufacturing output in Nigeria. The Monetarist view, as articulated by Milton Friedman, emphasizes the role of money supply in determining price levels and real output through the Quantity Theory of Money (MV = PY). In this framework, increased money supply boosts liquidity, reduces borrowing costs, and

encourages credit expansion—key drivers of manufacturing growth. However, excessive monetary expansion may lead to inflation, eroding purchasing power and disrupting production efficiency.

The Keynesian framework focuses on aggregate demand and sees monetary policy as a tool for managing interest rates. Lower interest rates reduce the cost of capital, promoting investment and output in the manufacturing sector. Nevertheless, the theory highlights risk such as inflation, exchange rate volatility, and structural constraints like weak monetary transmission mechanisms and liquidity traps, which are especially pertinent in developing economies like Nigeria.

To capture the complex, bidirectional relationships among key variables—money supply, interest rate, inflation, exchange rate, and manufacturing output—the study adopts a Structural Equation Modeling (SEM) approach. SEM is suitable for modeling feedback loops and endogenous interactions, such as how manufacturing output may influence money demand and foreign exchange flows. For example, expansionary monetary policy can boost output through lower interest rates but may simultaneously fuel inflation and increase production costs. Similarly, exchange rate depreciation can support exports while raising the cost of imported inputs. Given these interdependencies, SEM provides a robust framework for understanding the monetary transmission mechanism in Nigeria (Kline, 2015; Pearl, 2009).

Empirical Review

Some studies have explored the impact of monetary policy variables on manufacturing output, employing various methodologies and yielding mixed results. For instance, many researchers have employed the Ordinary Least Squares (OLS) method, despite its known weaknesses. For example, Adebiyi et al. (2022) analyzed the relationship between bank credit and manufacturing growth (1995–2020) and established a long-run relationship, but reported insignificant effects for key variables such as the lending rate and inflation, highlighting the limitations of OLS-based short-run inference.

Moreover, Efuntade and Efuntade (2021) used OLS to assess the effects of exchange rate, government expenditure, consumer price index, and interest rate on manufacturing output (1980–2020). Although they reported significant relationships, the study was constrained to short-run analysis and undermined by OLS's sensitivity to outliers. Similarly, Ezu et al. (2020) analyzed the impact of macroeconomic variables on the manufacturing sector (1981–2019) using OLS and found that real interest rates, exchange rates, and inflation positively influenced output. However, the reliability of their findings is questionable due to OLS's vulnerability to model overfitting.

To capture long-run relationships, some studies adopted cointegration techniques and Vector Error Correction Models (VECM). Orji and Ezeanyaeji (2022) employed Canonical Cointegration Regression (CCR) to evaluate the effects of exchange rate fluctuations on manufacturing output (1990–2020), finding

that exchange rate volatility hampered industrial performance. However, CCR's reliance on nonstandard distributions and simulation-based inference introduces complexity and instability. Ayunku and Olulu-Briggs (2020) applied the Johansen cointegration technique and VECM to assess the impact of monetary policy on manufacturing output (1981–2018), revealing a 55% speed of adjustment and significant effects of money supply. Nonetheless, the theoretical limitations of VECM and sensitivity to specification errors cast doubt on the robustness of their conclusions. Further, Odondo (2021) utilized VECM with monthly data (2017–2020) to examine inflation's effect on manufacturing output and found positive long-run relationships with different inflation measures. Yet, the study's short time span and VECM's susceptibility to misuse limit the generalizability of its findings.

A few researchers explored alternative models. Onwuka (2022) applied the ARCH/GARCH and ARDL models to investigate the impact of exchange rate volatility (1981–2020). While the GARCH model confirmed significant volatility and ARDL identified positive effects of imports and capital formation on output, the high sensitivity of GARCH to data fluctuations and ARDL's limitations in small samples raise concerns about model stability and inference reliability. Lastly, Ac-Ogbonna (2021) employed only descriptive statistics to examine the effects of exchange rate, lending rate, and inflation (1970–2018), concluding that macroeconomic instability negatively affected manufacturing. However, the absence of inferential analysis weakens the study's policy relevance.

Gap in the literature

The review of existing literature reveals a notable gap: no prior study has applied the Structural Equation Model (SEM) framework to examine the interrelationships among monetary policy variables and manufacturing output in Nigeria. This study addresses that gap by integrating Two-Stage Least Squares (2SLS) estimation within the SEM framework, which yields asymptotically unbiased estimators by leveraging additional instrumental information, thereby enhancing reliability over conventional Ordinary Least Squares (OLS) methods.

Previous studies have employed alternative models with inherent limitations. For instance, the Autoregressive Distributed Lag (ARDL) model, while useful for analyzing dynamic relationships, becomes less efficient in small samples with extensive lag structures, increasing the risk of overfitting or omitted variable bias. Similarly, the Vector Error Correction Model (VECM) is sensitive to model specification and relies on strict assumptions; violations of these can produce misleading inferences about short- and long-run dynamics. The frequent use of OLS also poses concerns due to its sensitivity to outliers and vulnerability to multicollinearity and endogeneity, often resulting in biased estimates.

To overcome these challenges, this study adopts the SEM with 2SLS estimation, a methodologically rigorous and theoretically grounded approach. SEM not only corrects for endogeneity but also

accommodates complex, simultaneous causal relationships and accounts for measurement errors—features essential for analyzing the interdependent and dynamic nature of Nigeria's manufacturing sector. This approach thus ensures more accurate, consistent, and policy-relevant results.

3. Methodology

Model Specification

In Nigeria, the monetary policy is one of the traditional macroeconomic tools by which the government attempts to control the aggregate economy. The monetary policy block takes the lead from the study conducted by Ajudua and Imoisi (2018). The selected monetary policy variables block model consists of one endogenous and four exogenous variables. The manufacturing output is the endogenous variable while money supply, interest rates, inflation, and exchange rates are the exogenous variables. The functional model for the monetary block is given as thus;

MO=f(MS, INTR, INF, EXR)_____(1)

The econometric form of the model is specified as thus:

$MO = \beta_0 + \beta_1 MS_t + \beta_2 INTR_t + \beta_3 INF_t + \beta_4 EXR_t + \mu_t$ _____(2)

Where:

MO= Manufacturing output

MS= Money supply

INTR= Interest rates

INF= Inflation

EXR= Exchange rates

The model examines how money supply (MS), interest rate (INTR), exchange rate (EXR), and inflation (INF) influence manufacturing output (MO). The theoretical expectation is rooted in standard macroeconomic principles. Money supply (MS) is expected to have a positive relationship with manufacturing output, as higher liquidity fosters investment and industrial expansion. Interest rates (INTR), on the other hand, increase the cost of borrowing and discourage investment, implying a negative effect on output. Similarly, currency depreciation (EXR) tends to raise the cost of imported inputs and increase macroeconomic uncertainty, thereby reducing manufacturing output. Inflation (INF) raises production costs and undermines price stability, which adversely affects output. Accordingly, the a priori expectations are: $\beta_1 > 0; \beta_2, \beta_3, \beta_4 < 0$.

To account for the possible endogeneity of the regressors, behavioral equations for the independent variables are specified below, with each grounded in macroeconomic theory.

Money Supply Equation:

$$MS_t = \beta_0 + \beta_1 INF_t + \beta_2 INTR_t + \beta_3 EXR_t + \beta_4 GDP_t + \mu_t \quad (3)$$

Interest Rate Equation:

$$INTR_t = \beta_0 + \beta_1 MS_t + \beta_2 INF_t + \beta_3 GDP_t + \beta_4 EXR_t + \mu_t \quad (4)$$

Inflation Equation:

$$INF_t = \beta_0 + \beta_1 MS_t + \beta_2 EXR_t + \beta_3 GDP_t + \mu_t \quad (5)$$

Exchange Rate Equation:

$$EXR_t = \beta_0 + \beta_1 MS_t + \beta_2 INTR_t + \beta_3 INF_t + \mu_t \quad (6)$$

Data and Sources of Data

The Study employs secondary data obtained from the publications of various Government agencies. Data on Gross Domestic Product is obtained from the National Bureau of Statistics (NBS) Statistical Bulletin. The data on (Manufacturing output, interest rates, exchange rates, inflation, and money supply) will be obtained from the Central Bank of Nigeria (CBN) Statistical Bulletin.

Techniques of Data Analysis

Quantitative data were used in the study and data were obtained from CBN and NBS Statistical Bulletins. Two-stage least squares techniques were used in the estimation of the behavioural equations. The two-stage least squares (2SLS) method permits corrected errors and does not require a normal distribution, and it is less sensitive to specification errors than the full information estimator. Therefore, it is unnecessary to test for stationarity before estimating the model.

4. Results and Discussions of Findings

This section presents the study's findings and discusses their implications for Nigeria's macroeconomic context and the existing literature. It employs specified econometric models to assess the relationship between monetary policy variables and manufacturing sector output, focusing on the statistical significance, direction, and robustness of the estimated coefficients.

Table 1: The main equation for the monetary policy variables block is presented as thus: **Dependent Variable Manufacturing Sector Output = MO**

Variables	Coefficient	Standard error	P-Value
MS	177.509	30.060	0.000

INTR	-79.343	94.695	0.408
INF	-50.556	15.780	0.003
EXR	-16.941	6.038	0.008

Rsquared 0.721	**Adjusted R-squared** 0.696	**Durbin-Watson stat** 1.804	**Prob (J-Stat)** 0.253
(J-Stat)1.304			

Authors' computation from Eviews 12

Table 1 presents the impact of monetary policy variables—money supply, interest rate, inflation, and exchange rate—on manufacturing output in Nigeria. The results indicate that money supply has a positive and statistically significant impact, suggesting that a unit increase in money supply leads to a 177.5 unit rise in manufacturing output. This finding aligns with the Monetarist Quantity Theory of Money as proposed by Friedman, as well as the Keynesian transmission mechanism, both of which emphasize the role of liquidity in stimulating economic activity. According to Keynesian theory, increased money supply can lower interest rates, reduce the cost of capital, and thereby encourage investment in the manufacturing sector.

Conversely, interest rate, inflation, and exchange rate exert negative impacts on manufacturing output. Among these, the impacts of inflation and exchange rate are statistically significant, while the impact of interest rate, although negative, is statistically insignificant. The insignificance of interest rates may reflect structural inefficiencies in the financial system, limited access to credit, or the dominance of informal financing channels. Specifically, a one-unit rise in interest rate, inflation, and exchange rate is associated with reductions in manufacturing output of approximately 79.34, 50.56, and 16.94 units, respectively. These outcomes align with theoretical expectations, as higher interest rates and inflation typically increase

production costs, while exchange rate volatility can raise input costs and disrupt access to imported raw materials.

However, these findings contrast with Nwofor (2022), who reported positive impacts of inflation, interest rate, and exchange rate on manufacturing output. In contrast, Efuntade and Efuntade (2022) found that inflation and interest rates negatively affect manufacturing output, while the exchange rate exerts a positive influence. The model's R^2 value of 0.721 indicates that 72.1% of the variation in manufacturing output is explained by the monetary policy variables, suggesting a good model fit. The adjusted R^2 of 0.696 confirms this robustness after accounting for degrees of freedom. Furthermore, the Durbin-Watson statistic of 1.804 suggests no significant evidence of serial correlation in the residuals. The J-statistic of 1.304, with a p-value of 0.253, indicates that the overidentifying restrictions are valid, confirming the appropriateness of the instruments used in the model.

Table 2: Money supply equation

Variable	Coefficient	Standard Error	P-Value
INF	0.0464	0.120	0.702
INTR	-0.077	0.204	0.706
EXR	0.0170	0.0173	0.331
GDP	0.0007	0.0002	0.002
R^2 0.866	**Adj R^2 0.8493**		**D-W 1.76**

Authors' computation from Eviews 12

Table 2 represents the behavioural equation of the independent variables as captured in equation 3 of the model specification. It showed how inflation, interest rates, exchange rates, and GDP impacted on money supply over the study period. It revealed that inflation, exchange rates, and GDP have a positive impact on money supply in Nigeria. On the contrary, interest rates portrayed a negative impact on the money supply in Nigeria. Moreover, all the variables are insignificant except for GDP, which has a positive and significant impact on money supply. However, the results of the estimates conform to the a priori expectation. The R^2 and the Adj R^2 of 86.6 % and 84.93% depicted the goodness of fit of the model. The Durbin-Watson statistics show the absence of serial correlation in the model.

Table 3: Interest rate Equation

Variables	Coefficient	Standard error	P-value
MS	-0.1430	0.1149	0.222
INF	-0.1935	0.0719	0.011
GDP	0.0002	0.0001	0.077
EXR	-0.0564	0.0619	0.369
R^2 0.497	**ADJ R^2** 0.468		**D-W 1.91**

Authors' computation from Eviews 12

Table 3 represents the estimation of equation 4 of the model specification. It represents the behavioural equation in which interest rates is a dependent variable. From the result, money supply, inflation and GDP have negative impact on interest rates in Nigeria. While exchange rate has positive impact on interest rates in Nigeria. However, only inflation has significant impact on interest rates in Nigeria. Moreso, only inflation and money supply conform with a priori expectation. The R^2 and adj R^2 of 49.7 % and 46.8% shows fairly good fitness of the model. The Durbin- Watson statistics of 1.91 depicts the absence of serial correlation in the model.

Table 4: Inflation Equation

Variables	Coefficient	Standard error	P-value
MS	0.4575	0.2065	0.033
EXR	-0.0617	-1.304	0.201
GDP	-0.0006	0.0002	0.014
R^2 0.753	**ADJ R^2 0.685**		**D-W** 1.1872

Authors' computation from Eviews 12

Table 4 represents the estimation of equation 5 of the model specification. It represents the behavioural equation in which inflation is a dependent variable. The result depicts that the money supply has a positive and significant impact on inflation. On the contrary, exchange rates and GDP has a negative impact on inflation in Nigeria. Though GDP's impact is significant, the exchange rate is insignificant. The variables conform with the a priori expectation except for exchange rates. The R^2 and the Adj R^2 are 75.3% and

68.5% percent respectively, showing goodness of fit of the model. The Durbin-Watson statistics suggest the absence of serial correlation in the model.

Table 5: Exchange rates Equation

Variables	Coefficient	Standard error	P-value
MS	0.4672	0.5188	0.374
INTR	-1.6836	0.7553	0.032
INF	-0.7142	0.4203	0.098
R^2 0.738	**ADJ R^2** 0.683		**D-W** 1.055

Authors' computation from Eviews 12

Table 5 represents the estimation of equation 6 of the model specification. It represents the behavioural equation in which the exchange rate is a dependent variable. From the result, money supply has a positive impact on exchange rates, while interest rates and inflation have a negative impact on exchange rates. Moreover, only interest rates have a significant impact on exchange rates. All the variables conform to a priori expectations except for inflation, which recorded a negative impact on exchange rates. The R^2 of 73.8 % and Adj R^2 of 68.3 % suggested the goodness of fit of the model.

Table 6 : Post Estimation/ Diagnostic Test

Test	Result	Implication
Heteroskedasticity Test	(p > 0.48)	This suggests the absence of heteroskedasticity. This means the residuals are homoskedastic**.**
Endogeneity Test	Some evidence (p = 0.0842)	Use of the IV/2SLS method is appropriate
Instrument Validity	Supported (J-statistic p = 0.2534)	Overidentifying restrictions are not violated
Normality test	Prob Value of Jarque bera test=0.1114	Residuals are normally distributed

Authors' computation from Eviews 12

Table 6 represents a diagnostic test to ensure that the estimates' results can be taken seriously for policy formulation and recommendation. It depicts that residuals are homoscedastic and normally distributed. Moreover, the endogeneity test and the instrument validity test depict that the 2SLS technique is appropriate and that the overidentifying restrictions are not violated. This makes the result valid for policy formulation and recommendation.

5. Conclusion and Recommendation

This study analyzed the impact of monetary policy variables—money supply, interest rate, inflation, and exchange rate—on Nigeria's manufacturing output. The findings revealed that money supply has a positive and statistically significant impact on manufacturing output, underscoring the importance of liquidity in boosting manufacturing output in Nigeria and aligning with both Monetarist and Keynesian economic theories. In contrast, interest rate, inflation, and exchange rate negatively impact manufacturing output, with inflation and exchange rate showing significant impacts.

Based on the findings, the Study recommends that:

i) Government/Policymakers should consider maintaining or moderately increasing the money supply to support manufacturing output, particularly through targeted interventions such as development finance and manufacturing sector-specific credit facilities. Also, the Central Bank of Nigeria should adopt measures to stabilize inflation, such as tightening excess liquidity when necessary. To achieve inflation stability, the CBN should strengthen its inflation-targeting framework by enhancing transparency in policy communication and ensuring timely monetary responses to inflationary pressures.

ii) The Central Bank of Nigeria should adopt measures to reduce exchange rate fluctuations and maintain a credible foreign exchange policy. To address exchange rate volatility, the CBN should adopt and maintain a credible, rules-based foreign exchange-management system. Moreover, the government should provide Policies that ease access to affordable credit for manufacturers. To achieve this, the government can strengthen and expand targeted financing programs through institutions such as the Bank of Industry (BOI) and the Central Bank of Nigeria (CBN).

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