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Monetary Policy Shocks and Industrial Output in Nigeria

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Authors' contributions

This work was carried out by three authors. Author OBO designed the study. Authors EEO and EPO conceived the methodology and performed the statistical analysis. All authors read and approved the final manuscript.

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ABSTRACT

This study investigated the impact of monetary policy shocks on industrial output in Nigeria using restricted VAR (VECM) model and Granger causality test for the period 1970 to 2015. In doing this, data on the manufacturing and solid minerals subsectors was used for the analysis. Results show that contribution of manufacturing subsector to GDP responded positively to shocks in monetary policy, commercial bank credit to industrial sector and exchange rates, while contribution of solid minerals subsector to GDP responded positively to shocks in commercial bank credit to the industrial sector and exchange rate after the first year. On the other hand, the causality test result indicated a unidirectional causality running from monetary policy rate and exchange rate to the contribution of manufacturing sector to GDP on the one hand, and commercial bank credit to the industrial sector and exchange rate to the contribution of solid mineral sector to GDP on the other. Recommendations included; proper evaluation by the central bank of Nigeria of the possible responses of the different subsectors of the industrial sector in its decision regarding choice of monetary policy channel; the need for extreme caution to be taken in the management of exchange rate, and the need for CBN to do more to encourage commercial banks to allocate more of their loans to small scale investors in the manufacturing sector.

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1. INTRODUCTION

While the primary objective for the implementation of monetary policy is the maintenance of price stability, the promotion of economic growth is also a major objective of monetary policy, albeit a secondary one. In this regard, monetary policy actions are sometimes used by central banks to promote the growth of economic activities in desired sectors of the economy. In doing this, the central bank is driven by the associated effects of monetary policy on the real sector.

In writing on monetary policy and its impact on the economy, [1] posited that changes in monetary aggregates will eventually have an impact on the real sector and that central banks are indeed mindful of such impacts. In a similar vein, [2] observed that there is a general agreement, based on empirical studies, concerning the effect of monetary shocks on output, and that such effects are persistent, though delayed, with the general impulse response having output peaking six to eight quarters after a monetary policy shock.

However, while several studies have been carried out to examine the output effects of monetary policy shocks on the overall economic growth in economies such as the Nigerian economy, few studies exist on the sectoral impacts. Traditionally and in line with the aggregate analysis in economics, it is assumed that the effects of monetary policy on the real economic activities are uniform. However, this view does not take into account the possible differences that might exist in the responses of different sectors in an economy to monetary policy [3]. Recent empirical evidence indicates that different sectors vary in their response to monetary shocks. This has serious implications for the conduct of monetary policy which must be taken into account by central banks because while a particular monetary policy innovation might have favourable output effects on the economy as a whole, the individual sectors might react differently to this [4]. In particular, special attention has to be given to the impact of monetary policy on the output of sectors such as the industrial sector. This is based on the fact that any adverse effects of monetary policy on the industrial sector will usually be transmitted to the rest of the economy. Given the importance of the industrial sector to the growth of the Nigerian economy, the need to evaluate the impact of monetary policy shocks on industrial outcomes cannot be over emphasized. Evidence from the World Bank World Development Indicators showed that the contribution of the industrial sector to GDP was 52 per cent in 2000 and thereafter dropped to 43.5 per cent in 2005. However, the trend continued as reflected in the continuous fall of percentage contribution of the sector to GDP; for instance, in 2010 the figure stood at 25.3 per cent and further dropped sharply to 20.3 per cent in 2015. In view of this, this study investigates the impact of monetary policy shocks on the industrial sector in Nigeria by examining the output responses of two sub-sectors of the industrial sector. The study is divided into four sections which include; the introduction, review of literature, empirical model and methodology, conclusion and policy recommendations.

2. REVIEW OF RELATED LITERATURE

The output effect of monetary policy has been an issue of interest to central banks and researchers for a long time [5,6]. In particular, researchers have given emphasis to evaluating the effects of monetary policy innovations on the performance of macroeconomic variables so as to provide information necessary for enhancing monetary policy formulation and implementation. For instance, a study by [7] used the VAR method to examine the impact of post-war monetary policy shocks in G-7 countries. The study found out that changes in output were associated with monetary policy shocks in the short run, though, on a trivial basis. It was thus concluded that output fluctuations of G-7 countries during the post war were not primarily determined by the shocks in monetary policy.

[8] Assessed the correctness of the conclusions from the study by [2] which showed that the effect of monetary policy shocks on output and prices depends on the shock’s timing. [2] Found that in the United States of America, a monetary policy shock that takes place in the first half of the year has a larger effect on output than on prices, while the opposite is true in the second half of the year. Based on this [2] argued that a greater fraction of wage rates are re-contracted in the second half of the year, implying that wages (and prices) are less flexible in the first

half. The results of [8] assessment of the aforementioned study indicated that the within-year differences in the responses of output and prices following a monetary policy shock are not more pronounced in the service-producing sector, where labour costs account for a large portion of total production costs. The results of the study also revealed that price instability following a monetary shock tends to lead wage changes. Based on the results, the study concluded that factors other than uneven wage adjustment could be responsible for the differential within-year effect of monetary policy shocks as portrayed in [2].

Another study by [9] used the VAR model to assess the effect of monetary policy shocks on output and employment in Turkey. The study found that shocks in the broad money supply impacted the level of employment and output through the credit stock [10]. Assessed the impact of monetary policy shocks in New Zealand. The study found that the "New Zealand producer price index (PPI) responds more sluggishly than consumer price index (CPI)" to monetary shocks. It was concluded that this was "due to a restrictive domestic monetary stance; suggesting the differences between the exchange rate pass-through of monetary policy shocks to CPI and PPI resulting from exporters' different pricing strategies".

On the other hand, [4] used the VAR approach to evaluate the sectoral effects of monetary policy in Pakistan. The results of the study revealed that differences exist in the responses of the different sectors to monetary tightening. In particular, it was observed that performance of finance and insurance, retail and wholesale trade, as well as the manufacturing sector deteriorated as a result of shocks in interest rate. On the other hand, the mining and quarrying sector, as well as agricultural sector was found to be insensitive to changes in interest rate.

The results of a similar study by [11] on the Turkish economy revealed that the output of all sub-sectors of the manufacturing sector declined in response to contractionary monetary policy shocks. However, degree of decline in output differed between the sectors. [3] sought to unravel the effects of monetary policy on industry value added in India using the VAR model. The study's result showed that differences exist in the response of the different sectors to monetary tightening. Furthermore, it was found that interest rate and accelerator variables were the main causes of these trend.

With respect to the Nigerian economy, a study was carried out by [12] to examine the effects of asymmetric monetary policy shocks on fluctuations in real output using the modified GARCH. The study was based on the use of several measures of output such as; GDP, the output of the agricultural, industrial and services sectors. The study found that the monetary policy had a negative and insignificant impact on most of the aggregate measures of output used. In particular, it was found that expansionary monetary policy resulted in a reduction in the level of output.

On the other hand, [13] used the VAR model and Granger causality test, and quarterly data to examine the sectoral output effects of monetary policy transmission channels in Nigeria between 1986 and 2009. The study found "interest rate channel as the most effective in transmitting monetary policy to Agriculture and Manufacturing sectors, while, exchange rate channel was most effective for transmitting monetary policy to Building/Construction, Mining, Services and Wholesale/Retail sectors". Based on the results, it was concluded that the exchange rate and interest rate channels were the most effective for the promotion of productivity increases in Nigeria.

Another study by [14] evaluated the responsiveness of the real sector output to monetary policy shocks in Nigeria through the use of the VAR model. The study found that private sector credit and investment had faster effect on output. The real GDP was observed to have a higher response rate to Monetary Policy Rate (MPR) and CPI shocks, and own innovations in the long-run. Furthermore, the study found that while interest rate MPR were direct and instantaneous on the real sector, they did so indirectly via the investment and credit channels.

Using the SVAR approach, [5] examined the impact of monetary policy shocks in Nigeria. The results indicated that broad money supply shocks had small output and price effects with rapid speed of adjustment. Conversely, shocks in the monetary policy and real exchange rates had neutral and fleeting output effects. It was concluded that broad money supply is the most potent instrument of monetary policy in Nigeria.

In a similar vein, [15] assessed the price and output impacts of monetary policy in Nigeria using an ARDL model. The study found a significant positive relationship between anticipated monetary policy changes and output, as well as prices in Nigeria. On the other hand, unanticipated changes in monetary policy were found to not have substantial impact on the variables.

The main conclusions from the review of literature in this study is that, whereas a number of studies have been conducted to test the output impact of monetary policy shocks, very few have investigated the impacts of such shocks on the sub-sectors within the various sectors in an economy. This is especially true of studies on the Nigerian economy. The implication of this lack of attention on monetary policy shocks and the respective responses of sub-sectors is that there is limited information for central banks for efficient monetary policy formulation. This study seeks to address this issue by investigating the impact of monetary policy shocks on two of the key sub-sectors in the industrial sector in Nigeria. While the study by [13] examined the impact of monetary shocks on the output of the manufacturing, building/construction and mining sectors, this study extends their work by widening the scope of analysis from 1970 to 2015. The study also differs from that of [13] because it utilizes the contribution of the manufacturing and solid mineral sectors to the GDP as measures of the output of these sectors. Finally, the study also considers the effect of shocks in the commercial bank credit to industrial sector which is not captured in the study by [13].

2.1 Value and Variety of Firms Found in Industrial Subsectors in Nigeria

According to the Central Bank of Nigeria 2015 annual Bulletin and National Bureau of Statistics (NBS) 2015, the Nigeria industrial sector is made up of a variety of subsectors which include (a) Crude Petroleum & Natural Gas (b) Solid Minerals and (c) Manufacturing. A variety of firms (products) are classified under these subsectors, Table 1 shows the number of firms found in each industrial subsector.

Oil production was 2.18 million barrels per day in the first quarter of 2015. This figure is not so different from that of the previous quarter. However, it was 0.08 million barrels per day (mbpd) lower than the 2.24 mbpd in the first quarter of 2014. Furthermore, growth in the oil sector has been truncated by dwindling oil prices and local supply bottlenecks; this is reflected in the negative growth rate of -8.15 per cent in real terms, showing a decline of 1.55 per cent from -6.60 per cent in the first quarter of 2014. As at first quarter of 2015, the oil sector represented 10.45 per cent of total real GDP. The major industry operators in the Nigerian oil sector include; NNPC, NLNG, Shell, Exxon Mobil, British Petroluem (BP), Total Nigeria Plc, Elf Petroluem Nigeria Ltd, Addax, Capital oil, Dowell Schlumberger Oilfield Services Ltd, etc.

Estimates of Manufacturing subsector growth was 1.25 per cent during the first quarter of 2015, and 18.80 per cent lower than the 20.05 per cent for the same period in 2014. Some of the fastest growing manufactures in Nigeria include; non-metallic products, plastics and rubber, and chemical/pharmaceutical products. These manufactures have been reported to be growing at 26.42 per cent and 30.64 per cent respectively. However, by 2015 (first quarter), output in the subsector dropped to -0.07 per cent from 15.41 per cent in the first quarter of 2014. The major manufacturing companies in Nigeria include; Dangote Group, Unilever Nigeria Plc, Nestle Nigeria Plc, Nigerian Breweries, PZ Cussons Nigeria Plc, Flour Mills Nigeria, Dufil Prima Foods Ltd, United Africa Company of Nigeria (UACN), Guiness Nigeria Plc, Lafarge Cement Wapco Nigeria Plc, etc.

Solid minerals subsector recorded -46.20 growth rate during the first quarter of 2015. However, this growth rate was -5.07 per cent lower for the same period in 2014, and 29.03 per cent lower during the fourth quarter of 2014. Coal mining and quarrying contributed about 18.24 per cent to total output of the subsector while other minerals had a relative share of 12.56 per cent. These two comprise of the major growth performance in the subsector. In 2015, the sector contributed about 10.61 per cent to Real GDP, showing a sharp decline of -1.37 per cent. Some of the operators include; Global Exploration and Mining Services, Green field Metals Ltd, Nigerian Mining Cadastre, SBOG Nigeria Ltd, Tongyi Allied Mining Ltd, Western Goldfields Group Ltd, Aquagem Mining and Engineering Ltd, etc.

Table 1. Variety of firms (products) found in each industrial sub-sector

Crude petroleum & natural gas sub-sector	Solid minerals sub-sector	Manufacturing Sub-sector
- Automotive Gas Oil - Aviation Turbine Kerosene - Premium Motor Spirit - Naptha - Bitumen - Liquid Petroleum Gas - Liquid Natural Gas - Gas Oil - Low Profile Gas - Fuel Oils, etc.	- Coal Mining - Metal Ores - Quarrying & Other Mining	- Oil Refining - Cement - Food, Beverage and Tobacco - Textile, Apparel and Footwear - Wood and Wood Products - Pulp, Paper and Paper Products - Chemical and Pharmaceutical Products - Non-Metallic Products - Plastic and Rubber products - Electrical and Electronics - Basic metal , Iron and Steel - Motor vehicles & assembly - Other Manufacturing

Source: Central Bank of Nigeria Statistical Bulletin (2015) and National Bureau of Statistics (2015)

3. METHODOLOGY AND EMPIRICAL MODEL

This study is based on the use of restricted VAR (VECM model). The choice of this model is based on the fact that the results it yields provide insights which are easily readable [16]. The Granger Causality test is also used to investigate the existence of causal relationships among the variables involved. However, before this is done, the data used for the study was subjected to unit root testing through the use of the Dickey Fuller unit root test.

Three main monetary policy variables are used in this study. These are: the *monetary policy rate (MRA), exchange rate (ERR)* and *bank credit to the industrial sector (BID).* On the other hand, the study utilizes the *contribution of the manufacturing sector to the GDP (MOT)* and *the contribution of the solid mineral sector to the GDP (PSM)* to capture the level of output in the industrial sector. However, a set of times series data spanning the period 1970 through 2015 was used for the empirical analysis and data was sourced from Central Bank of Nigeria (CBN) annual statistical bulletin 2015, as well as National Bureau of Statistics (NBS) bulletin 2015.

The VAR model for the study is given as follows:

(I) $MOT_t = \sum \delta_1 MOT_{t-1} + \sum \lambda_1 PSM_{t-1} + \sum a_1 MRA_{t-1} + \sum \beta_1 BID_{t-1} + \sum \eta_1 ERR_{t-1} + U_{1t}$

(II) $PSM_t = \sum \delta_2 MOT_{t-1} + \sum \lambda_2 PSM_{t-1} + \sum a_2 MRA_{t-1} + \sum \beta_2 BID_{t-1} + \sum \eta_2 ERR_{t-1} + U_{2t}$

4. EMPIRICAL RESULTS

4.1 Unit Root Test

The Dickey Fuller unit root test was adopted to test for stationarity among the variables in the model and result indicates that all variables are stationary after first differencing and as such are integrated of order 1, i.e 1(1) as shown in Table 2.

4.2 VAR Lag Order Selection Criteria

The preliminary stage for the estimation of a VAR/VECM usually involves the selection of an optimal lag length and in this study, lag order selection criteria is based on the Akaike Information Criteria (AIC), although, all the lag selection criteria indicated an optimal lag length of 5 and as such justifies the choice of the lag selection. This is shown in Table 3.

Table 2. Dickey fuller GLS (ERS)

Variable	Dickey-fuller statistic	Critical V. (5%)	Critical V. (10%)	Decision
MRA	-7.658741	-3.190000	-2.890000	I(1)
ERR	-6.614751	--3.190000	-2.890000	I(1)
BID	-4.024695	-3.190000	-2.890000	I(1)
MOT	-2.989196	-3.190000	-2.890000	I(1)
PSM	-3.779134	-3.190000	-2.890000	I(1)

Source: Eviews 9 result

Table 3. Lag selection criteria

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-1754.353	NA	1.10e+32	87.96765	88.17876	88.04398
1	-1521.557	395.7527	3.42e+27	77.57787	78.84453	78.03585
2	-1486.387	50.99704	2.19e+27	77.06935	79.39156	77.90899
3	-1406.684	95.64417	1.67e+26	74.33418	77.71194	75.55547
4	-1336.459	66.71350	2.46e+25	72.07294	76.50625	73.67588
5	-1083.491	59.06041*	7.09e+21*	61.92454*	68.46894*	64.29079*

Source: Eviews 9 result

4.3 Co-integration Result

The Johansen co-integration test was adopted to test for the existence or otherwise of a long-run relationship among the variables in the industrial output models. The justification for this test is based on the result of the unit root test as reported in Table 1; all variables in the model are integrated of order one and as such informs the choice of a Johansen co-integration test. Secondly, the Granger Causality Test result reported in Table 10 also confirmed a bi-directional causality running from the independent variables to the dependent variable and vice versa and thus corroborating the result of the unit root test and the choice for a Johansen System co-integration test. However, the result of the test as indicated by the Trace Statistics and Maximum Eigenvalue reports two co-integrating equations each and as such points to the existence of a longrun relationship among the variables in the model. This result is shown in Tables 4a and 4b.

4.4 Vector Error Correction Model (VECM)

The Vector Error Correction Model (VECM) was estimated following the existence of a long-run relationship in the estimated model; the result is presented in Table 5. The result shows that there is a longrun causality running from the independent variables (BID, ERR, PSM and MRA) to the dependent variable (MOT). This is shown by the negative coefficient of ecm(-1) which is also statistically significant at one percent level. This implies there's a speed of adjustment of 33.77 per cent from the shortrun to longrun equilibrium. However, to determine the existence or otherwise of shortrun causality from the independent variables to the dependent variable, a Wald test was conducted for each of the independent variables and the result as presented in the appendix shows the existence of shortrun causality running from BID, ERR, PSM, and MRA to MOT. This result is however corroborated by the granger causality test result presented in Table 10; it establishes causality running from the independent variables to MOT, except ERR which was not significant at five percent and hence the acceptance of the null hypothesis.

However, the result showed a very high R-squared of 89.51 per cent implying that about 90 percent of variation in the dependent variable is accounted for by variations in the independent variables. Also, Prob(F-statistic) of 0.000 shows that F-statistic is significant at one percent and that the overall model is statistically significant.

More so, the estimated VECM result was subjected to some diagnostic tests such as the Breusch-Godfrey Serial Correlation LM Test and Breusch-Pagan-Godfrey Heteroskedasticity Test as shown in Tables 6 and 7. The tests show that the estimated model is free of serial correlation and heteroskedasticity since the prob. of Chi-Square for both tests are greater than five percent, indicating that the null hypotheses should be rejected. Therefore, the model estimates are statistically reliable.

Table 4a. Unrestricted Cointegration rank test (Trace)

Hypothesized		Trace	0.05	
No. of CE(s)	Eigenvalue	Statistic	Critical value	Prob.**
None *	0.618225	101.7399	69.81889	0.0000
At most 1 *	0.560010	59.37121	47.85613	0.0029
At most 2	0.298943	23.24705	29.79707	0.2341
At most 3	0.155670	7.619713	15.49471	0.5069
At most 4	0.003956	0.174401	3.841466	0.6762

Trace test indicates 2 cointegrating eqn(s) at the 0.05 level

Table 4b. Unrestricted cointegration rank test (Maximum Eigenvalue)

Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	0.05 Critical value	Prob.**
None *	0.618225	42.36864	33.87687	0.0038
At most 1 *	0.560010	36.12416	27.58434	0.0032
At most 2	0.298943	15.62733	21.13162	0.2474
At most 3	0.155670	7.445312	14.26460	0.4379
At most 4	0.003956	0.174401	3.841466	0.6762

Max-eigenvalue test indicates 2 cointegrating eqn(s) at the 0.05 level
Source: Eviews 9 result

Table 5. VECM result (Equation One)

Dependent Variable: D(MOT)

	Coefficient	Std. Error	t-Statistic	Prob.
ECM(-1)	-0.337790	0.121816	-2.772953	0.0001
D(MOT(-1))	1.498077	0.224385	6.676360	0.0000
D(MOT(-2))	0.991215	0.366306	2.705979	0.0191
D(MOT(-3))	0.427337	0.371529	1.150212	0.2725
D(MOT(-4))	1.279929	0.449666	2.846398	0.0147
D(MOT(-5))	0.667115	0.785244	0.849564	0.4122
D(BID(-1))	-0.296261	0.047425	-6.246889	0.0000
D(BID(-2))	-0.244077	0.040198	-6.071819	0.0001
D(BID(-3))	-0.124183	0.036625	-3.390708	0.0054
D(BID(-4))	-0.135562	0.027639	-4.904689	0.0004
D(BID(-5))	-0.120280	0.026948	-4.463324	0.0008
D(ERR(-1))	-540.6314	364.6783	-1.482489	0.1640
D(ERR(-2))	-65.54479	220.0741	-0.297830	0.7709
D(ERR(-3))	230.3091	97.15978	2.370416	0.0354
D(ERR(-4))	79.75503	221.0566	0.360790	0.7245
D(ERR(-5))	-22.53666	120.6266	-0.186830	0.8549
D(MRA(-1))	-2361.240	568.2316	-4.155418	0.0013
D(MRA(-2))	-2376.824	722.8923	-3.287937	0.0065
D(MRA(-3))	-3211.196	704.0761	-4.560865	0.0007
D(MRA(-4))	-2951.923	630.6935	-4.680440	0.0005
D(MRA(-5))	-2251.104	611.6142	-3.680594	0.0031
D(PSM(-1))	-2.025199	2.202708	-0.919413	0.8901
D(PSM(-2))	-4.681196	2.436764	-1.921071	0.0788
D(PSM(-3))	-12.13630	3.943043	-3.077902	0.0096
D(PSM(-4))	-11.27917	4.256277	-2.650009	0.0212
D(PSM(-5))	-5.608984	3.924570	-1.429197	0.1785
C	8478.982	2836.957	2.988759	0.0113
R-squared	0.895145	Mean dependent var		22342.09
Adjusted R-squared	0.874220	S.D. dependent var		23429.63
S.E. of regression	2943.220	Akaike info criterion		19.00842
Sum squared resid	1.04E+08	Schwarz criterion		20.19064
Log likelihood	-352.1685	Hannan-Quinn criter.		19.43588
F-statistic	75.09035	Durbin-Watson stat		2.387264
Prob(F-statistic)	0.000001			

Source: Eviews 9 result

4.5 VECM Result (Equation Two)

Equation two models the impact of monetary policy innovations on the solid minerals sub-sector (PSM) and the result is presented in Table 7. The result shows the absence of a longrun causality between monetary policy innovations and PSM since ecm(-1) is without a negative sign, though it is statistically significant. The Wald test however showed the existence of shortrun causality running from BID, ERR, and MOT to PSM and the absence of shortrun causality from MRA to PSM. Evidence is provided in the results of Wald test presented in appendix 2. The causality test presented in Table 10 also confirms the shortrun relationship given the existence of causality running from MOT, BID and ERR to PSM.

R-squared of 0.987599 shows a high goodness of fit and consequently about 98.75 per cent variation in the dependent variable is accounted for by variations in the independent variables. Prob(F-statistic) of 0.000353 shows that F-Statistic is statistically significant at one percent and the overall model is statistically significant. Diagnostic tests showed the absence of Serial Correlation and Heteroskedasticity given that the Prob. Chi-Square is more than five percent and thus informs the rejection of the null hypotheses. These results are presented in Tables 8, 9 and 10.

Table 6. Breusch-Godfrey serial correlation LM test

F-statistic	1.327943	Prob. F(2,10)	0.3080
Obs*R-squared	8.394155	Prob. Chi-Square(2)	0.2050

Source: Eviews 9 result

Table 7. Heteroskedasticity test: Breusch-Pagan-Godfrey

F-statistic	0.250896	Prob. F(30,9)	0.9980
Obs*R-squared	18.21731	Prob. Chi-Square(30)	0.9549
Scaled explained SS	5.073256	Prob. Chi-Square(30)	1.0000

Source: Eviews 9 result

Table 8. VECM result (Equation Two)

Dependent Variable: D(PSM)

	Coefficient	Std. Error	t-Statistic	Prob.
ECM(-1)	1.072567	0.370001	2.898823	0.0134
D(PSM(-1))	-1.753978	0.384365	-4.563308	0.0007
D(PSM(-2))	-0.271347	0.425207	-0.638152	0.5354
D(PSM(-3))	-0.136999	0.688048	-0.199113	0.8455
D(PSM(-4))	-3.373523	0.742707	-4.542202	0.0007
D(PSM(-5))	0.718911	0.684825	1.049773	0.3145
D(BID(-1))	-0.028237	0.008276	-3.412048	0.0052
D(BID(-2))	0.009033	0.007014	1.287731	0.2221
D(BID(-3))	-0.004146	0.006391	-0.648807	0.5287
D(BID(-4))	-0.005672	0.004823	-1.176029	0.2624
D(BID(-5))	-0.008334	0.004702	-1.772303	0.1017
D(ERR(-1))	129.9832	63.63517	2.042632	0.0637
D(ERR(-2))	-42.52074	38.40222	-1.107247	0.2899
D(ERR(-3))	-17.97353	16.95407	-1.060131	0.3100
D(ERR(-4))	-96.17020	38.57366	-2.493157	0.0283
D(ERR(-5))	-38.67476	21.04895	-1.837373	0.0910
D(MOT(-1))	-0.101383	0.039155	-2.589300	0.0237
D(MOT(-2))	0.011534	0.063919	0.180447	0.8598
D(MOT(-3))	0.193631	0.064831	2.986724	0.0113
D(MOT(-4))	0.105903	0.078465	1.349678	0.2020
D(MOT(-5))	0.044344	0.137023	0.323625	0.7518
D(MRA(-1))	-15.13173	99.15457	-0.152608	0.8812
D(MRA(-2))	-57.68867	126.1424	-0.457330	0.6556
D(MRA(-3))	-31.00310	122.8590	-0.252347	0.8050
D(MRA(-4))	98.34184	110.0540	0.893578	0.3891
D(MRA(-5))	-12.94857	106.7247	-0.121327	0.9054
C	2075.056	495.0398	4.191696	0.0013

R-squared	0.987599	Mean dependent var	1773.733
Adjusted R-squared	0.959697	S.D. dependent var	2558.231
S.E. of regression	513.5823	Akaike info criterion	15.51672
Sum squared resid	3165202.	Schwarz criterion	16.69894
Log likelihood	-282.3345	Hannan-Quinn criter.	15.94418
F-statistic	35.39491	Durbin-Watson stat	2.016103
Prob(F-statistic)	0.000000		

Source: Eviews 9 result

Table 9. Breusch-Godfrey serial correlation LM test

F-statistic	0.529827	Prob. F(3,9)	0.6730
Obs*R-squared	6.003999	Prob. Chi-Square(3)	0.1114

Table 10. Heteroskedasticity test: Breusch-Pagan-Godfrey

F-statistic	0.340367	Prob. F(30,9)	0.9873
Obs*R-squared	21.26075	Prob. Chi-Square(30)	0.8796
Scaled explained SS	5.130932	Prob. Chi-Square(30)	1.0000

Source: Eviews 9 result

Table 11. Pairwise granger causality tests

Null hypothesis:	**Obs**	**F-Statistic**	**Prob.**
BID does not Granger Cause MOT	44	2.78666	0.0739
MOT does not Granger Cause BID		6.84847	0.0028
ERR does not Granger Cause MOT	44	3.60894	0.0326
MOT does not Granger Cause ERR		1.27470	0.2909
MRA does not Granger Cause MOT	44	6.47560	0.0037
MOT does not Granger Cause MRA		0.92620	0.4046
PSM does not Granger Cause MOT	44	3.26148	0.0490
MOT does not Granger Cause PSM		11.3071	0.0001
ERR does not Granger Cause BID	44	10.1869	0.0003
BID does not Granger Cause ERR		1.92780	0.1591
MRA does not Granger Cause BID	44	0.84072	0.4391
BID does not Granger Cause MRA		0.74188	0.4828
PSM does not Granger Cause BID	44	2.82400	0.0716
BID does not Granger Cause PSM		4.91614	0.0125
MRA does not Granger Cause ERR	44	0.40259	0.6713
ERR does not Granger Cause MRA		0.43444	0.6507
PSM does not Granger Cause ERR	44	0.26126	0.7714
ERR does not Granger Cause PSM		10.0223	0.0003
PSM does not Granger Cause MRA	44	0.31527	0.7314
MRA does not Granger Cause PSM		3.01993	0.0603

Source: Eviews 9 result

5. CONCLUSION AND POLICY IMPLICATIONS

This study investigated the impact of monetary policy shocks on industrial output in Nigeria using the contribution of the manufacturing and solid minerals subsectors to the GDP. In doing this, the Restricted VAR (VECM) and Granger causality models were estimated, the results of which yield interesting findings. For instance, estimated VECM result for equation one showed that Commercial Bank Credit to the Industrial Sector (BID) and Monetary Policy Rate (MRA) caused major changes in the Manufacturing subsector-GDP Ratio; this is shown by the positive impact on MOT in all five lag periods. Exchange Rate (ERR) and Solid Mineral subsector (PSM) was found to exert changes on MOT after a three years lag period. These findings were further buttressed by the Granger Causality test result which revealed the existence of causality running from Exchange Rate (ERR) and Monetary Policy Rate (MRA) to the contribution of Manufacturing Sector to GDP (MOT). Conversely, shocks in commercial bank credit to the industrial sector were found to not exert any significant impact on the contribution of the manufacturing sector to GDP. The Granger causality test also indicated that manufacturing sector performance was the main cause of the flow of commercial bank credit to the industrial sector.

The VECM result for the second model revealed that the contribution of the solid mineral subsector to GDP responded positively to shocks in the commercial bank credit to the industrial sector after the first year. Also, PSM responded negatively to shocks in the exchange rate after the first year and positively to shocks in the manufacturing sector-GDP ratio after the first year. This result is confirmed by the uni-directional causality running from commercial bank credit to the industrial sector and exchange rate to the contribution of solid mineral subsector to GDP.

The results obtained in this study have serious implications. For instance, they generally bring to fore monetary policy and exchange rates as the most effective instruments for stimulating the improvements in the performance of the manufacturing sector. As such, any changes in the rates, such as devaluation of the Naira will have serious impacts on the sector. This finding is in line with those of [13]. The relevance of the exchange rate may be largely due to the fact that manufacturing activities in Nigeria, especially with regards to textiles, plastics and electrical appliances, depend on foreign sources for their inputs. Furthermore, improvements in the performance of the manufacturing sector were found to be necessary for the attraction of commercial bank credit to the sector. This is not surprising in view of the unwillingness of Nigerian banks to lend to manufacturing concerns. It also raises questions as to the effectiveness of the CBN’s effort towards the promotion of investment in small and medium scale enterprises.

On the other hand, the exchange rate and commercial bank credit to the industrial sector are found to be the most relevant instruments for the promotion of growth in activities in the solid mineral subsector. These findings are also in line with those of [13], which identified the exchange rate channel as a dominant channel of monetary policy transmission to the solid minerals subsector. The causality test results confirm the results of the VAR analysis. The result indicated a unidirectional causality running from exchange rate and commercial bank credit to the industrial sector to the solid mineral subsector-GDP ratio.

Based on the findings, the study concludes that shocks in monetary policy have had a significant impact on the industrial sector in Nigeria. However, in line with the findings of [4], the results confirm that differences exist in the response of the different subsectors of the industrial sector to shocks in the different monetary policy variables. This indicates the need for the proper evaluation of the possible responses of the different subsectors in the choice of a monetary policy channel. This is primarily germane for the actualization of monetary policy goals. Furthermore, exchange rate shocks were found to exert a significant impact on the two industrial subsectors used in the study. As such, the study recommends that extreme caution should be taken in the management of the exchange rate. Finally, the study also recommends that the central bank of Nigeria do more to encourage commercial banks to allocate more of their loans to small scale investors in the manufacturing sector.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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APPENDIX 1

Wald Test:
Null Hypothesis: C(8)=C(9)=C(10)=C(11)=C(12)=0

Test Statistic	Value	df	Probability
F-statistic	12.25770	(5, 12)	0.0002
Chi-square	61.28852	5	0.0000

Wald Test:
Null Hypothesis: C(13)=C(14)=C(15)=C(16)=C(17)=0

Test Statistic	Value	df	Probability
F-statistic	4.559622	(5, 12)	0.0146
Chi-square	22.79811	5	0.0004

Wald Test:
Null Hypothesis: C(18)=C(19)=C(20)=C(21)=C(22)=0

Test Statistic	Value	df	Probability
F-statistic	7.677632	(5, 12)	0.0019
Chi-square	38.38816	5	0.0000

Wald Test:
Null Hypothesis: C(23)=C(24)=C(25)=C(26)=C(27)=0

Test Statistic	Value	df	Probability
F-statistic	20.48879	(5, 12)	0.0000
Chi-square	102.4440	5	0.0000

APPENDIX 2

Wald Test:
Null Hypothesis: C(8)=C(9)=C(10)=C(11)=C(12)=0

Test Statistic	Value	df	Probability
F-statistic	13.62804	(5, 12)	0.0001
Chi-square	68.14018	5	0.0000

Wald Test:
Null Hypothesis: C(13)=C(14)=C(15)=C(16)=C(17)=0

Test Statistic	Value	df	Probability
F-statistic	12.99549	(5, 12)	0.0002
Chi-square	64.97746	5	0.0000

Wald Test:
Null Hypothesis: C(18)=C(19)=C(20)=C(21)=C(22)=0

Test Statistic	Value	df	Probability
F-statistic	4.782510	(5, 12)	0.0123
Chi-square	23.91255	5	0.0002

Wald Test:
Null Hypothesis: C(23)=C(24)=C(25)=C(26)=C(27)=0

Test Statistic	Value	df	Probability
F-statistic	0.913585	(5, 12)	0.5042
Chi-square	4.567925	5	0.4708

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