THE ASYMMETRIC EFFECT OF REAL INTEREST RATE ON INDUSTRIAL OUTPUT IN NIGERIA

Kabir Risqot Mohammed
Department of Economics,
Air Force Institute of Technology, Kaduna
mrisqot@gmail.com (Corresponding)

BERNARD, Ojonugwa Anthony
Department of Economics,
Air Force Institute of Technology, Kaduna
bernarddecobros@gmail.com

Alfa Yakubu
Department of Economics,
Nigerian Defence Academy, Kaduna
yakubualfa@nda.edu.ng

Ayodeji Salihu
Department of Economics,
Nigerian Defence Academy, Kaduna
fsayodeji@gmail.com

A**bstract**
This study investigates the asymmetric effect of real interest rate on industrial Output in Nigeria using the linear and nonlinear autoregressive distributed lag techniques. Quarterly time series data sourced from CBN Statistical Bulletin (2022) spanning 1986: Q1 to 2022: Q4 for industrial production index (IPI) which is the dependent variable and real interest rate (RNTR), inflation rate (INFR) and exchange rate (EXHR) which are considered explanatory variables. Major findings from this study show the existence of a long-run co-integrating relationship among the variables. However, further findings revealed the absence of an asymmetric effect of real interest rate on industrial production in Nigeria. Real interest rate has a significant negative effect on industrial production in the long run and short run holding all other variables constant, hence, concluding that there is no asymmetry in the effect of interest rate on industrial production in Nigeria. Therefore, the study recommends Central Bank of Nigeria embark on monetary policies that will reduce real interest rates, allow for credit accessibility for owners of industries and hence productivity and output.
Keywords: Asymmetric, Real Interest Rate, Industrial Output, NARDL

INTRODUCTION

The process by which a central bank alters its instruments, such as the money supply and interest rate to induce changes in other variables of target is known as the transmission channel of monetary policy. This process impacts the overall economy and in turn, important macroeconomic variables like employment, inflation, investment, and real sector output are affected (Nwoko et al.,2016). These

avenues aid in the explanation of how actions made by Central Banks affect different economic actors and sectors. The transmission of monetary policy is facilitated by several vital channels, including asset prices, bank lending, interest and exchange rates. These channels can reinforce or counteract one another's effects on the economy since they are linked. The intricacy of these channels highlights the difficulty the Central Bank encounters in carrying out efficient monetary policy to meet predetermined goals (Anwar & Nguyen, 2018).

One significant route that has attracted a lot of attention in monetary literature is the interest rate. This lends credence to the claims that interest rates have a more profound effect on industrial output than other monetary channels. One example of such empirical data comes from a study conducted by Alfa et al. (2021). The study found that interest rates tend to send impulses to target variables within three months in the first horizon and seven months in the second, such as employment, inflation, or output. Conversely, after roughly 18 and 21 months, respectively, changes in the money supply and exchange rate translate to the target variables. This implies that monetary policy initiated through the interest rate channel reaches its goal more quickly than policy initiated through other channels. The industrial output responds to interest rate changes more quickly than it does to changes in other monetary policies (Alfa et al., 2021).

The decision between different channels depends on several factors, including the pace of economic development and the monetary policy framework that decision-makers employ. Nations with imperfect financial markets, like Ghana, rely more on credit and asset channels (Afrin, 2017). Also, nations with sufficient market data depend primarily on the interest rate channel to transmit monetary policy (Alfa, 2019). The Central Bank of Nigeria (CBN) uses transmission channels as a nominal anchor, even though this has also changed multiple times from exchange rate to interest rate channel and currently to both transmission channels, in nations like Nigeria where the monetary policy framework adopted over the years has changed severally from targeting exchange rate to targeting monetary aggregate further to target inflation partially. Hence, the framework of monetary policy adopted by a country strongly informs her choice of the transmission channel in the conduct of her monetary policy (Alfa & Sa'ad, 2016).

For instance, the industrial output dropped from 3.6 per cent in 2021 to 3.3 per cent in 2022. As a result, the Nigerian industry as a whole declined by 5%. Evidence suggests that, on the supply side, the decline in the industrial output over time has been primarily caused by a decline in the output of the oil sector. This has been argued to be the main demand-side driver of the decline in the industrial output in Nigeria, and it explains the $103 billion increase in public debt in 2022, the 2 per cent decline in public consumption, and the 80 percent decline in net export. Furthermore, the Central Bank of Nigeria's monetary contraction policy - which placed a strong emphasis on price stability and paid little attention to sustainable growth has over time contributed to Nigeria's industrial output decline. For example, there was a decline in industrial output from 6.31 percent in 2014 to 2.65

percent in 2015 coinciding with the Central Bank of Nigeria's decision to increase interest rates from 11 percent in 2014 to 12 percent in 2015. Subsequently, industrial output experienced a downturn, reaching -1.62 percent by the close of 2018 and further dropping to -1.69 percent by 2019 (National Bureau of Statistics, 2023). In 2016, the Central Bank of Nigeria implemented successive interest rate hikes in March and July, raising the rate from 12 percent to 14 percent. This means that the output's responses to rising and falling interest rates could be the same (symmetric) or different (asymmetric). Nonetheless, the majority of earlier research has concentrated on the interest rate channel's symmetric manner. The prevailing issue is that the monetary policy adopted has not drastically boosted the industrial sector. The significance of this research is supported by findings from studies by (Uzah, etal (2021), Yahaya et al., (2021)). Thus, this study seeks to investigate the asymmetric effect of real interest rates on industrial output in Nigeria.

LITERATURE REVIEW

This section provides a conceptual review of interest rates and industrial output. It also provides the theoretical underpinning of this study. To further justify the motivation for this study, some empirical literature related to this study was reviewed.

Concept of Interest Rate

Broadly speaking, interest rates are the cost of money; they indicate the amount paid for the use of funds over a predetermined period (Obansa, et al., 2013). In other words, interest rates influence borrowing and spending decisions by signaling the cost of obtaining capital. The Central Bank of Nigeria (2018) defined interest rates as the cost of borrowing or the return on investment, expressed as a percentage. It encompasses the amount charged by financial institutions for lending funds and the earnings accrued from savings or investments. The interest rate is a crucial economic indicator influencing borrowing and investment decisions, impacting overall economic activities, and serving as a tool for monetary policy regulation. Also, Svensson (2017) defined the interest rate channel as the transmission mechanism through which a change in the policy interest rate set by the central bank causes changes in other interest rates, asset prices, and exchange rates, ultimately affecting aggregate demand and output in the economy.

In my opinion, the interest rate is the cost of acquiring capital or the reward of saving in the Bank.

Concept of Industrial Output

Different contexts have been used to conceptualize industrial output. As stated by Orji et al. (2015) industrial output is the observable and quantifiable value of the products generated by the industrial sectors. Except for activities connected to agriculture service and financial sector, it comprises the actual physical output of industries, agriculture, and other productive sectors. It is the measurable and observable economic activities that go into calculating a nation's gross domestic product (GDP), according to Ductor and Grechyna (2015) According to Samsi et al. (2012), industrial output is the total amount of goods and services produced, minus the impact of inflation. 2012). Total value of final goods and services produced in an economy, adjusted for changes in the general price level is what Mankiw (2014) defines as industrial output.

Theoretical Review

The main theoretical review of this study is the Keynesian approach. Due to its emphasis on the impact of aggregate demand on output levels and economic activity, Keynesian theory is especially appropriate. The significance of interest rates as a major conduit through which monetary policy influences industrial output is perhaps even more critically highlighted by the Keynesian perspective. Furthermore, as per the Keynesian framework, the monetary policy tool of interest rate adjustments by the Central Bank has an immediate impact on the borrowing costs of consumers and businesses. One way to increase aggregate demand and overall economic activity is by lowering interest rates, which can encourage borrowing for consumption and investment. A rise in the industrial output may follow from this. However, if the Central Bank hikes interest rates, borrowing becomes more expensive, which might reduce investment and consumption. The industrial outputs may contract as a result, and aggregate demand may decline. Changes in monetary policy therefore have an important effect on the overall economy, affecting output, employment, and economic growth through the interest rate channel. Using a Keynesian methodology, this research attempts to investigate the relationship between changes in interest rates and other monetary policy shifts and Nigeria's real economy. In this view, monetary policy decisions, interest rates, and their derivatives are all interrelated.

Empirical Review

Many empirical studies have revealed the impact of monetary channels of interest rate transmission on industrial production in Nigeria. A recent study by Alfa and Gambo (2023) examined the interest rate channels of monetary transmission and real sector output in Nigeria using the NARDL technique over the period 1981 to 2021. Sourcing data from WDI and CBN statistical bulletin, major findings revealed interest rate and inflation rate to have a significant negative impact on real sector output. Further findings revealed exchange rate had a positive and significant impact on real sector output along with asset prices in Nigeria, during the period investigated. The study concludes in favour of lowering interest rates to encourage industrial output through an increase in borrowing.

Uzah, et al. (2021) examined the interest rates channel of the monetary policy transmission mechanism and the earnings of commercial banks in Nigeria. The goal was to determine the extent to which the interest rates channel of the monetary policy transmission mechanism affects the earnings capacity of the quoted commercial banks. Time series data were obtained from annual financial reports of commercial banks and various issues of the Central Bank of Nigeria statistical bulletins. Earnings measures like earnings per share and earnings before interest and taxes were modelled as a function of the Monetary Policy Rate, Prime Lending Rate, Short-term Savings Rate, Long-term Savings Rate, and Maximum Lending Rate. The findings revealed that short-term and long-term savings rates have negative effects on the earnings capacity of Nigerian commercial banks, whereas the monetary policy rate, maximum lending rate, and prime lending rate have positive effects. As a result, we recommend that interest rate policies be integrated with commercial banks' earnings objectives.

Using the Impulse Response Separation Vector Auto Regression (IRSVAR) technique, Li et al. (2021) investigated the individual effects of the monetary transmission channels (asset price channel, credit channel, interest rate channel, and exchange rate channel) in China. The outcomes are as follows: First, although China's market-oriented reform has been carried out for 40 years, the role of the neoclassical interest rate channel in the overall effect of monetary policy is still relatively low (31%). Second, while the credit channel's relative importance has declined, it is still the most important transmission channel (42% on average). It demonstrates that there are still significant frictions in China's economy and that market-oriented reforms must be strengthened further. Third, the relative marginal role of asset price channels has increased significantly (20%), owing primarily to China's stock and property markets' rapidly increasing wealth effect on households. Since the exchange rate has always been tightly controlled, the role of the exchange rate channel has been minimal (7%).

Nevertheless, one central proposition in research on the role of banks in the transmission mechanism is that monetary policy has a direct impact on deposits and that deposits drive bank lending. The emphasis on policy-induced changes in deposits, according to Leonardo and Marques (2011), is misguided. A bank lending channel reformulation is proposed, which focuses on the impact of monetary policy on banks' balance sheet strength and risk perception. Contrary to popular belief, such a recasting implies that increased reliance on market-based funding increases the channel's relevance.

On, et al. (2021) concentrated on the performance characteristics of Ukraine's monetary transmission mechanism (MTM) as a small open economy. To evaluate the efficiency of monetary transmission channels, it is necessary to reveal their interaction and to define criteria and tools for analyzing their impact on key macroeconomic parameters. The study extends approaches to analyzing the intensity of using monetary, credit, interest rate, and exchange rate channels in Ukraine from 2005 to 2020, and it detects violations in the MTM's operation. The

impact of the major channels of monetary transmission on the real GDP growth rate and inflation in Ukraine was evaluated using economic and statistical methods and regression models. It was concluded that it is necessary to clarify the conditions for increasing the efficiency of MTM in Ukraine, as well as the parameters for forecasting the intensification of its channels in the medium and long term.

Gunduz (2021) analyzed the stock market transmission channel of the monetary policy of the Turkish economy not only at the aggregate but also at the sectoral level in a structural vector autoregression (SVAR) framework. He adopted alternative variables as a policy instrument. When the spread is used as a policy instrument, he found that contractionary monetary policy has a significant negative effect on both output and the price level, and it appreciates the Turkish Lira. Besides, the tight monetary policy reduces both aggregate and sectoral market returns. Hence, he observed that there are effective interest rates, exchange rates, and asset price channels in the Turkish economy. As a result, he observed that the Turkish economy has effective interest rate, exchange rate, and asset price channels. Nonetheless, the study analyzed the channel of stock market transmission of monetary policy in the Turkish economy; while this study is analyzing the interest rate channel of monetary policy transmission and real sector output in Nigeria.

Abrar et al. (2020), theorized that the inflation rate responds positively to asset prices and that this response weakens if the interest rate is tilted against the winds of inflation, output, and asset prices. To test these hypotheses, we estimated various specifications of the vector autoregressive (VAR) model and discovered impulse response functions after identifying structural shocks. For the period 2000m01 to 2019m06, data from Pakistan's economy on inflation rate, large-scale manufacturing index, interest rate, and asset price index - which includes house prices, stock prices, and exchange rate - are used. The study found evidence in support of both hypotheses; asset price inflation positively transmits into goods price inflation, and this transmission is heightened if the interest rate does not respond to other variables in the model. Moreover, the transmission of asset prices into inflation rate, as compared to output, is influenced more by monetary policy. Eventually, they also found that the transmission of the exchange rate and house prices to the inflation rate is very much affected by the monetary policy while in the case of stock prices, the influence of policy is moderate. However, the study is basically on the inflation rate assets prices and interest rate in Pakistan; while this study is based on the interest rate transmission channel of monetary policy and real sector output in Nigeria.

Kelikume (2014) examined the interest rate channel of monetary transmission in Nigeria to determine the degree of stickiness in interest rates in achieving macroeconomic policy objectives. The study investigated the channel through which nominal interest rates influence long-run economic aggregates using co-integration and error correction mechanisms. Secondary time series data with quarterly frequency from Q1:1996 to Q3:2013 were used in the study. the result Interest rates influenced long-run output with the expected sign and were

statistically significant. A 10% increase in interest rates, for example, reduces output by 0.8 per cent because of the impact on investment and aggregate consumption.

Another study with methodological relevance to this research is the work of Wafure et al. (2023) which examined the linear and asymmetric impact of domestic debt outstanding on economic growth in Nigeria using the NARDL technique over the period 1981 to 2021. Data were sourced from the WDI and CBN statistical bulletin. Major findings revealed a weak linear impact of domestic debt holdings on economic growth in both the short and long run and a significant asymmetric impact of domestic debt on economic growth in the long run.

METHODOLOGY

This study uses secondary data quarterly spanning 1986 (Q1) to 2022 (Q4). The choice of quarterly data was justified by the need to have a large sample size required to fulfil the central limit theory of the None Linear Autoregressive Distributed Lag Model (NARDL), which is better suited for analyzing quarterly data. 1986 is chosen to capture the period of the Structural Adjustment Programme (SAP) when a major change took place. 2022 is selected based on the availability of data. The data are sourced from World Development Indicators (WDI) 2024 and Central Bank of Nigeria (CBN), 2023. That is, the real interest rate is from WDI, while Exchange rates, industrial output and inflation rates are from CBN.

This study uses the NARDL model introduced by Shin and Greenwood-Nimmo (2014). The model is a time series econometric technique that allows for estimating nonlinear relationship among the variables. The NARDL approach allows for a more accurate understanding of the positive (increase) and negative (decrease) effects of change in the real interest rate on industrial output. Therefore, the general specification of the NARDL model is:

$$y_t = \alpha_0 + \beta x_t^{+ve} + \beta x_t^{-ve} + \varepsilon_t \qquad 1$$

where y_t and x_t are the dependent and independent x_t is decomposed into partial sum processes of positive (increase) and negative (decrease) changes. The econometric model of this paper is adapted from that of Alfa and Gambo (2023) with major modifications to suit the peculiarities of this paper. The asymmetric model by Alfa and Gambo (2023) is stated in Equation 2.

$$\Delta lnRSO_t = \alpha_0 + \sum_{i=1}^{p} \beta_1 \Delta lnRSO_{t-i} + \sum_{j=0}^{p} \beta_2 \Delta ln\mathrm{INT}_t^{+ve}{}_{t-i} + \sum_{j=0}^{p} \beta_3 \Delta ln\mathrm{INT}_t^{-ve}{}_{t-i} + \sum_{j=0}^{p} \beta_4 \Delta ln\mathrm{EXR}_t^{+ve}{}_{t-i} + \sum_{j=0}^{p} \beta_5 \Delta ln\mathrm{EXR}_t^{-ve}{}_{t-i} + \sum_{j=0}^{p} \beta_6 \Delta ln\mathrm{ASP}_t^{+ve}{}_{t-i} + \sum_{j=0}^{p} \beta_7 \Delta ln\mathrm{ASP}_t^{-ve}{}_{t-i} + \sum_{j=0}^{p} \beta_8 \Delta ln\mathrm{INF}_t^{+ve}{}_{t-i} + \sum_{j=0}^{p} \beta_9 \Delta ln\mathrm{INF}_t^{-ve}{}_{t-i} + \alpha_1 lnRSO_{t-1} + \alpha_2 ln\mathrm{INT}_t^{+ve}{}_{t-1} + \alpha_3 ln\mathrm{INT}_t^{-ve}{}_{t-1} + \alpha_4 ln\mathrm{EXR}_t^{+ve}{}_{t-1} + \alpha_5 ln\mathrm{EXR}_t^{-ve}{}_{t-1} + \alpha_6 ln\mathrm{ASP}_t^{+ve}{}_{t-1} + \alpha_7 ln\mathrm{ASP}_t^{-ve}{}_{t-1} + \alpha_8 lnINF_t^{+ve}{}_{t-1} + \alpha_9 ln\mathrm{INF}_t^{-ve}{}_{t-1} + \varepsilon_t \quad 2$$

Where: RSO is real sector output, INT is the interest rate, EXR is the exchange rate, ASP is asset price and INF is inflation. The modified asymmetric model for this paper is stated in Equation 3.

$$\Delta lnIPI_t = \alpha_0 + \sum_{i=1}^{p} \beta_1 \Delta lnIPI_{t-i} + \sum_{j=0}^{p} \beta_2 \Delta ln\mathrm{RNTR}_t^{+ve}{}_{t-i} + \sum_{j=0}^{p} \beta_3 \Delta ln\mathrm{RNTR}_t^{-ve}{}_{t-i} + \sum_{j=0}^{p} \beta_4 \Delta ln\mathrm{EXHR}_t^{+ve}{}_{t-i} + \sum_{j=0}^{p} \beta_5 \Delta ln\mathrm{EXHR}_t^{-ve}{}_{t-i} + \sum_{j=0}^{p} \beta_6 \Delta ln\mathrm{INFR}_t^{+ve}{}_{t-i} + \sum_{j=0}^{p} \beta_7 \Delta ln\mathrm{INFR}_t^{-ve}{}_{t-i} + \alpha_1 lnIPI_{t-1} + \alpha_2 ln\mathrm{RNTR}_t^{+ve}{}_{t-1} + \alpha_3 ln\mathrm{RNTR}_t^{-ve}{}_{t-1} + \alpha_4 ln\mathrm{EXHR}_t^{+ve}{}_{t-1} + \alpha_5 ln\mathrm{EXHR}_t^{-ve}{}_{t-1} + \alpha_6 ln\mathrm{INFR}_t^{+ve}{}_{t-1} + \alpha_7 ln\mathrm{INFR}_t^{-ve}{}_{t-1} + \varepsilon_t \quad 3$$

Where: The industrial production index (IPI) is a measure of the Industrial Sector. The positive and negative changes in the real interest rate (RNTR), Exchange Rate (EXHR) and inflation rate (INFR). These changes are represented by positive (increase) and negative (decrease) partial sums of respective variables. The α and β represent the long-run and short-run coefficients respectively. The α_0, represents the constant term in the model. The error term is ε_t.

A major point of departure between the model of this study and that of Alfa and Gambo (2023) is that while they relied on real sector output as a measure of industrial sector productivity, this paper used the industrial production index as a measure of industrial sector productivity. Moreover, Alfa and Gambo (2023) incorporated all three monetary policy transmission mechanisms in their model,

while in line with its objectives, this paper focused on the interest rate transmission channel.

RESULTS AND DISCUSSION

Table 1: *Descriptive Statistics*

Statistic	**IPI**	**RNTR**	**INFR**	**EXHR**
Mean	5.033426	2.464410	19.81847	129.5712
Median	2.153949	4.946734	13.28687	126.1452
Maximum	26.07087	18.18000	76.75887	425.9811
Minimum	0.027229	-31.45257	0.223606	2.020575
Std. Dev.	6.389189	8.908114	16.78443	113.6490
Skewness	1.563830	-1.290084	1.843594	0.886222
Kurtosis	4.775807	5.031362	5.292388	3.023096
Jarque-Bera	78.15349	65.15149	113.8879	18.98345
Probability	0.000000	0.000000	0.000000	0.000075
Sum	729.8468	357.3394	2873.678	18787.83
Sum Sq. Dev.	5878.330	11427.05	40567.24	1859919.

Source: Researcher Computation, 2024

The descriptive statistics of the variables are presented in Table 1. The results show that IPI has a mean of 5.03, and ranges between 0.03 and 26.1 over the scope of the data. RNTR has a mean of 2.46%, with a range of -31.5% and 18.2%. The mean of INFR is 19.81%, with a range of 0.22% and 76.7%. The mean of exchange rate (EXHR) is 129.7% with a maximum of 425.9 and a minimum of 2.02. The standard deviation of IPI, RNTR, INFR, and EXHR, are 6.4, 8.9, 16.8, and 113.7 respectively. While the Jarque-Bera test for normality suggest that all the variables are not normality distributed at 5% level of significance. All the variables are Leptokurtic, with Kurtosis above 3. Since the variables are not normally distributed, this necessitated the need to carry out a unit root test for stationarity

Table 2*: Unit Root Test*

	ADF		***PP***		
Variables	*At level I(0)*	*First Difference I(1)*	*At level I(0)*	*First Difference I(1)*	*Order of integration I(p)*
IPI	3.2006	-3.4413**	2.8204	-1.7482*	I(1)
	(1.0000)	(0.0500)	(0.9988)	(0.0763)	
RNTR	-3.0476	-3.7650***	-2.4402**	-3.2935***	I(0)
	(0.1232)	(0.0213)	(0.0147)	(0.0011)	
INFR	-2.9494	-4.6242***	-1.5556	-3.2544***	I(1)
	(0.1504)	(0.0014)	(0.1123)	(0.0013)	
EXHR	-0.1215	-4.1331***	2.0457	-2.9403***	I(1)
	(0.9941)	(0.0071)	(0.9903)	(0.0035)	

Source: Researcher Computation, 2024

Notes: (*) Significant at the 10%; (**) Significant at the 5%; (***) Significant at the 1%. and (no) Not Significant

The summaries of unit root test results in Table 2 are to determine the stationarity of the variables using the Philip Perron (PP) and Augmented Dickey-Fuller (ADF) Statistics. The unit root test results in Table 2 show a mixed order of integration for the variables. That is, RNTR is stationary at a level while the growth of IPI, INFR and EXHR are stationary at the first difference, I(1). Thus, suggesting the test of cointegration for the long-run relationship existence of the variables. If there is the existence of cointegration, the short-run and long-run results are interpreted with particular interest on the error correction term (the rate of adjustment).

Table 3. *ARDL Bounds Test for Cointegration*

	ARDL	*I(0)*	*I(1)*	*Sig.*	*I(0)*	*I(1)*	*NARDL*
F-statistic	4.4714**	2.97	3.74	10%	2.49	3.38	3.7044**
K	3	3.38	4.23	5%	2.81	3.66	5
		4.3	5.23	1%	3.6	4.63	

Source: Researcher Computation, 2024. Notes: (*) Significant at the 10%; (**) Significant at the 5%; (***) Significant at the 1%. and (no) Not Significant.

Given the existence of a mixed order of integration during the stationarity test, a need to find the long-run relationship of the variables and the bound cointegration results of ARDL and NARDL in Table 3. It is observed that there a long-run relationship exist among the variables of interest at a 5 per cent level of significance for the two models. This is evident in the value of the F-statistic (ARDL, 4.47) and (NARDL, 3.70) which lies above the upper bounds, 4.23 and 3.66 of 5% level of significance respectively.

Table 4*. Autoregressive Distributed-Lag (ARDL) Model*

Long run	***Coefficient***	***p-value***
C	-0.0756**	0.0123
@TREND	0.0238***	0.0003
LOG(IPI(-1))	-0.0240***	0.0021
RNTR	-0.0499**	0.0147
INFR	-0.0034	0.7035
LOG(EXHR)	0.0238***	0.0010
Short run		
DLOG(IPI(-1))	0.5823***	0.0000
D(RNTR)	-0.0082***	0.0000
D(INFR)	-0.0016***	0.0005
Ect(-1)	-0.0240***	0.0000
Post Estimation Test		
R^2	0.7482	
Adj. R^2	0.7370	
F-stat.	67.3342***	0.0000
Breusch-Godfrey Serial Correlation LM Test:	0.4782	0.6210

Source: Researcher Computation, 2024

Notes: (*) Significant at the 10%; (**) Significant at the 5%; (***) Significant at the 1%. and (no) Not Significant.

Table 5. *Non-Linear Autoregressive Distributed-Lag (NARDL) Model*

Long run	***Coefficient***	***p-value***	***Wald Test***
C	-0.2403***	0.0007	Ho: No asymmetry
@TREND	0.0188***	0.0000	H1: There is asymmetry
LOG(IPI(-1))	-0.0685***	0.0009	
$RNTR^{+ve}$	-0.0171**	0.0144	
$RNTR^{-ve}$	-0.0383***	0.0000	0.2794 (0.5980)
Short run			
DLOG(IPI(-1))	0.5988***	(0.0000)	
$D(RNTR^{+ve})$	-0.0082***	(0.0000)	
$D(RNTR^{-ve})$	-0.0108***	(0.0001)	
Ect(-1)*	-0.0686***	0.0000	
Post Estimation Test			
R^2	0.7936		
Adj. R^2	0.7812		
F-stat.	63.9372***	0.0000	
Breusch-Godfrey Serial Correlation LM Test:	0.0148	0.9854	

Source: Researcher Computation, 2024

Notes: (*) Significant at the 10%; (**) Significant at the 5%; (***) Significant at the 1%. and (no) Not Significant

Having detected cointegrating relationships, the study proceeded to investigating the long and short-run outcome using ARDL estimation technique and NARDL estimation technique both techniques employed the automatic AIC lag length selection criteria of using the model lag length selection criteria of 2,2,2,0 and 2,2,2,0,2,0. models with special interest in the error correction mechanism aimed at knowing the rate of adjustment to shocks and dynamics of the dependent variables to disequilibrium caused by the explanatory variables. It is also, worth noting that the result of NARDL is interpreted only when there is asymmetric effect. Otherwise, the linear ARDL result suffice.

The result in Table 5 indicates that real interest rate (RNTR) has no asymmetric effect on industrial production (IPI). This is detected from the Wald test conducted on the decomposed positive and negative values of RNTR. The probability of the Wald test of 0.2794 is insignificant, thus, suggesting an absence of nonlinearity or asymmetric effect. Hence, following the approach of Wafure et al. (2023), the linear ARDL estimates are interpreted. From Table 4, RNTR has a significant negative relationship with IPI in the long- and short-run. That is, for every one per cent increase (or decrease) in RNTR, holding all other variables constant, IPI will decrease (or increase) by about 0.05 per cent in the long run and 0.0082 per cent in the short run. Both the control variables, inflation rate (INFR) and exchange rate (EXHR), are negatively and positively related to IPI in the long- and short-run respectively. Though, INFR is not significant in the long run but significant in the

short-run, however, EXHR is significant. Overall, the results suggest that the real Interest rate (RNTR) on production output is linear and significantly negative. The error correction term has the required negative sign, less than one and significant. This implies a 2.4 per cent rate of adjustment for any deviation from short-run equilibrium to be restored in the long run. The estimates are shown to be reliable by the diagnostic tests reported in Tables 4 and 5. The adjusted R^2 shows that 73 per cent of the industrial output is jointly explained by the explanatory variables. The insignificance of the F-statistic at 5 per cent of significance confirms the absence of autocorrelation shown by the Breusch and Godfrey (BG) test for serial correlation.

The result of this study conforms with the studies of (Uzah, et al., (2021), Yahaya et al., (2021)) found a positive effect of interest rates on the earning capacity of Nigerian commercial banks in the long- and short-run; while the Kelikume (2014) concluded that interest rate significantly influences long-run output negatively.

CONCLUSION AND POLICY IMPLICATIONS

This study investigated the asymmetric effect of real interest rate on industrial sector output in Nigeria using ARDL and NARDL models on quarterly data. The study concluded that there is no asymmetric effect of real interest rate on industrial output (proxy by industrial production index), but a linear indirect impact. This study therefore concluded that any monetary policy that will increase real interest rates will lead to a further decrease in industrial output in Nigeria.

The study also observed inflation rate (INFR) and exchange rate (EXHR) are negatively and positively related to Industrial output in Nigeria both in the long and short-run respectively. This study therefore concluded that the unstable inflation rate and exchange rate may not be healthy for investors in the industrial sector. Therefore, there is a need for a more stable inflation rate that could allow for investor's confidence and planning.

Finally, the CBN needs to pay closer attention to the channel through which interest rates affect industrial output in Nigeria. A reduction in the monetary policy rate (MPR) which is the driver of interest is recommended as it will allow better liquidity in the capital market and hence, credit accessibility and growth of industrial output.

References

Abrar, U., Rohaizat, B., Muhammad, Y., & Khalil, M. D. N. (2020). The Role of Monetary Policy in Transmission of Asset Prices into Goods Prices. *Journal of Applied Economics and Business Studies, 4(2), 181–204.*

Afrin, S. (2017). Monetary Policy Transmission Mechanism, Financial Frictions in Closed and Open Economy DSGE Models. *Journal of Asian Economics, 49(C), 60-80.* https://doi.org/10.1016/j.asieco.2016.10.003

Alfa, Y., & Sa'ad, S. (2016). Length of transmission lag from monetary policy rate (MPR) and broad money supply (M2) to inflation in Nigeria. *West African Journal of Monetary and Economic Integration, 21*(1), 85-113.

Alfa, Y., & Gambo, H. (2023). Interest rate channel of monetary transmission and real sector output in Nigeria. *Journal of Arid Zone Economy* 2(2), 117-132.

Alfa, Y., Sa'ad, S., & Abdulrasheed, Z. (2021). Length of transmission lag from monetary policy rate (MPR) and broad money supply (M2) to inflation in Nigeria. *West African Journal of Monetary and Economic Integration, 21*(1), 85-113.

Anwar, S., & Nguyen, L. P. (2018). Channels of monetary policy transmission in Vietnam. *Journal of Policy Modeling*, *40*(4), 709-729.

Central Bank of Nigeria. (2018). Statistical Bulletins (Various Issues).

Ductor, L., & Grechyna, D. (2015). Financial development, real sector, and economic growth. *International Review of Economics & Finance*, *37*, 393-405.

Gunduz, I. (2021). Stock Market Transmission Channel of Monetary Policy: Empirical Evidence from Turkey. *International Journal of Finance and Economics, 26(4), 6421–6443.*

Ishioro, B. O. (2013). Stock market development and economic growth: Evidence from Zimbabwe. *Ekonomska misao i praksa*, *22*(2), 343-360.

Kelikume, I. (2014). Transmission Mechanism: Evidence from Nigeria. *The International Journal of Business and Finance Research, 8(4), 97–108.*

Nwoko, N. M., Ihemeje, J. C., & Anumadu, E. (2016). The impact of monetary policy on the economic growth of Nigeria. *African Research Review*, *10*(3), 192-206.

Obansa, S. A. J., Okoroafor, O. K. D., Aluko, O. O., & Eze, M. (2013). Perceived relationship between exchange rate, interest rate and economic growth in Nigeria: 1970-2010. *American journal of humanities and social sciences*, *1*(3), 116-124.

Svensson, L. E. (2017). Cost-benefit analysis of leaning against the wind. *Journal of Monetary Economics*, *90*, 193-213.

Samsi, S., Krishnamurthy, A. K., & Gurcan, M. N. (2012). An efficient computational framework for the analysis of whole slide images: Application to follicular lymphoma immunohistochemistry. *Journal of computational science*, *3*(5), 269-279.

Uzah, K. C., Clinton, A. M. A., & Kpagih, L. (2021). Interest Rate Channel of Monetary Policy Transmission Mechanism and Commercial Banks Earnings In Nigeria.

Wafure, G. O., Gana, U., Shuaibu, S., Murtala, I. (2023). Domestic debt outstanding and
economic growth: a linear or nonlinear evidence in Nigeria. *International Journal of Global Economic Light (JGEL)*, 9(6).
Yahaya, U. I., Olarinde, M., & Isah, A. (2021). Monetary policy and stock market prices in Nigeria. *Lafia Journal of Economics and Management Sciences*, 6(1), 1.