



Interest Rate Channel of Monetary Transmission and Real Sector Output in Nigeria

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Abstract

This study examines the interest rate channels of monetary transmission and real sector output in Nigeria from 1980 -2021. The study used annual secondary data and were analysed using the Nonlinear Autoregressive Distributed Lag (NARDL) Model. Findings show that interest rate and inflation negatively impacted real sector output in Nigeria over the period of the study. This means that a higher interest rate and inflation rate translate to a lowering of the output of the real sector in Nigeria. Findings further reveal that asset price and exchange rate positively impact real sector output. However, in terms of the sizes of the estimated coefficients, asset price had the most negligible impact on real sector output. At the same time, the exchange rate channel exerted a more significant impact on real sector output in Nigeria. Based on the findings, the study recommends that the monetary authority in Nigeria should maintain low and stable interest and inflation rates. The low-interest rate should be maintained to encourage borrowing for investment purposes.

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1. Introduction

One of the channels of monetary transmission that has received much attention in monetary literature is the interest rate channel. This is evident in the arguments of many empirical studies that interest rate, when compare with other monetary policy variables (such as money supply, exchange rate, expectation), has a far-reaching impact on real sector output than other channels. One of such empirical evidence is the result of study by Alfa, Sa'ad and Abdurashed

(2021). According to the study, the interest rate channel of monetary policy has the tendency of transmitting monetary impulse to the target variables (output, inflation or employment) within three months in the first horizon and seven months in the second horizon. Whereas, changes in exchange rate and in money supply transmit to target variables after about 18 months and 21 months have respectively elapsed. This implies that monetary policy initiated through the interest rate channel is faster in reaching the target than

those initiated through other policy channels. This also means that the real sector output adjusts to changes in interest rate faster than to changes in other policy variables such as the exchange rate, money supply and inflation expectations.

Apart from the interest rate channel, other fundamental channels of monetary transmission often discussed in monetary literature include the asset price channel, the credit channel and the exchange rate channel. The asset price channel is responsible for the distribution of the effects induced by monetary policy decisions that affect the price of assets in financial and real capital markets, which in turn affect the economy (Rafindadi, 2017). The credit channel affects the economy by altering the amount of credit firms and/or households have access to, while the credit channel generates direct impact on aggregate demand and output. The exchange rate channel transmits impulse to the economy through its impact on domestic currency, domestic inflation, the external sector, macroeconomic credibility, capital flows, and financial stability (Alfa, 2019).

The choice between the various channels of monetary transmission in the conduct of monetary policy depends on factors such as the state of advancement of the economy and the monetary policy framework adopted by a country. For example, advanced economies like the United States, with adequate market information, rely on the interest rate channel as the principal transmission channel of monetary policy, whereas developing economies such as Ghana, characterized by imperfect financial markets, place greater reliance on the credit, exchange rate and the asset price channels (Afrin, 2017). However, in countries like Nigeria where monetary policy framework adopted over the years have changed severally from exchange rate targeting to monetary aggregate targeting and to partial inflation targeting, transmission channels used as nominal anchor by the Central bank of Nigeria has also change severally from exchange

rate channel to interest rate channel and to a mixed of both over the years (Sa'ad & Alfa, 2016). This implies that the monetary policy framework adopted by a country also informs her choice of the channel of monetary transmission in the conduct of her monetary policy.

Like interest rate channel of monetary transmission, the real sector of an economy and its interaction with other sectors has also received wide range attention in research. By real sector, it meant the part of the economy that produces tangible goods and services. The sector is considered the "real" part of the economy because its output can be physically touched, used, and sold. It includes sectors such as agriculture, manufacturing, construction, and mining. The output of real sector refers to the potential or actual goods produce within the earl sector and it adds to the overall level of production in the economy. When actual output is rising, the output gap is often declining and the economy is said to be moving closer to her production possibility frontier by increasing the level of capacity utilization (Mordi, Adebisi, Adenuga, Adebayo, Abeng, Akpan, Adeboye, Adamgbe, Igue & Evbuomwan, 2013).

A very interesting but debatable aspect of interest rate channel of monetary transmission that is yet to be widely explored in the literature is whether or not the pass-through from interest rate to output is asymmetric. Interest rate channel pass-through is consider asymmetric if increases and decreases in interest rate lead to different adjustment patterns in output or target variable. It is symmetric however, if increases and decreases in the interest rate lead to the same adjustment patterns in output or target variable. Detecting asymmetric behaviour in how the real sector reacts to interest rate changes is vital for several reasons. First, it can provide insights into how the central bank's interest rate rate changes pass through to output over important periods of government regulated and deregulated (market-determined) interest rate regimes (the pre- and

post-financial sector liberalization periods) in Nigeria. Second, notwithstanding the significance of investigating the possible asymmetries in the transmission process of monetary policy in an economy, there is a paucity of research investigating this issue in Nigeria. The few exceptions include studies by Sanusi (2010), Fomum (2011), Bangura (2011), Mangwengwende (2011), Ogundipe and Alege (2013), Kelilume (2014), and Mordi et al., (2019).

Available data from National Bureau of Statistics (2023) shows that in Nigeria, the growth rate of real sector output has not been promising over the years. In 2022 for example, the output of real sector fell to 3.3% from 3.6% in 2021. This led to 5% shrinkage in overall industries in the country. On the supply side, the decline in the growth rate of real sector output was precipitated mainly by a decline in oil production, while on the demand side, it was driven by contraction in public consumption (2.5%) and net exports (80%) and increase in public debt to \$103.1 billion in 2022 from \$92.6 billion in 2021. Furthermore, the Central Bank of Nigeria's (CBN) policy of monetary tightening, which focuses on key objective price stability with little attention on sustainable growth, has also contributed to declining real sector output in Nigeria over the years. For example, when the CBN rises in interest rate from 11% in 2014 to 12% in 2015, the real output fell from 6.31% in 2014 to 2.65% in 2015. In 2016 the CBN again raised the rate in March and in July, from 12% to 14%, while real output hit a negative value of to -1.62% by the end of 2018 and falls further to -1.69 by 2019, following covid-19 pandemic. As the economy recovers from the covid-19 pandemic in 2020, the CBN reduces the interest rates to 13.5% in order to accelerate the economy. This is expected to increase the real sector output in the country. Unfortunately, this effort by the CBN leaves much to be desired as inflation remains persistent

in the economy, and the output within the real sector was witnessing a decline (Yusuf & Oghenekaro, 2022).

The forgoing has demonstrated that the response of real sector output to increasing and decreasing interest rate may be same (symmetric) or different (asymmetric). However, most previous studies have focused on the symmetric pass-through of interest rate channel of monetary transmission. Such studies include Obafemi and Ifere (2020), Ekong (2018), Ishioro (2013), and Ogbulu and Torbira (2012). This study employ the nonlinear autoregressive distributed lag (NARDL) model that make it possible to capture asymmetric response of real sector output to interest rate channel of monetary transmission in Nigeria.

2. Literature Review

2.1 Conceptual Clarification

Monetary Transmission Mechanism

Various explanations, from specific to general, complementary and contradictory, have been given to explain how monetary policy decisions are transmitted to economies to affect macroeconomic variables (Abdulwahab, 2012). Nwosa and Saibu (2011) describe monetary transmission as the channels through which monetary policy impulse is transmitted to the economy to affect aggregate output. These channels, they argued, had been a subject of continuous discourse among academia and researchers, given that an understanding of the transmission of monetary policy to real output is a key factor for central bankers to conduct monetary policy effectively. The authors added that for a small open economy like Nigeria, it is vital to analyse monetary policy transmission at the sectoral level rather than individual sectors, given that there is mixed evidence regarding monetary policy transmission in individual sectors.

Wong and Kyguun (2013) describe the transmission process as how interest rate changes

affect economic activity and inflation. The main impact is through the level of aggregate demand. Higher interest rates limit people's ability to spend and so reduce aggregate demand. However, there are a variety of other effects as well through expectations, asset prices and the exchange rate. According to the European Central Bank (2014), the transmission mechanism of monetary policy is the process through which monetary policy decisions affect the economy in general and the price level in particular. The transmission mechanism is characterised by long, variable and uncertain time lags. Thus, it is difficult to predict the precise effect of monetary policy actions on the economy and price level.

Lorenzo (2009) opines that the transmission mechanisms of monetary policy may be seen as the channels, not mutually exclusive, through which the evolution of monetary aggregates affect, often after variable and not wholly predictable intervals, the level of production and prices. According to him, the most economic literature on monetary transmission has identified at least four different mechanisms through which monetary policy can influence the price level and the national income: the prices of financial assets, the domestic credit and the exchange rate.

Cevik and Teksoz (2012) posit that the efficacy of monetary transmission channels provides central banks with pertinent insight for better decision-making. Unless policymakers know more about how monetary policy decisions influence macroeconomic variables such as aggregate output, employment, and consumer prices through the different channels of monetary transmission, they will always face more significant uncertainty about the timing and effectiveness of policy actions and, consequently, in maintaining macro-financial stability.

Peter (2008) posits that the monetary transmission mechanism describes how policy-

induced changes in the nominal money stock or the short-term nominal interest rate impact real variables such as aggregate output and employment. Recent research on the transmission mechanism seeks to understand how these channels work in the context of dynamic, stochastic, and general equilibrium models.

Kuttner and Mosser (2002) note that the monetary transmission process is complex and interesting because there is not one but many channels through which monetary policy operates. The process begins with the transmission of open market operations to market interest rates through the reserves market or the supply and demand for money more broadly. From there, the transmission may proceed through several channels, with the interest rate channel being the primary mechanism in conventional macroeconomic models.

Interest Rate Channel of Monetary Transmission

The interest rate channel of monetary policy transmission has been described by Ogunkola and Abubakar (2008), Clarida *et al.* (2000) and Besimi *et al.* (2006) as the standard Keynesian channel of monetary transmission which operates within the IS-LM framework. It is the primary mechanism at work in conventional macroeconomic models. The traditional Keynesian view of how monetary tightening is transmitted to the real economy, as observed by Mishkin (1995), can be represented by:

$$MP\downarrow \rightarrow I_R\uparrow \rightarrow INV\downarrow \rightarrow Y\downarrow ,$$

where \downarrow denotes a decrease or a fall and \uparrow represents an increase or a rise. In addition, $MP\downarrow$ indicates a contractionary monetary policy, while $I_R\uparrow$ denotes a rise in real interest rates. $INV\downarrow$ denotes a decline in investment spending, with $Y\downarrow$ indicating a fall in output. The schematic diagram above indicates that a contractionary monetary policy increases the real interest rate,

which leads to a rise in the cost of capital, thereby reducing investment expenditure. This process also leads to a decline in aggregate demand and, eventually, aggregate output.

In asserting the importance of the interest rate channel in the transmission mechanism, Taylor (1995) argues that financial market prices are critical components of how monetary policy affects real activities, in which case a contractionary monetary policy raises short-term interest rates in the money markets. Since prices and wages are assumed to be rigid downwards, real long-term interest rates also increase in capital markets. These higher real long-term rates lead to a decline in real investment, real consumption, and, thereby, real GDP. In the long run, after wages and prices of goods begin to adjust, real GDP returns to normal.

Exchange Rate Channel of Transmission Mechanism

The exchange rate channel is an essential element in conventional open-economy macroeconomic models. The chain of transmission here runs from interest rates to the exchange rate via the uncovered interest rate parity condition relating interest rate differentials to expected exchange rate movements. Thus, an increase in the domestic interest rate relative to foreign rates would lead to a stronger currency and a reduction in both net exports and aggregate demand. In other word, an increase in interest rates would typically lead to an appreciation of the exchange rate, which lowers the price of imported goods and services and thereby pushes down domestic inflation.

The exchange rate channel is an important transmission mechanism for monetary policy actions in a small open economy with a flexible exchange rate regime. Under the flexible exchange regime, the exchange rate channel works through the aggregate demand and supply effects. The effectiveness of the exchange rate channel depends on the exchange rate regime, the

extent of exchange rate pass-through and the degree of openness to capital flows (Taylor, 1995).

Alternatively, when the exchange rate is fixed, as in the Gulf Cooperation Countries (GCC) countries, the exchange rate channel works effectively by adjusting domestic interest rates relative to foreign interest rates (Obstfeld and Rogoff, 1995). Mishkin (1995) presented the schematic diagram for the monetary transmission mechanism operating through the exchange rate channel:

$$MP\downarrow \rightarrow I_R\uparrow \rightarrow EXC\uparrow \rightarrow NX\downarrow \rightarrow Y\downarrow ,$$

where \downarrow (\uparrow) denotes a decrease (an increase) or a fall (a rise). $MP\downarrow$ represents the contractionary monetary policy, $I_R\uparrow$ stands for the interest rate (real) increase, while $EXC\uparrow$ denotes the increase in the exchange rate. Furthermore, $NX\downarrow$ represents a decrease in net export while $Y\downarrow$ indicates a fall in output. When domestic real interest rates rise ($I_R\uparrow$), domestic deposits become more attractive relative to deposits denominated in foreign currencies, thus leading to a rise in the value of the domestic currency relative to other currencies and deposits; this gives rise to an increase in the exchange rate ($EXC\uparrow$), thereby causing a fall in both net exports ($NX\downarrow$) and output ($Y\downarrow$).

Assets Price Channel (Equity Price Channel)

Other asset price channel operates through the impact of monetary shocks on yields of equity shares, real estate, and other domestic assets. The channel works through the investment effect, which relies on Tobin's 'q' theory of money (1969) and the consumption effect, advanced by Modigliani (1963) in his life-cycle income hypothesis. This is represented schematically as:

$$MP\downarrow \rightarrow Pe\downarrow \rightarrow q\downarrow \rightarrow INV\downarrow \rightarrow Y\downarrow ,$$

where ↓ indicates a decrease, $MP\downarrow$ represents the contractionary monetary policy, $Pe\downarrow$ denotes a decrease in equity prices, and $q\downarrow$ stands for dividend by the replacement cost of capital. $INV\downarrow$ denotes a fall in investment, while $Y\downarrow$ denotes a decrease in output.

The rise in interest rates due to the contractionary monetary policy makes bonds more attractive relative to equities, thereby causing the price of equities to fall. The primary intuition drawn from the above analysis is that lower equity prices (Pe) will lead to a lower q (q) and, therefore, a lower investment spending (I), culminating into one of the sub-channels of the other asset prices channel of the monetary transmission mechanism.

2.2 Theoretical Framework

This study adopted the Keynesian approach as the framework for analysing the transmission channels of monetary policy to real sector outputs in Nigeria. The transmission process in the Keynesian framework is explained in Figure 1.

In Figure 1, a deliberate increase or decrease in policy rate will affect the real sector through either demand or supply sides. On the demand

axis, monetary policy transmits directly through three channels: the exchange rate, the interest rate and asset channels or indirectly through the bank credit, which is transmitted through the bank-lending channel and the balance sheet channel. From the supply side, monetary policy impulse affected real variables via changes in inventory cost (Baksh and Craigtwell, 2017).

While acknowledging the supply side channel, this study adopted aggregate demand side channels. For two reasons, first, in the Keynesian framework, the aggregate supply was relatively fixed due to price stickiness, at least in the short run. Second, the Nigerian economy needs to be more structurally strong and better developed to adjust if the inventory cost approach is relevant. The economic intuition behind the aggregate demand channels of policy influence on real variables is usually described by the traditional Keynesian (IS-LM) framework. The framework focused on the equilibrium position between the demand for and the supply of money to determine the rate of interest, which influenced investment spending and, consequently, output level (Dornbusch *et al.*, 2002).

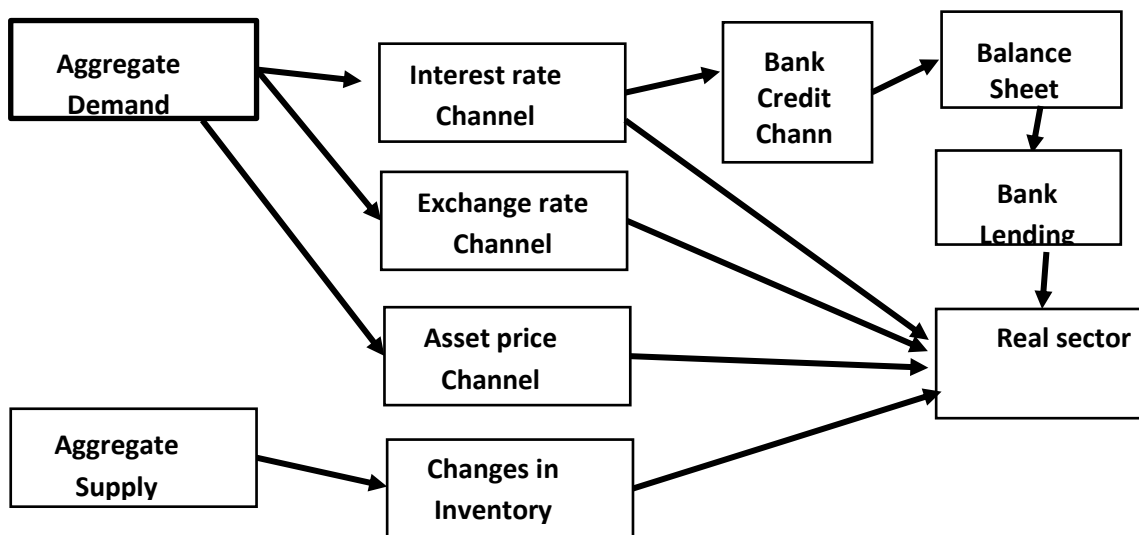


Figure 1: Monetary transmission process to real sector output
Source: Constructed

An important observation with the theoretical exposition above is that interest rate is cardinal in any channel monetary policy passes through to the real sector. An important observation with the theoretical exposition above is that interest rate is cardinal in any channel monetary policy passes through to the real sector. So, in recognising this fact, the channel that formed the basis for the subsequent analysis was represented schematically as:

$$Ms \uparrow \rightarrow i \downarrow \rightarrow PSC \uparrow \rightarrow Ps \uparrow \rightarrow Er \downarrow \rightarrow I \uparrow \rightarrow Y \uparrow,$$

where $Y \uparrow$ indicates a rise in output with $Ms \uparrow$ indicating expansionary monetary policy resulting from government purchases of securities in the open market, leading to a fall in real interest rate, which in turn: (a) increases the amount of credit by banks to the private sector; (b) increases in the price of security prices given the inverse relationship between security prices and interest rate and (c) decreases in the exchange rate; these effects stimulate investment and consequently output.

2.3 Empirical Review

Oladimeji *et al.* (2022) re-examine the channel through which monetary policy affects the economy using the Structural Vector Autoregression (SVAR). Seasonally adjusted quarterly data between 2008Q1 and 2018Q4 were used for the study. The results revealed that credit and asset price channels are the most dominant monetary policy transmission channels to the real sector. However, the intervening role of credit risk in the effectiveness of monetary policy to the real sector was established, as it reordered the percentage response of sectoral outputs to shocks from the variables that represent channels of monetary policy transmission to the real sector.

Mordi *et al.* (2019) document some robust evidence on interest rate pass-through in Nigeria.

Their work confirms, among others, that a long-run relationship exists between the Monetary Policy Rate (MPR) and each of the prime lending and savings deposit rates, despite significant structural breaks occurring in the cointegrating vectors at different periods. The study further shows that the transmission of changes in MPR to the retail market needs to be completed and that bank retail rates (except the savings rate) adjust symmetrically to changes in the policy rate. They argued that changes to the savings rate depend on the nature of the shock to the policy rate. Positive shocks in the policy rate get transmitted wholly to the savings rate in 2 months in contrast to 8 months for adverse shocks. They further find that it takes about 14 months for shocks to the policy rate to be passed entirely to the prime lending rate, while the full impact on the 6-month deposit rate takes place in about 11 months.

Elem-Uche *et al.* (2019), using the variables that reveal different types of monetary policy transmission channels, employed the VECM model to forecast real output in Nigeria. According to the cointegration result, the monetary policy variable cointegrated with its transmission channels. In contrast, credit, exchange rate and money supply channels accounted for the variations in real output in the short run. In the long-run, real output values adjusted speedily to the increases or decreases in the money supply, credit channel, interest rate and exchange rate channel. Considering some variables, the study observes that the real sector's success and growth depend on the monetary policy's efficacy to forecast its policy outcome. They conclude that the influence of monetary policy channels significantly stabilises Nigeria's economy.

Vo, *et al.* (2019) examined the risks returns, and portfolio diversification at the industrial level in four ASEAN countries: Malaysia, Singapore, Thailand, and Vietnam. The study

used daily indices for the periods of 2007 to 2016 and characterize the period into three groups: during a crisis (2007-2009), after the crisis (2010-2012), and normal period (2013-2016). The data are collected from 10 different sectors in the countries which are: consumer goods, consumer services, basic materials, finance, healthcare, industry, telecommunication, oil and gas, and utilities. The study employed the conditionally expected losses that exceed the VAR (CVAR) model; which has the advantage of capturing the extreme risks than the normal VAR, and Markowitz risk-return framework. However, the study findings revealed that the healthcare sector has the highest returns with the lowest extreme risk among the industries in Vietnam, and the second industry with the highest contribution to the portfolio. A similar happens in Malaysia and Singapore; but in Thailand, the industry with the highest return and lowest extreme risk is consumer services. However, the study is a panel analysis and it examined the impact of risk-return on portfolio investment at the industrial level meanwhile, this study is a country-specific study and it is examining the impact of interest rate channel of monetary transmission on money deposit and bank lending in Nigeria.

Düz, Tan, and Taş (2019) examine the relationship between direct firm-specific investor attention and stock returns in Istanbul, Turkey. The study employed the VAR model with a monthly dataset spanning 2013M04 to 2017M09. The study further utilized Raw stock returns, abnormal Google search volume index (ASVI), market values, a book-to-market ratio, abnormal turnover, turnover, stock return volatility, and several news stories, as sample variables. They found that firms attracting high abnormal attention, earn higher returns, and the pressure of the ASVI price effect is larger among small stocks. Further, there is evidence of persistence of predictability of searches for abnormal returns, while the ultimate price reversal occurs

in one year. However, the study analyzed the relationship between direct specific investor attention on firms and stock returns in Istanbul Turkey. Therefore, the study was conducted on a particular region in the country, not the entire country in which the result cannot be reliable for conclusions on Turkey as a whole. But this study is going to be conducted on Nigeria as a country not some part of it.

Ravenna and Walsh (2019) investigate the effect of monetary policy transmission and the role of the labour market on welfare in the United States, Latin America and Japan using the nonlinear ARDL model. Findings from the study revealed that the welfare cost of search inefficiency could be high. However, the incentive for policy to deviate from the inefficient flexible-price allocation is generally tiny. Sizable welfare gains are available if the economy's steady state is inefficient, and these gains do not depend on the existence of an inefficient dispersion of wages.

Ayodeji and Oluwole (2018) employ the Johansen cointegration and VECM model to examine the impact of monetary policy on the economy in Nigeria. The model used the gross domestic product, broad money supply, interest rate, liquidity rate, and exchange rate as explanatory variables. As revealed by the study, the exchange rate and money supply had a positive but relatively insignificant impact on the economy. Further findings showed a long-run relationship between monetary policy and the economy. The liquidity ratio was included in the model to determine output growth. However, the cash reserve ratio would have been a better variable. The liquidity ratio is the ratio of deposits that banks must hold in highly liquid assets; the cash reserve ratio is the ratio of the deposit that must be kept with the central bank, which determines the banks' capacity to lend to the productive sector.

Asaleye *et al.* (2018), in a study spanning the period 1981 to 2016, explain how shifts in the

central bank's monetary policy influence economic growth as well as the level of employment in Nigeria. The study, which used autoregressive distributed lag and structural vector autoregressive models, showed that changes to monetary policy had a more significant impact on GDP than unemployment during the initial periods. However, this trend was reversed in later periods when the impact on unemployment became larger. The findings did not indicate a long-run relationship when output is explained by other variables, while a long-run association is found when unemployment is explained. The indicator of monetary policy was seen to be very important in explaining unemployment in the study area.

Matousek and Solomon (2018) employ the generalised method of moments (GMM) two-step estimator to investigate the implications of the Central Bank of Nigeria's (CBN) bank restructuring policies from 2002 to 2008 period on bank lending channel of transmission and found that more prominent and more capitalised banks are less sensitive to changes in monetary policy. Osadume (2018) examines how monetary policy rates and other discount rates affect development in the country. They documented an indication that discount rates – represented by interest and monetary policy rates – have a significant short-run impact and positive and long-term impact on economic development with the substantial speed of adjustments.

However, Ekwe *et al.* (2017) use money supply and credit to the private sector as the only monetary variable to explain the Nigerian economy; GDP represents this. The model specification may suffer the error of omitted variables, as the model is more of a closed one. Nigeria is an open economy to the rest of the world, so interest rate and exchange rate are vital variables that influence the output in Nigeria.

3. Methodology

This study used time series data drawn from the Central Bank of Nigeria (CBN) statistical Bulletin (2022). The variables on which the data were collected are interest rate (INT), the exchange rate (EXC), inflation (INF), asset prices (ASP) and real sector output (RSO). The data for the variables cover a period of 42 years (1980 to 2021). The choice of this time frame has been justified earlier.

3.1 Model Specification

The study adopted the Nonlinear Autoregressive Distributed Lag (NARDL) Model credited to Shin *et al.* (2011, 2013, 2014). The model was adopted from the work of Ravenna and Walsh (2019) but will differ from those of the authors in the choices and measurements of model variables. This is because this study differs from Ravenna and Walsh (2019) studies in specific objectives. The NARDL model is a single-equation model that allows for asymmetry concerning positive and negative changes in the explanatory variable(s). That is, with respect to the monetary variables employed in this study, the NARDL model can show how the expansionary monetary policy (positive) and contractionary monetary policy (negative) will simultaneously impact the variable of interest. In other words, the asymmetric property of the NARDL model has the power to reveal how rising and falling interest rates, money supply, and exchange rates could impact the variable of interest.

The choice of the NARDL model was to overcome the linearity restrictions imposed by most standard linear models (such as classical cointegration models and error correction models), despite recognising the nonlinearity of many macroeconomic variables over the years. In other words, information revealed by linear models may need to be more robust to permit strong inference or to yield reliable forecasts. More generally, it suggests a general concern that

the assumption of linear adjustment may be excessively restrictive in a wide range of economically interesting situations, mainly where policy interventions are observed in the sample (Shin *et al.*, 2011). To correct the limitations of the linearity assumption, the NARDL model is constructed within a framework of symmetry and asymmetry so that the partial sums of positive and negative changes introduced asymmetry in the specification are unbalanced. In other words, positive can have a different effect on the dependent variable from negative.

Compared to the classical cointegration models, NARDL models present some other advantages. First, they better determine cointegration relations in small samples (Romilly *et al.*, 2001). Secondly, they can be applied irrespective of whether the regressors are stationary at the level or the first difference (i.e., I(0) or I(1)). The other advantage of NARDL is that the asymmetric NARDL framework of Shin *et al.* (2013) is particularly suitable as it allows us not only to gauge the short- and long-run asymmetries but also to detect hidden

cointegration. For example, a positive shock may have a more significant absolute effect in the short run, while a negative shock has a more significant absolute effect in the long run (or vice-versa). In this study, following Ravenna and Walsh (2019), the NARDL model is specified by decomposing the monetary variables (INT, EXC, ASP, INF) into positive and negative partial sums for each country as follows:

$$\ln INT = \ln INT_0 + \ln INT t^+ + \ln INT t^- \quad 1$$

$$\ln EXR = \ln EXR_0 + \ln EXR t^+ + \ln EXR t^- \quad 2$$

$$\ln ASP = \ln ASP_0 + \ln ASP t^+ + \ln ASP t^- \quad 3$$

$$\ln INF = \ln INF_0 + \ln INF t^+ + \ln INF t^- \quad 4$$

where; $\ln INT t^+$, $\ln EXR t^+$, $\ln ASP t^+$, $\ln INF t^+$ and $\ln INT t^-$, denote, partial sums of the positive and negative changes in $\ln INT t$, $\ln EXC t$, $\ln ASP t$ and $\ln INF t$ respectively. The positive and the negative partial sums are defined formally as:

$$POS = \ln INT t^+ = \sum_{j=1}^t \Delta \ln INT_{j+} = \sum_{j=1}^t \max(\Delta \ln INT_j, 0) \quad 4a$$

$$NEG = \ln INT t^- = \sum_{j=1}^t \Delta \ln INT_{j-} = \sum_{j=1}^t \max(\Delta \ln INT_j, 0) \quad 4b$$

$$POS = \ln EXR t^+ = \sum_{j=1}^t \Delta \ln EXC_{j+} = \sum_{j=1}^t \max(\Delta \ln EXC_j, 0) \quad 5a$$

$$NEG = \ln EXR t^- = \sum_{j=1}^t \Delta \ln EXC_{j-} = \sum_{j=1}^t \max(\Delta \ln EXC_j, 0) \quad 5b$$

$$POS = \ln ASP t^+ = \sum_{j=1}^t \ln ASP_{j+} = \sum_{j=1}^t \max(\Delta \ln ASP_j, 0) \quad 6a$$

$$NEG = \ln ASP t^- = \sum_{j=1}^t \Delta \ln ASP_{j-} = \sum_{j=1}^t \max(\Delta \ln ASP_j, 0) \quad 6b$$

$$POS = \ln INF_{t+} = \sum_{j=1}^t \Delta \ln INF_{j+} = \sum_{j=1}^t \max(\Delta \ln INF_j, 0) \quad 7a$$

$$NEG = \ln INF_{t-} = \sum_{j=1}^t \Delta \ln INF_{j-} = \sum_{j=1}^t \max(\Delta \ln INF_j, 0) \quad 7b$$

The equations 4a, 4b, 5a, 5b, 6a, 6b, 7a and 7b can then be used to derive the nonlinear ARDL model of estimating the impact of monetary policy (proxied by INT, EXR ASP and CPS) on Real Sector Output (RSO), as stated in the

specific objective of this study. Following Shin et al. (2014), we substitute the variables of the study by POS and NEG to arrive at the following NARDL model:

$$\begin{aligned} \ln RSO_{i,t} = & \theta_0 + \sum_{q=1}^n \theta_{1q} \Delta \ln RSO_{i,t-q} \\ & + \sum_{q=1}^n \theta_{2q} \Delta \ln INT_{i,t-q} + \sum_{q=1}^n \theta_{3q} \Delta \ln EXC_{i,t-q} + \sum_{q=1}^n \theta_{4q} \Delta \ln ASP_{i,t-q} \\ & + \sum_{q=1}^n \theta_{5q} \Delta \ln INF_{i,t-q} + \sum_{q=1}^n \theta_{6q} \Delta \ln POS_{i,t-q} + \sum_{q=1}^n \theta_{7q} \Delta \ln NEG_{i,t-q} \\ & + Y_1 \Delta \ln RSO_{i,t-q} + Y_2 \Delta \ln INT_{i,t-q} + Y_3 \Delta \ln EXC_{i,t-q} \\ & + Y_4 \Delta \ln ASP_{i,t-q} + Y_5 \Delta \ln INF_{i,t-q} + Y_6 POS_{i,t-q} + Y_7 NEG_{i,t-q} \\ & + \mu t \end{aligned} \quad 8$$

The nonlinearity in the model (Equation 8) is associated with the partial sums POS and NEG. By construction, if the coefficients of POS and NEG have the same sign and size, we can conclude that changes in the independent variables have symmetric impacts on RSO. The impacts are asymmetric if the signs and sizes are different. Specifically, the short-term effects are the coefficients of the first-differenced variables. In contrast, the long-term effects are obtained by setting the non-first-differenced lagged component of Equation (7) to zero and normalising Y_2 to Y_1 . Analytically, Shin et al. (2014) have demonstrated that Pesaran et al. (2001) bounds testing procedure is applicable in this case.

4. Analysis and Discussions of Results

Table 1 shows the summary statistics for the variables used in the study. The result shows smaller mean values for EXC, RSO, ASP and INT, suggesting that the estimates lie within acceptable limits. Also, the standard deviations are as minor as possible, suggesting that the errors due to the estimates are negligible. Furthermore, the probability values for the Jarque-Bera test are not significant at 5% except for INF. This means that the null hypothesis that the data set is typically distributed cannot be rejected except for INF. Finally, skewness results suggest that all the variables are positively skewed except INT.

Table 1: Descriptive Statistics

EXC	RSO	INF	INT	ASP
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2	-496.3	36.50*	1.03e+10*	34.34*	36.01	34.88
3	-485.0	13.09	1.6e+10	34.65	37.05	35.43
4	-465.5	17.634	1.8e+10	34.42	37.56	35.44

* indicates lag order selected by the criterion

Source: Computed by the Authors using E-views 12

Cointegration is a way of reconciling the short-run and long-run equilibrium relationship among the variables of the study. Since the variables are confirmed to be non-stationary, their linear combination is expected to give a stationary result in the long run. The result of F-bound cointegration in Table 4 revealed that the F-statistics is 14.30, which is greater than 1%, 2.5%, 5% and 10% asymptotic critical values. Therefore, the null hypothesis of no cointegration is rejected, while the alternative

hypothesis of cointegration among the variables is accepted. Based on the result in Table 4, it can be concluded that the variables of interest have a long-run equilibrium relationship. Specifically, it could be inferred from the result that RSO in the current year had an equilibrium relationship with inflation (INF), the exchange rate (EXC), real interest rate (INT) and asset price (ASP), which keep them in proportion to each other in the long run for the period under study.

Table 4: Result of Bound Test of Cointegration

F-Bounds Test		Null Hypothesis: No levels relationship			
Test Statistic	Value	Signif.	I(0)	I(1)	
Asymptotic: n=1000					
F-statistic	14.30447	10%	2.2	3.09	
K	4	5%	2.56	3.49	
		2.5%	2.88	3.87	
		1%	3.29	4.37	
Finite Sample: n=40					
Actual Sample Size	40	10%	2.427	3.395	
		5%	2.893	4	
		1%	3.967	5.455	

Source: Computed by the Authors using E-views 12

To analyse the dynamic interaction among the various monetary transmission channels, the nonlinear ARDL model with positive and negative coefficients was estimated. Four of the variables in the model are monetary policy variables (interest rate, exchange rate, inflation and asset prices). In contrast, the fifth variable is a real sector variable (real sector output). The model was estimated at a lag of 2, the optimal lag length suggested by the lag selection criteria. From the result in Table 5, interest rate (positive

and negative) negatively impacts real sector output. The result shows that 1% increase in *INT_POS*, *INT_POS (-1)* and *INT_POS (-2)* decreases real sector output by 63%, 38% and 20%, respectively.

Similarly, 1% increases in *INT_NEG*, *INT_NEG (-1)*, and *INT_NEG (-2)* decrease real sector output by 0.08%, 77% and 28%, respectively. All the estimated coefficients, except *INT_NEG (-2)*, are statistically significant. The negative impacts of interest rates on real sector output

conform to the *a priori* expectation. Interest rate is the cost of borrowing capital for investment. Therefore, an increase in the cost of borrowing will discourage the investor from taking loans from financial institutions for investment purposes. This reduces the amount of investment that goes to the real sector of the economy.

Also, the result in Table 5 shows that a positive exchange rate positively impacts real sector output. In contrast, negative exchange negatively impacts real sector output in Nigeria. 1 unit appreciation in EXC_POS increases RSO by 17.5%. All the estimated exchange rate coefficients are statistically significant, and the estimates conform to the *a priori* expectation. This is because when the exchange rate (foreign currency) appreciates, the value of the domestic currency falls. A fall in the value of a domestic currency is synonymous with the devaluation of the domestic currency. This makes exports

cheaper relative to imports, increases demand for exports, increases export revenue and then adds to the real sector output.

Also, 1 unit appreciation in *EXC_NEG*, *EXC_NEG(-1)* and *EXC_NEG(-2)* decrease *RSO* by 3.8 units, 7.6 units and 4.4 units, respectively. These results also conform to the *a priori* expectation. The logical idea behind the negative impact of EXC appreciation is that it makes imports dearer. Hence, it becomes costlier for domestic firms to import the raw materials required for production. By implication, the import volume may be reduced, but expenditures on imports (outflows) increase. When expenditure on imports rises more than revenue from exports, it creates a balance of payment deficit. This finding agrees with Abdullahi et al. (2018), Nwanosike et al. (2017), Nwaolisa (2017) and Osisanwo et al. (2019).

Table 5. Result of Nonlinear ARDL Model - Dependent Variable (RSO)

Variable	Coefficient	Std. Error	t-Statistic	Prob.*
RSO(-1)	0.933758	0.111446	8.378591	0.0000
INT_POS	-0.631312	0.192954	-3.271821	0.0036
INT_POS(-1)	-0.379088	0.189911	1.996135	0.0590
INT_POS(-2)	-0.198587	0.011914	-16.66846	0.0000
INT_NEG	-0.800020	0.132619	-6.000182	0.0001
INT_NEG(-1)	-0.771336	0.168307	-4.582918	0.0002
INT_NEG(-2)	-0.276627	0.202841	-1.363765	0.1871
EXC_POS	0.175347	0.068579	2.556870	0.0184
EXC_NEG	-3.846627	1.065958	-3.608611	0.0016
EXC_NEG(-1)	-7.569541	1.705445	-4.438456	0.0002
EXC_NEG(-2)	-4.354890	1.151635	-3.781485	0.0011
ASP_POS	0.041687	0.016363	2.547617	0.0187
ASP_POS(-1)	0.043268	0.018566	2.330510	0.0298
ASP_NEG	0.010596	0.008919	1.188121	0.2480
ASP_NEG(-1)	0.011404	0.011223	1.016131	0.3211
ASP_NEG(-2)	0.020420	0.008130	2.511531	0.0203
INF	-0.152952	0.098152	-1.558323	0.1341
C	1.790418	3.608631	0.496149	0.6249
R-squared	0.899271	Mean dependent var		168.3518
Adjusted R-squared	0.878681	SD dependent var		153.7730

Source: Computed by the Authors using E-views 12

However, asset prices had positive impacts on RSO. The result in Table 5 shows that 1% increases in *ASP_POS*, *ASP_POS (-1)*, *ASP_NEG*, *ASP_NEG (-1)* and *ASP_NEG (-2)* increase RSO by 4.2%, 4.3%, 1.1%, 1.1% and 2.0% respectively. However, only the coefficients of *ASP_POS*, *ASP_POS (-1)* and *ASP_NEG (-2)* are statistically significant. This result supports the findings of Benhard (2013) of a positive relationship between asset price and output growth in Nigeria. The result suggests that monetary policy impulse is better transmitted to the economy through the interest rate channel and exchange rate channel than other transmission channels.

The coefficient of inflation is negative but statistically insignificant. It shows that a unit

increase in INF decreases RSO by about 15%. This conforms to the *a priori* expectation and supports the classical theory that inflation is a disaster to any economy where it exists. The negative relationship between inflation and economic growth is consistent with the findings of Saeed (2007) for Kuwait for the periods of 1985 to 2005. Similarly, Ahmed and Mortaza (2005) established an inverse relationship for Bangladesh in which they used data on real GDP growth rate and CPI. However, the result was insignificant for the period 1980 to 2005. The finding equally agrees with Olu and Idih (2015) study of the Nigerian economy between 1980 and 2013.

Table 7: Result of Post Estimation Diagnostic

<i>Serial Correlation LM Test; H₀: No autocorrelation</i>			
F-statistic	0.104235	Prob. F(2,19)	0.9015
Obs*R-squared	0.423266	Prob. Chi-Square(2)	0.8093
<i>Heteroskedasticity Test;</i>			
F-statistic	5.324437	Prob. F(2,34)	0.0097
Obs*R-squared	8.824598	Prob. Chi-Square(2)	0.0121

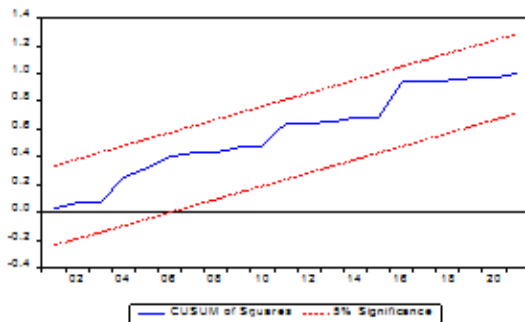


Figure 2: CUSUM Square Plot
Source: Computed by the Authors using E-views 12

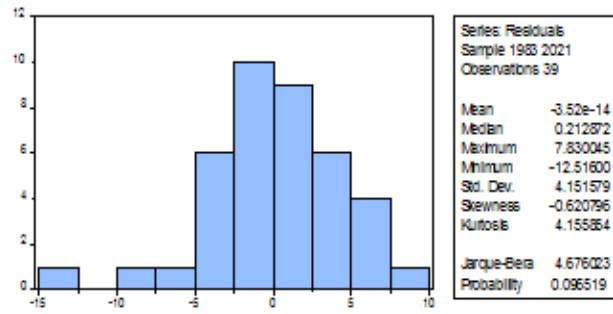


Figure 3: Normality Plot

Table 7, Figures 2 and 3 show the post estimations statistics. The serial correlation LM test has a probability value of 0.9015, more significant than 0.05. This suggests that the null hypothesis of the absence of autocorrelation in the model cannot be rejected. Furthermore, the stability plot reported in Figure 2 shows that the residuals of the data are stable. This is because the CUSUM plot in Figure 2 does not cross either of the 5% critical lines. Therefore, the estimated parameters for the study are stable for the period under investigation. This is because the probability value of the Jarque-Bera is about 0.0, which is greater than 5%. Hence, the null hypothesis that the error terms of the data are typically distributed cannot be rejected. However, the result failed the test of heteroscedasticity. This is because the probability value for the heteroskedasticity test is 0.0097, implying that the null hypothesis of the absence of heteroskedasticity in the model cannot be accepted.

5. Conclusion and Recommendations

This study used annual time series data covering 1980 -2021 to examine the interest rate channel of monetary policy transmission mechanisms and real sector output in Nigeria. The result shows that interest rate has a negative impact on real sector output. This indicates that a higher interest rate translates into a lower real sector output. This finding supports economic theory since producers will increase the prices of their produced goods when the cost of borrowing for production is high. Findings reveal that, in terms of the sizes of the estimated coefficients, asset price had marginal impacts on real sector output than the exchange rate channel and exchange rate channel than the interest rate channel. What could be inferred from the result is that monetary policy impulse is better transmitted to the economy through the interest rate channel and the exchange rate channel as compared to other channels of transmission.

The major conclusion from these results is that real sector output is affected by changes in asset prices, exchange rate and interest rate, implying that monetary policy impulses are transmitted to the economy to influence output through the interest rate, exchange rate and asset price channels. However, in terms of the sizes of coefficients, the interest rate channel is more effective than other channels.

Given the negative impact of interest rates on real sector output, the study recommends that the monetary authority in Nigeria should maintain a low and stable interest rate. The low-interest rate should be maintained to encourage borrowing for investment purposes. This will involve lowering the monetary policy rate (MPR) and, by so doing, decreasing the nominal interest rates, which, again, translates into a decrease in the real interest rate (the cost of capital). These changes will lead to an increase in consumption and investment spending, thereby increasing real sector output in the economy. Commercial banks and other financial intermediaries must be forced to ensure compliance with the stipulated prudential interest rate guidelines. Deviations from the set regulations by commercial banks should be punished accordingly to deter others.

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