

The Transmission Mechanism of Monetary Policy Shocks in Nigeria: The Interest and Exchange Rates Channels

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ABSTRACT

This paper examines the effectiveness of the interest and exchange rates channels of monetary policy transmission mechanism. The paper employed several statistical cum econometric methodology in a baseline structural vector autoregressive (SVAR) model to evaluate the influence of policy shocks on selected endogenous variables; gross domestic product (GDP), consumer price index (CPI), money supply (MS), treasury bill rate (TBR) and nominal exchange rate (NER) for Nigerian spanning 1981Q1 to 2020Q1. The contemporaneous coefficients in the structural model reveals that key monetary aggregates reacts positively to unexpected changes in the monetary policy instruments. Furthermore, the variance decomposition results indicate that shocks of the selected variables were found to be important for interest rate growth in the short and longer horizons. The exchange rate channel however appears to have a stronger impact on prices. These results mean that depreciation of the nominal exchange rate could be an external deflationary element, particularly for Nigeria.

Keywords: monetary policy, transmission, mechanism, structural shock.

INTRODUCTION

Monetary policy (MP) can be described as a central banks action aimed at influencing the availability and cost of money and credit, as a means of achieving price stability and promoting national economic goals. Specifically, MP is a mixture of actions considered to regulate the value, supply and cost of credit in an economy in tandem with the anticipated level of economic activity. Broadly, the objectives of monetary policy include; low interest rates, price stability, economic growth, full employment, exchange rate stability, and balance of payments equilibrium.

The monetary policy instruments currently in use in Nigeria include; the monetary policy rate (MPR), open market operations (OMO), reserve requirements (cash and liquidity ratios), moral suasion and exchange rate. The implementation of monetary policy revolves around the manipulation of these instruments to influence the intermediate targets, such as, money supply, interest rates, which would eventually impact on the real and external sectors of the economy. The overall effect of these would result to changes in output growth, inflation rate and external reserve position.

The linkages between monetary policy shocks and changes in output, employment and inflation are known as the monetary policy transmission mechanism. This mechanism describes how changes in monetary policy transmit through the financial system via interest rate, exchange rate and money supply to the real economy. For example, in Nigeria changes in the Central Bank of Nigeria (CBN) monetary policy rate may impact on other short-term interest rates which in turn may affect lending rates in the medium to long run and may ultimately affect domestic demand. Other channels may include exchange rate and money/credit. Under the indirect approach, the link between monetary policy and money stock, which determined by the money multiplier is emphasized under the monetary targeting framework, which the bank adopted. Since the introduction of OMO as the main instrument of monetary policy in 1993, the interest rate and to a large extent, the exchange rate channels have been explicitly prominent in transmitting monetary policy impulses to the real economy. However, the effectiveness or otherwise of these two channels have not been subjected to empirical investigation.

The challenges that resulted from the global financial and economic crises had compelled monetary authorities to adopt plethora of monetary policy measures. In Nigeria, such challenges include the dwindling external reserves due to falling crude oil prices in the international market, low fiscal buffers sustained pressure in the foreign exchange market due to low supply of foreign exchange, and excess liquidity in the banking system. These developments have serious implications for both internal and external balance and had attracted several monetary policy measures aimed at restoring economic stability. Importantly, the falling crude oil price led to a drastic decline in Nigeria's foreign exchange earnings which resulted to a depreciation of the naira exchange rates at both the interbank and BDC segments. Accordingly, the monetary policy posture of the Bank was mottled to reflect the prevailing developments. The monetary policy rate (MPR) fluctuated between 11.0 and 13.0 per cent in 2015, and 11.0 to 14.0 per cent in 2016. The cash reserve ratio (CRR) was increased to 22.5 per cent in 2016 from 20.0 per cent in 2015.

In addition, the symmetric interest rate corridor that was put at ± 200 basis points around the MPR for standing facility window was altered to an asymmetric corridor of $+200/-700$ basis points around MPR in 2015. This measure was aimed at discouraging dumping of funds at CBN and promoting credit availability to the real sector. The asymmetric interest rate corridor was narrowed to $+200/-500$ basis points in 2016. The open market operation (OMO) continued to be the primary tool for liquidity management and was supplemented by reserve requirements, repurchase transactions as well as interventions in the foreign exchange market.

Apart from few theoretical and empirical attempts on the monetary policy transmission in Nigeria such as that of the CBN Research Department (2010), Chukwu (2013) and Hassan (2015), no study had specifically examined the effectiveness of the interest and exchange rates channels of monetary

policy shocks. Therefore, in order to achieve the primary objective of price stability by CBN, a better understanding of the monetary transmission process is required to develop instruments that can reinforce the efficacy of monetary policy transmission in Nigeria. A good knowledge of the dominant channels of transmission would be critical to effective design and implementation of monetary policy. This study intends to fill the existing gap in empirical literature on monetary policy transmission in Nigeria through the channels of interest and exchange rates. Specifically, this study will investigate empirically how monetary policy actions are transmitted to the real sector (output and prices) of the economy through the interest and exchange rates channels and evaluate the effectiveness, strengths, speed of monetary policy transmission through these channels. The outcome would guide the Management of the Bank on policy choices for effective monetary policy implementation.

The rest of the paper is structured as follows; following the introduction, Section 2 provides the theoretical underpinnings and review of empirical literature on monetary policy transmission mechanism. Section 3 discusses the recent monetary policy frameworks and initiatives of the Bank and its effects on the real sector, Section 4 is on the methodology, estimation and analysis of results and the last section focuses on the policy implications of the results, conclusion and policy recommendation.

THE MONETARY POLICY TRANSMISSION MECHANISM IN NIGERIA

Theoretical literature

The transmission of monetary policy is the process through which monetary policy pronouncements affect the real economy, especially the price level. It is usually long, variable with uncertain time lags. The main transmission channels of monetary policy are discussed below:

Interest rate channel

According to the expectation hypothesis of the term structure, a rise in the short-term nominal interest rate leads to an increase in the longer-term nominal interest rates. Since prices are assumed to be sticky in the short-term, a reduction in the long-term real interest rate decreases the cost of capital, and the money paid on interest bearing deposits such as treasury bills. As the cost of capital falls firms increase their investment expenditure and households increase their consumption of durable goods. These increase the aggregate demand, output and employment. In the traditional Keynesian IS-LM model, the main channel of monetary policy transmission is the interest rate channel. An expansionary monetary policy transmission is captured as follows:

$$M\uparrow \rightarrow i_r\downarrow \rightarrow I\uparrow \rightarrow Y\uparrow$$

where M stands for expansionary monetary policy, i_r equals real interest rate, I connotes investment spending and household spending on durable goods, and Y means output. This depicts that an expansionary monetary policy would lead to a decline in real interest rates, which reduces the cost of capital and increase investment and consumption spending, thereby increasing aggregate demand and output.

The fact that real and not nominal interest rate impacts on spending shows that monetary policy can stimulate the economy, even in a liquidity trap where nominal interest rates hit a floor of zero as in the global financial crisis of 2008. When nominal interest rates is zero, an increase in money

supply ($M \uparrow$) would increase the expected price level ($P^e \uparrow$), thus, the expected inflation ($\pi^e \uparrow$), thereby reducing the real interest rate ($i_r, \downarrow$) and stimulating spending through the interest rate channel above: $M \uparrow \rightarrow P^e \uparrow \rightarrow \pi^e \uparrow \rightarrow i_r \downarrow \rightarrow I \uparrow \rightarrow Y \uparrow$. This shows that monetary policy will still be effective, when nominal interest rates have been reduced to zero by the monetary authorities.

Exchange rate channel

Exchange rate channel encompasses interest rate effects for the reason that when domestic real interest rates decreases, domestic deposits in local currency becomes unattractive, when compared to deposits denominated in foreign currencies. This leads to a depreciation of the local currency ($E \downarrow$). The depreciation of the local currency, makes the domestic goods cheaper than foreign goods, thereby leading to a rise in net exports ($NX \uparrow$) and, thus, in aggregate output. The monetary transmission mechanism through the exchange rate is captured as:

$$M \uparrow \rightarrow i_r \downarrow \rightarrow E \downarrow \rightarrow NX \uparrow \rightarrow Y \uparrow$$

The effectiveness of the exchange rate channel is contingent on the reaction of the exchange rate to monetary shocks, the exchange rate arrangement of the country and the degree of openness of the economy. Nevertheless, the increasing interaction among economies and adoption of more flexible exchange rates has attracted monetary authorities to understand the monetary policy transmission mechanism through exchange rate effects on net exports.

Asset Price Channel

The asset price channel is divided into two channels: the equity price channel, and the housing and land price channel.

The Equity Price Channel

The equity price channel is further divided into two: Tobin's Q theory and wealth effect.

Tobin's Q Theory

In Tobin's Q theory, Q represent the ratio of market value of firms to the replacement cost of capital. Therefore, if Q is high, the replacement cost of capital is low compared with the market price of firms, as such new machinery and equipment capital would be cheaper, when compared to the market value of business firms. Thus, investment spending will increase as the firm buys more lots of new investment goods with only a small issue of equity. However, when Q is low, firms will not procure new investment goods as the cost of capital is high compared with the market price of firms. According to the monetarist school of thought, an expansionary monetary policy reduces interest rates, making bonds less attractive relative to equities, thereby raising the price of equities. Higher equity prices leads to increase in Q and thus higher investment spending. This is captured as follows:

$$M \uparrow \rightarrow P^e \uparrow \rightarrow Q \uparrow \rightarrow I \uparrow \rightarrow Y \uparrow$$

Wealth Effects

The wealth effect was promoted by Franco Modigliani. In his life-cycle model, consumption spending was determined by the lifetime resources of the consumer which is consist with human capital, financial wealth and real capital (Modigliani, 1971). According to Modigliani, stock is a major

cause of financial wealth. As stock prices rise, the value of financial wealth rises so the consumers' lifetime resources or wealth and total consumption.

$$M\uparrow \rightarrow P^e\uparrow \rightarrow \text{Wealth}\uparrow \rightarrow \text{Consumption}\uparrow \rightarrow Y\uparrow$$

The Housing and Land Price Channels

Likewise, housing and land prices are significant component of wealth and are very important channels of monetary policy transmission. An increase in housing and land prices increase wealth and consumption. As described in the wealth and Tobin's Q channel, monetary expansion which raises land and housing prices, raises the level of aggregate demand

Inflation expectation channel

The success of policies (monetary and fiscal) hinges on the expectations of economic agents. According to Blinder (1998), a successful monetary policy emerges as a result of the effective management of expectations not overnight interest rates. Milton Friedman's theory of adaptive expectations (inflation expectations are modeled based on simple extrapolation of past inflations) was the first attempt at explaining expectations in monetary policy. The inflation expectations of economic agents are transmitted to the economy as individuals bargain for higher wages and as firms amend their prices. When the concern of monetary policy to decrease inflation drastically, then, its efficiency is enhanced by its potential to influence inflation expectations. Consequently, expectations about the future posture of monetary policy by economic agents feed back into the present (Mordi, 2010).

Credit Channel (bank lending and balance sheet)

Monetary policy impacts on the real sector through its effect on the financial sector. Credit is an important macroeconomic variable that enhances economic activity. Bank lending and balance sheet channels arise as a result of asymmetric information problem in credit markets.

In the bank lending channel, expansionary monetary policies increase the quantity of bank loans available by increasing the bank reserves and bank deposits. As bank loans increase, investment spending will also rise. $M\uparrow \rightarrow \text{Bank deposits}\uparrow \rightarrow \text{Bank loans}\uparrow \rightarrow I\uparrow \rightarrow Y\uparrow$

As depicted above, unlike big firms that can directly access credit markets through bond and stock markets without going through the banks, then the credit channel impacts more on smaller firms as they are more dependent on bank loans. Bernanke & Blinder (1988) state that the lending channel is effective when the following conditions are met:

1. Firms must not be perfectly indifferent between borrowing money from financial institutions through borrowing money and loans from the general public by way of bonds. If firms are unmoved between the two types of financing, then the reduction in supply of loans would affect the firms.
2. The central bank should be able to influence the supply of loans through the use of monetary instruments.

The balance-sheet channel operates through the net worth of business firms. Reduction in net worth means that lenders have fewer indemnity for their loans, therefore, fatalities from adverse selection are higher. A decline in net worth raises the adverse selection problem, thus, leading to a reduced

lending to finance investment spending. Reduction in net worth of business firms also upsurges the moral hazard problem as owners have reduced equity stake in their firms.

Monetary policy can affect the balance sheet of firms in various ways: Contractionary monetary policy (CMP), that leads to a fall in equity prices (P_e) reduces the net worth of firms and leads to lower investment spending (I) and aggregate demand (Y), because of the rise in adverse selection and moral hazard problems (Taylor, 1995). This can be represented as follows:

$$M\downarrow \rightarrow P_e\downarrow \rightarrow \text{adverse selection}\uparrow \ \& \ \text{moral hazard}\uparrow \rightarrow \text{lending}\downarrow \rightarrow I\downarrow \rightarrow Y\downarrow$$

Literature review

Monetary policy transmission channels provide central banks with precise valuation of the timing and effect of their policies on the economy. A real-world grasp of how monetary policy actions are transmitted to the real economy has been a major challenge to economists and policy makers. Some early empirical research in this area were carried out by Bernanke & Blinder (1992), Sims (1992), Taylor (1995), Grilli & Roubini (1995), Eichenbaum & Evans (1995), Mishkin (1996), Clarida & Gertler (1997), and Christiano et al. (1998).

Kim & Roubini (2000) using estimated SVAR models proffered solutions to empirical anomalies (the liquidity, price, exchange rate and forward discount bias puzzles) encountered by early research that employed VAR in studying the effects of monetary policy in closed and open economies. The monetary policy model developed by Kim & Roubini (2000) allow exchange rates to be concomitantly affected by all the factors in the model, which transmits more to the floating exchange rate regime of advanced economies. They find the effects of non-US G-7 monetary policy shocks on exchange rates and macroeconomic variables to be consistent with the forecasts of a broad set of theoretical models.

Using VAR and structural models, Angeloni et al. (2003) in their comprehensive study of how monetary policy affects the euro area economy, find evidence of broad credit channels for many of the Euro area countries. They find plausible euro-area wide monetary policy responses for prices and output that are similar to those generally reported for the U.S. However, investment (relative to consumption) seems to play a larger role in euro area monetary policy transmission than in the U.S. Dungey and Pagan (2000) present an SVAR model of the Australian economy which models macro-economic outcomes as transitory deviations from a deterministic trend.

In extension of their original work, Dungey and Pagan (2009) modified their original model by; relating it to an emerging literature on DSGE modelling of small open economies and; allowing for both transitory and permanent components in the series to show how this modification has an impact upon the design of macroeconomic models. Nevertheless, they exclude bank credit variables in their models. Using an SVAR approach also, Berkelmans (2005) examines the endogenous relationship between credit and monetary policy of the Australian economy. They find that credit shock results in higher inflation for about two years, but it is moderated as a result of monetary policy's response. Also, they suggest that a positive shock to policy interest rate lowers both inflation and credit.

Catao & Pagan (2010) find that changes in interest rate have a faster effect on output and prices in Brazil and Chile relative to advanced economies, and exchange rate dynamics play an important role in monetary transmission mechanisms in both countries. The active roles of interest and exchange rates in monetary policy transmission are attributed to the floating exchange rates and significant levels of capital account openness in both countries. However, the monetary transmission literature on developing countries finds mixed evidence for the effectiveness of monetary policy. While Disyatat & Vongsinsirikul (2003) and Ahmed & Islam (2006) find a weak bank lending channel for Thailand and Bangladesh, respectively, Aleem (2010) finds that the banking sector plays a dominant role in transmitting monetary policy to the real sector in India. Also, Afrin (2016) find that exchange rate channel is less effective in the transmission process in Bangladesh, suggesting a high degree of intervention in the foreign exchange market.

Given the floating nature of exchange rate regimes in the US and Australia, their SVAR structures may not always be appropriate for developing countries like Nigeria, where exchange rates are either following a managed float or pegged. This paper follows the block recursive approach of Afrin, 2016; considering that in Nigeria and Bangladesh, the exchange rate may synchronously impact on other factors, such as real sector variables and monetary policy. The variables are not self-affected contemporaneously. However, with monetary policy, a separate foreign exchange market can be put in place for intervention to stabilize the exchange rates by the apex bank. In a developing country like Nigeria, exchange rate cannot be allowed to be simultaneously affected by other variables employed in the model. Also, for emerging small open economies, Nigeria and Bangladesh have similar attributes. As such, the factors employed in our structural vector Autoregression identification scheme are similar to that of Afrin (2016) for Bangladesh.

Also, the literature on exchange rate pass through (ERPT) approach employed the recursive structural vector autoregression with Cholesky decomposition. Monacelli (2005), Smets and Wouters (2002), Adolfson (2001) and Devereux (2001), in their separate study on a small open economy with an optimal monetary policy opined that this may positively affected level of the exchange rate pass through. The ordering of factors in the exchange rate pass through literature were output gap, oil price, wholesale and consumer price inflation, exchange rate and import price inflation. In their ordering, consumer price instead of the exchange rate was contemporaneously affected by all foreign and domestic variables. This situation are commonly found in emerging and developing countries as it reflects the nature of managed of exchange rate regimes they adopt.

McCarthy (2007) observed that exchange rate pass through have decreased considerably in the economies of sub Saharan African countries since the mid-1990s. He also opined that there is a drop of about 50 percent in exchange rate pass-through from the estimated coefficients. Razafimahefa (2012) also finds that the pass-through is incomplete for SSA. For Nigeria, Adeyemi and Samuel (2013) find a significantly huge exchange rate pass-through to inflation. They find that Nigeria's rising inflation was significantly attributed to exchange rate than actual money supply. Their study employs a SVAR model for the Nigeria's economy which is in tandem with literature for a unified SVAR identification akin to Bhattacharya et al. (2011) identification methodology for India economy. Bhattacharya et al. (2011) assume that the exchange rate of a small economy is not allowed to move contemporaneously with other macro variables; rather, price is affected by exchange rate and other variables as in highly intervened foreign exchange markets.

The main objective of monetary policy in Nigeria is the conservation of domestic exchange rate and price stability for the promotion of sustainable economic growth and external sector viability. This goal has however, been undermined by persistent liquidity overhang, fiscal dominance, oligopolistic banking system, and dualistic financial markets (Nnanna, 2001). Ndekwu (2013) employed an OLS and a dynamic logarithmic form VAR to study monetary policy transmission mechanism to the real sector of the Nigerian economy from 1981 to 2008, find that the credit channel is the corner stone of monetary policy transmission to the real sector economy, while exchange and interest rates channels had a feeble impact on the real sector economy. However, Abdullahi (2014) in assessing the effectiveness of monetary policy transmission mechanisms in Nigeria from 1980 to 2010 find that credit channel is inefficient and exchange rate channel is weak, while interest rate channel was found to be the greatest determinant channel for monetary policy transmission in Nigeria.

Obafemi and Ifere (2015) using quarterly data from 1970:1 – 2013:4, employed FAVAR model with 53 variables to evaluate the channel of transmission of monetary shocks in Nigeria, they found that credit and interest rates channels were the most important channels for transmission of monetary shocks, then the money and exchange rate channels. In addition, stock channel was insignificant in explaining transmission shock process in Nigeria. Uma et al. (2014) also show that exchange rate, credit and interest rate channels were amongst the channels of monetary policy transmission to the Nigerian economy.

To crown it all, the review of extant literature on Nigeria shows gaps that the interest and exchange rates channel of monetary transmission policy has not been explored thoroughly. Thus, the whole monetary policy transmission mechanism in remains Nigeria unclear and deserves more empirical studies.

STYLIZED FACT OF NIGERIA'S EXCHANGE RATE AND MACROECONOMIC FUNDAMENTALS

Trend analysis of naira-US dollar exchange rate

The trend analysis of quarterly Nigeria's naira-US dollar exchange rate for the period 1985Q1 – 2017Q1 is presented in Figure 1. The naira-US dollar exchange rate hovered around N0.89 and N9.87 to a US dollar during the period 1985Q1 – 1992Q2, before it depreciated sharply to N29.61/US\$1 in 1994Q4. This led to the liberalization of the foreign exchange market in Nigeria, Following the liberalization of the exchange policy in 1995, the naira-US dollar exchange rate further appreciated to N80.74/US\$1 in 1995Q2 from N29.61/US\$1 in 1994Q4. It however remained relatively stable around N80.74/US\$1 – N87.58/US\$1 till 1999Q4.

From 2000Q1, it depreciated steadily to N135.19/US\$1 in 2004Q2 before appreciating to N117.67/US\$1 in 2008Q3. Since then, the naira-US dollar exchange rate has maintained a sharp depreciation, though it steadied and averaged N306.20/US\$1 between 2016Q3 and 2019Q4, before depreciating further to N361.20/US\$1 in 2020Q1, occasioned by the devaluation of the naira to curb speculative attacks and the depleting reserves as a result of the plunge in oil price in the international market as well as the harmonization of the country's various exchange rates.

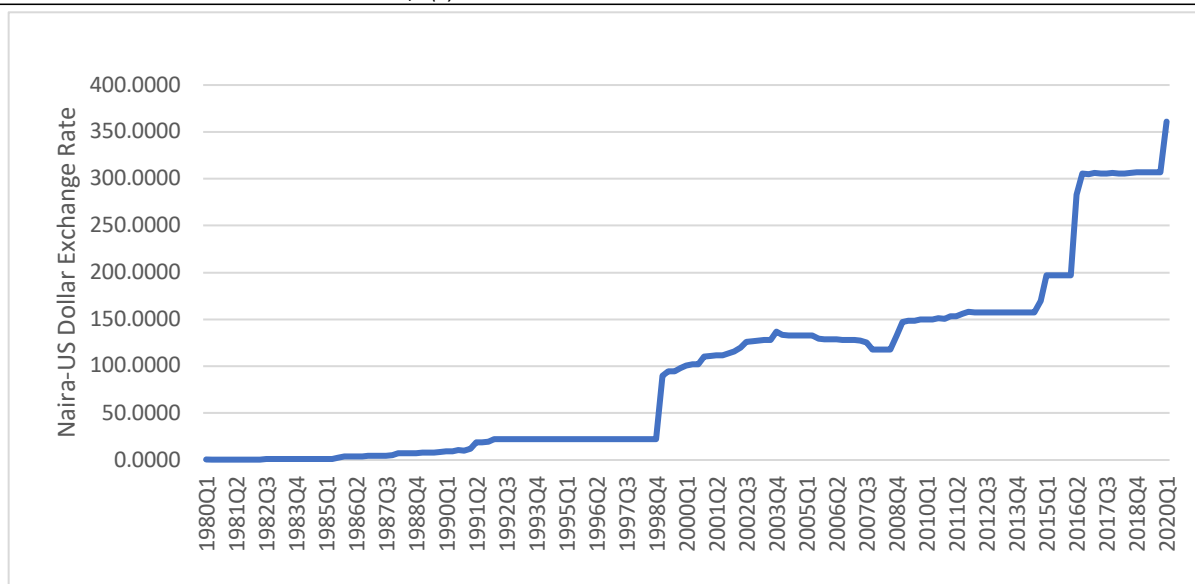


Figure 1: Naira-Dollar Exchange rate

Nominal Gross Domestic Product and Money Supply

An evaluation of the relationship between nominal gross domestic product (NGDP) and money supply (MS) is presented in Figure 2. A cursory look at the Figure show a stable relationship between NGDP and MS from 1995Q1 and 1992Q4. From 1993Q1 to 2017Q1, both variables have maintained an upward swing in the same trajectory. However, between 2007Q4 and 2009Q3, MS was higher than NGDP, while they equaled in 2009Q4. Further analysis revealed that in 2010Q1, NGDP was higher than MS with both variables being relatively volatile, though it declined marginally between 2016Q4 and 2020Q1. This was a result of the rebasing of the country's gross domestic product and covid-19 pandemic that disrupted economic activities.

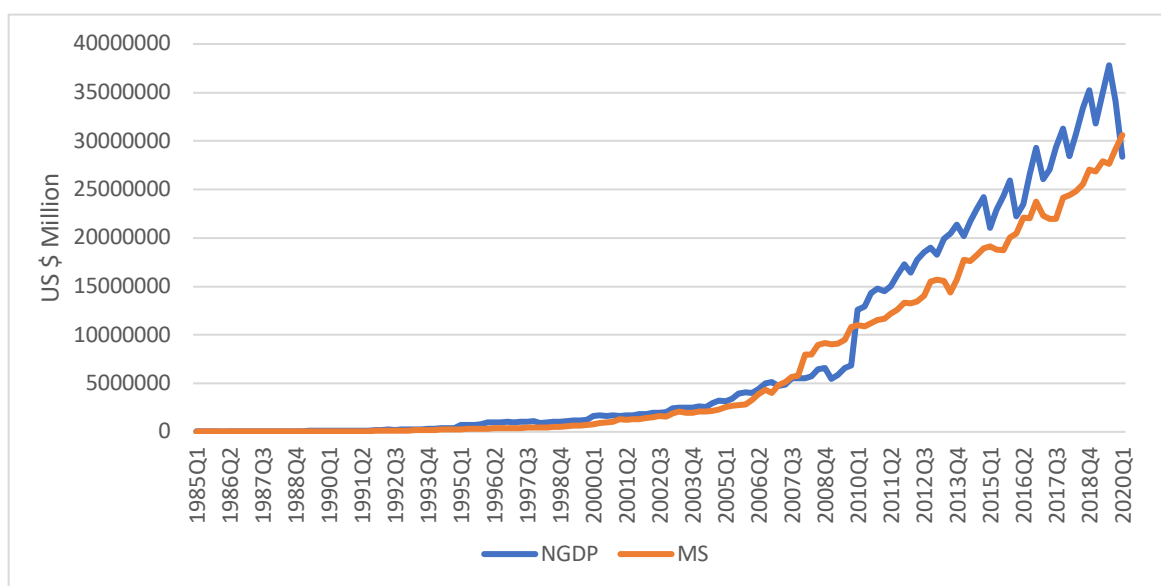


Figure 2: Trend in Nominal GDP and Money Supply

Crude oil Price and Consumer Price Index

The association between crude oil price (COP) and consumer price index (CPI) is presented in Figure 3. The Figure revealed that between 1985Q1 and 1994Q4, COP was higher than the CPI with the former been volatile. Conversely, between 1995Q3 and 2007Q2, CPI was higher than COP with the latter been more volatile. From 2008Q4 to 2017Q1, the CPI was higher than the COP. The global oil price in 2011Q2 stood at US\$119.89 per barrel, though it plunged relatively, it was stable at US\$103.41 per barrel in 2014Q2. Thereafter, it declined sharply to US\$33.37 per barrel in 2016Q1 before increasing marginally to US\$50.42 per barrel in 2017Q1 and maintained up trended to reach US\$82.65 per barrel in 2018Q3.

Thereafter, maintained a steady decrease to peg at US\$15.26 per barrel in 2020Q1. The relative stability in the CPI between 1985Q1 – 1995Q2 was attributable to high oil price in the world market, while the period 1995Q3 to 2011Q1 witnessed a sharp rise in CPI as due to a decline in oil output in Nigeria as result of youth restiveness and militancy activities in the Niger thus its revenue. The period 2011Q2 to 2020Q1 characterizes the period of plunge in international crude oil price that translated to an increased CPI since Nigeria is a mono culture economy and oil is the major source of revenue for the country and covid-19 pandemic leading to border closure.

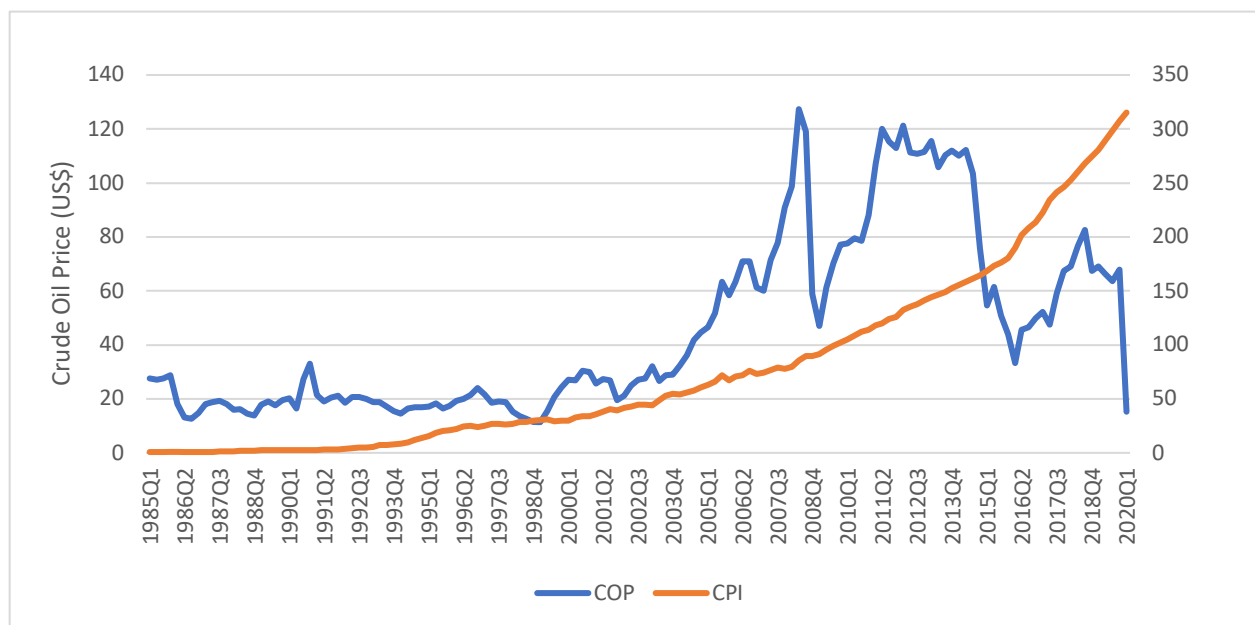


Figure 3: Movement in Crude Oil Price and Consumer Price Index

Monetary Policy Rate (MPR) and Treasury Bill rate (TBR)

The nexus between MPR and TBR is presented in Figure 4. The Figure showed that the movement in MPR and TBR was in the same direction during the period 1985Q1 and 1996Q2. The period 1996Q3 and 2006Q4 as well as 2010Q3 and 2017Q1, the TBR was slightly lower than the MPR but the reverse was the case during 2007Q1 and 2010Q2. The period 2010Q3 to 2020Q1 corresponded to the era of contractionary and expansionary monetary policy as a result of speculative attacks on the country's currency, depleting reserves following the drastic fall in crude oil price at the international market and covid-19 pandemic.

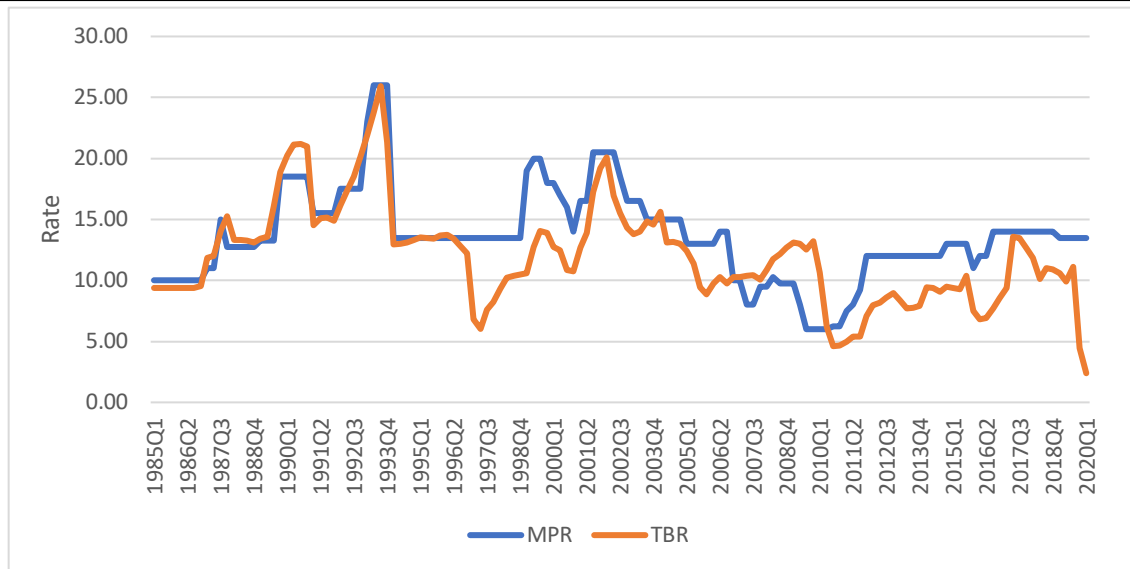


Figure 4: Relationship between Monetary Policy Rate and Treasury Bills

METHODOLOGY, DATA AND VARIABLES CHOICES

Methodology

In this research, the authors choose to estimate a baseline SVAR model with contemporaneous restrictions to analyze the effectiveness of interest and exchange rate channels of monetary transmission mechanism in Nigeria. For significance at risk (VAR) analysis, first of all, structural equation (1) is assumed thus: coefficient

$$A_0 Y_t = A_t X_t + \vartheta \omega_t \quad (1)$$

Where Y_t is $(n \times 1)$ vector of endogenous variables, A_0 is a $(n \times n)$ matrix of measurements of instantaneous relations on the endogenous parameters; X_t comprises the lag of endogenous factors, A is the matrix of quantities on the lagged factors in the model; μ_t as $(k \times 1)$ vector of the structural innovation is orthogonal and $\Sigma_{\omega t} = E(\omega_t \omega_t')$ presents variance covariance matrix of the structural innovation.

Furthermore, ω_t is orthogonal and has normal a distribution, it means that the shocks were unrelated and difference covariance milieu has normal spreading with zero means. The main problem in the estimation of the basic model, which the authors cannot directly evaluate the real values of A_0 and A . The sampling information is not adequate for identifying additional restriction. Gottschalk and Hoppner (2001), believed there were too many sets of unlike value of A_0 and A that all of them indicated similar probability distribution of data. The model then evaluates the actual value, of which A_0 and A will not possible. To overcome this, the authors derived the reduced form of equation (1). This resolved the issue by clarifying each endogenous variable solely as a function of preset variables.

$$Y_t = A^* X_t + \theta_t \quad (2)$$

With $A^* = A_0^{-1} A$ and $\theta = A_0^{-1} \vartheta \omega_t$

Hamilton (1994), opined that in order to recuperate the mechanical parameters from the abridged form model, the order condition must be fulfilled. This implies that the total number of factors in the covariance matrix must be the same. The variance covariance matrix of the abridged form is shown in equation (3).

$$\sum_{\theta} = E(\theta_t \theta_t') \text{ or } \sum_{\theta} = (A_0^{-1}) \sum_{\mu t} (A_0^{-1})' \quad (3)$$

For identification to be achieved, it is expected that the factors in ϑ and A_0 are convalesced from the abridged form. In equation (3) Σ encloses $K(K+1)/2$ factors, and has $K(K+1)$ free variables in equation (3), we then imposed $2K^2 - K - K(K+1)/2$ constraints on ϑ and A_0 . The imposition of $K(K-1)$ constraint is meant to constrain ϑ to be transverse, there by attaining an identification of at least $K(K-1)/2$ constraints are enforced on A_0 . When modeling the Cholesky decomposition in the VAR, A_0 is measured as a deltoid. Nevertheless, a structural VAR A_0 can take any form until it has sufficient constraint.

The Structural Vector Autoregression Estimates (SVAR) Model for Nigeria

We adopted the augmented Kim and Roubini's (2000), non-recursive SVAR methodology to investigate the effectiveness of monetary transmission mechanisms in Nigeria. The shocks in a mechanical SVAR can be identified by imposing some constraints in the baseline SVAR. A typical SVAR for the Nigeria economy contains seven equations and factors as shown by the X_t vector in equation (4):

$$X_t = (COP_t, MPR_t, NGDP_t, CPI_t, MS_t, TBR_t, NER_t) \quad (4)$$

From equation (4), COP_t represent the world crude oil price in terms of the US dollar, MPR_t refers to the Central Bank of Nigeria monetary policy rate, $NGDP_t$ is the nominal gross domestic production, CPI_t means the consumer price index, MS_t connotes the monetary aggregate, TBR_t represent the monetary policy instrument (as three-month TBRs), and NER_t means the nominal exchange rate.

From equation (4), the first identification arrangement is the standard approach which imposes a recursive structure of the VAR that shows the connection in the abridged-form inaccuracies (errors) and the structural disturbance is presented in equation (5).

$$\begin{bmatrix} \varepsilon_t^{COP} \\ \varepsilon_t^{MPR} \\ \varepsilon_t^{NGDP} \\ \varepsilon_t^{CPI} \\ \varepsilon_t^{MS} \\ \varepsilon_t^{TBR} \\ \varepsilon_t^{NER} \end{bmatrix} = \begin{bmatrix} 1 & 0 & 0 & 0 & 0 & 0 & 0 \\ \beta_{21} & 1 & 0 & 0 & 0 & 0 & 0 \\ \beta_{31} & \beta_{32} & 1 & 0 & 0 & 0 & 0 \\ \beta_{41} & \beta_{42} & \beta_{43} & 1 & 0 & 0 & 0 \\ \beta_{51} & \beta_{52} & \beta_{53} & \beta_{54} & 1 & 0 & 0 \\ \beta_{61} & \beta_{62} & \beta_{63} & \beta_{64} & \beta_{65} & 1 & 0 \\ \beta_{71} & \beta_{72} & \beta_{73} & \beta_{74} & \beta_{75} & \beta_{76} & 1 \end{bmatrix} \begin{bmatrix} u_t^{COP} \\ u_t^{MPR} \\ u_t^{NGDP} \\ u_t^{CPI} \\ u_t^{MS} \\ u_t^{TBR} \\ u_t^{NER} \end{bmatrix} \quad (5)$$

Unlike the recursive identification, in identifying the structural VAR, the authors employed Amisano and Gianini (1997) strategy. In Amisano, et al framework, sufficient constraints are imposed on

matrix A_0 and ϑ . The system can be said to be justly identified, if requires $k(3k - 1) / 2$ or $2k^2 - k(k + 1) / 2$ or $176 = 2(11^2) - 11(11 + 1) / 2$ constraints on A_0 and ϑ . We are required to impose 70 constraints on ϑ which is presumed the diagonal matrix in our model), also, additional 21 constraints must be placed on A_0 before the system can be justly identified.

The constraints imposed on the non-recursive simultaneous associations amongst the factors are presented in equation (6). The left-hand side of equation is the baseline SVAR while the constants b_{ij} show that factor j instantaneously affects parameter i . Equation (5) shows the justly identified system $A_0\theta_t = \vartheta\mu_t$.

$$\begin{bmatrix} 1 & 0 & 0 & 0 & 0 & 0 & 0 \\ \beta_{21} & 1 & 0 & 0 & 0 & 0 & 0 \\ \beta_{31} & 0 & 1 & 0 & 0 & 0 & 0 \\ 0 & 0 & \beta_{43} & 1 & 0 & 0 & \beta_{47} \\ 0 & 0 & \beta_{53} & \beta_{54} & 1 & \beta_{56} & 0 \\ \beta_{61} & \beta_{62} & 0 & 0 & \beta_{65} & 1 & \beta_{67} \\ \beta_{71} & \beta_{72} & \beta_{73} & \beta_{74} & \beta_{75} & \beta_{76} & 1 \end{bmatrix} \begin{bmatrix} u_t^{COP} \\ u_t^{MPR} \\ u_t^{NGDP} \\ u_t^{CPI} \\ u_t^{MS} \\ u_t^{TBR} \\ u_t^{NER} \end{bmatrix} = \begin{bmatrix} \varepsilon_t^{COP} \\ \varepsilon_t^{MPR} \\ \varepsilon_t^{NGDP} \\ \varepsilon_t^{CPI} \\ \varepsilon_t^{MS} \\ \varepsilon_t^{TBR} \\ \varepsilon_t^{NER} \end{bmatrix} \quad (6)$$

The crude oil price represents external shocks. The domestic factor shocks do not have any consequence on the exogenous variable simultaneously. Yet, the monetary policy rate reacts positively and instantaneously to the movement in crude oil price. This is because the Nigerian Central Bank tightens monetary policy whenever it encounter crude oil price shock. The exchange and interest rates as well as the aggregate money are expected to affect the level of economic activity (output) with a one period lag. The price level responds instantaneously to the GDP and nominal exchange rate.

We included exchange rate in our model because it is lead indicator for price stability adjustment in Nigeria. Furthermore, as crude oil price is determined by the government below the international level, the domestic price is not supposed to react at the same time to the oil price. As Nigeria is the seventh largest exporter of the crude oil, dollars play a crucial role in the economy of the country. It is expected that GDP positively responds to crude oil price. Money demand is expected to respond simultaneously to the interest rate (TBR), the price level (CPI), and GDP. The next factor is broad money supply (MS). The monetary authority which sets the interest rate after considering the current values of the crude oil price, money, exchange rate, and more significantly the country's anchor interest rate and the lagged values of all parameters in X_t .

The inclusion of exchange rate variable in the model, is meant to capture the pass through effect. The reason for the addition of exchange rate and money the interest rate function simultaneously is that the data on these variables are available instantaneously. However, for the monetary authority, the data of important variables such as output and the price level are not available at once, so these factors were not built-in in the monetary authority reaction function. The interest rate is expected to responds positively to nominal exchange rate and money supply. In conclusion,

Kim & Roubini, (2000), opined that because the exchange rate serves as a forward-looking asset price, hence, the variable was assumed to react simultaneously to all the other variables and thus, described the equilibrium of financial market.

Data

The relationship between monetary policy variables and other variables in the model is tested by using SVAR methods. Quarterly data spanning 1981Q1 – 2017Q1 is employed for these estimations. The first results of SVAR are presented and monetary policy shock through assumptions about variable ordering is identified. After that, all channels in this research, namely, interest rates and exchange rate channels are evaluated.

Variables Choices

COP is the crude oil price in terms of the US dollar; MPR (monetary policy rate) is the Nigerian anchor or monetary policy rate. This study employs Nigeria three-month TBR, which is the key short-term interest rate used by the CBN as pointer for its monetary policy. Nominal exchange rate (NER) is a proxy for evaluating the effects of exchange rate changes on output and prices. NER is employed instead of Nigeria real exchange rate, because the exchange rate of naira pegged/floated to USD over the time period. In addition to that, in this way, fluctuations in the exchange rate that may have inflationary effect are captured by NER. Moreover, the NER of the Naira is closely following the US dollar–Naira rate, which is a good point in this study because foreign exchange interventions to stabilize the value of the naira have concentrated on the dollar–Naira rates and MS is used as a substitute of monetary aggregate were employed.

Output is a measure of nominal GDP. The absence of quarterly data for the Nigeria GDP from 1985 to 2009 based on the rebased 2010 GDP, the authors used the Proportional Denton Method to extract quarterly GDP from the available rebased annual GDP data, while the consumer price index (CPI) measures the general price level. All variables employed in this study, were expressed in natural logs, except for the TBR and MPR variables that are in levels. Crude oil price booms, as oil dummy is applied in the estimation process.

SVAR Empirical Analysis and Results

Here, we evaluates the simultaneous constants in the structural VAR model and conduct an impulse responses function as well as the variance decompositions to ascertain the level of domestic tightening on monetary shock. We also examined the effects of monetary policy shocks on domestic variables by extending the model; the influences of monetary contractions on exchange rate was equally assessed.

Unit Root

When the mean, variance and covariance of a series is not constant over time, it implies that such series are non-stationary. When data contains unit root, it means any result that emanates from such data will be spurious or nonsensical. VAR-X models require that the stationarity of the variables, hence, as a first step we have to examine whether this condition is satisfied. To do this, we employed the Augmented Dickey-Fuller (ADF) and Phillips-Perron (PP) stationarity tests. The results of the unit root test in level form and first difference are presented in Table 1. The result indicates that all the variables are non-stationary.

Lag length selection criteria

The study employed the information criteria to analysis a reduced form VAR after establishing the statistical properties. To define at which level a VAR will be estimated, there is need to check the stability condition

Table 1: Augmented Dickey-Fuller and Phillips-Perron Unit Root Tests with Trend and Intercept

Stat.	ADF Test		Phillips-Perron Test		Order Of Integration
	Level	1 st diff	Level	1 st diff	
COP	-2.007766	-9.914089	-2.239426	-8.752804	I (1)
MPR	-2.755037	-11.20625	-2.555325	-11.60821	I (1)
GDP	-0.476797	-5.185720	-0.198744	-13.77246	I (1)
CPI	-2.508525	-1.064446	-4.445065	-9.910968	I (1)
MS	-2.326324	-9.245610	-1.144368	-13.54750	I (1)
TBR	-3.557386	-8.521027	-2.770993	-8.063089	I (1)
NER	-2.039957	-10.12952	-2.389207	-10.15419	I (1)
Critical Values: 1%, 5% & 10%; -4.023508, -3.441330 and -3.145211					

To estimate a VAR in level form, it has to be stable. This implies that all the roots must lie within the unit circle. Conversely, if it is not stable, the VAR is estimated in first difference. However, Cheung and Lai (1993), opined that different information criteria can be used to specify lag length. Ibrahim (2006), observed that when there is a shift in the average error term, the lag length test from such model may not achieve the appropriate results. We conducted the lag length selection criteria to ascertain if the residuals were serially uncorrelated under different lag lengths or not Johansen (1992) and Hall (1989) and the result of the lag lengths from the SVAR model for Nigeria is presented in Table 2, indicated an optimal lag of 2 for our analysis.

Table 2: Specification tests for Nigeria Monetary Transmission Mechanism SVAR

Lag	LogL	LR	FPE	AIC	SC	HQ
K=0	-1130.222	NA	0.6440	16.5872	16.7151	16.6392
K=1	87.4783	2310.97	2.0878	-0.6639	0.2313*	-0.3001*
K=2	140.4890	95.9609	1.6208*	-0.9122*	0.7502*	-0.2367*
K=3	161.9536	36.9755	2.02318	-0.7001	1.7297	0.2874
K=4	185.6494	38.7435	2.4568	-0.5204	2.6766	0.7788
K=5	228.4912	66.2953	2.2775	-0.6203	3.3440	0.9907
K=6	282.3664	78.6499*	1.8128	-0.8813	3.8504	1.0416
K=7	305.0512	31.1295	2.3115	-0.6869	4.8121	1.5478
K=8	324.2543	24.6698	3.1601	-0.4417	5.8246	2.1048

Source: Author's compilation

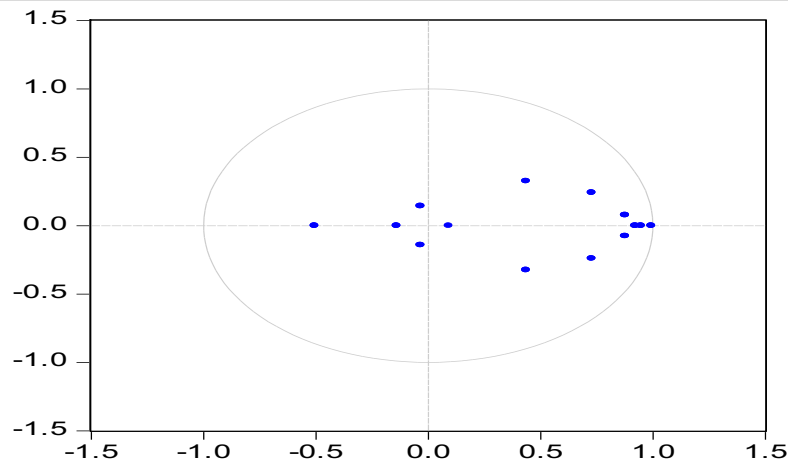


Figure 5: Inverse Root of AR Characteristic Polynomial

Table 3: Root of Characteristic Polynomial

Root	Modulus
0.9944	0.9944
0.9496	0.9496
0.9232	0.9232
$0.8780 - 0.0770i$	0.8814
$0.8780 + 0.0770i$	0.8814
$0.7298 - 0.2412i$	0.7686
$0.7298 + 0.2412i$	0.7686
$0.4380 - 0.3249i$	0.5454
$0.4380 + 0.3249i$	0.5454
-0.5039	0.5039
$-0.0334 - 0.1422i$	0.1461
$-0.0334 + 0.1422i$	0.1461
-0.1390	0.1390
0.0937	0.0937

Source: Author's computation

Notes: No roots lie outside the unit circle. VAR satisfies the stability condition

Testing for Cointegration

Cointegration usually defined a concept which mimics the existence of the long –run equilibrium relationship among variables. The results for the Johansen cointegration test based on trace and maximum-eigen values test statistics are presented in Table 4. The results for the maximum eigen values test statistic shows at least two test statistics which are greater than the 5% critical value thereby, rejecting the null hypothesis of no cointegrating variables. On the other hand, the trace test statistics revealed that there were four cointegrating equations. Thus, rejecting the null hypothesis of no cointegration of the variables at 5%. The trace test statistic is preferred to the maximum-eigen value test, because it is termed to be more specific and not general.

Table 4: Johansen Cointegration Test Based on Trace and Maximum Eigen Values of the Stochastic matrix

Trace Test				Maximum Eigen Value			
H ₀ : Rank r	H _a : Rank = r	Trace Statistics	0.05 Critical Value	H ₀ : Rank r	H _a : Rank = r	Statistics	0.05 Critical Value
r = 0	r = 1	181.00*	125.62	r = 0	r = 1	60.51*	46.23
r ≤ 1	r = 2	120.49*	95.75	r ≤ 1	r = 2	41.54*	40.08
r ≤ 2	r = 3	78.96*	69.82	r ≤ 2	r = 3	30.94	33.88
r ≤ 3	r = 4	48.01*	47.86	r ≤ 3	r = 4	23.48	27.58
r ≤ 4	r = 5	24.53	29.80	r ≤ 4	r = 5	14.48	21.13
r ≤ 5	r = 6	10.05	15.49	r ≤ 5	r = 6	5.89	14.26
r ≤ 6	r = 7	4.15	3.84	r ≤ 6	r = 7	4.15	3.84

Note: Trace tests indicate 4 cointegrating equations at the 0.05 level, while the Max-eigen value indicates two cointegrating equation.

Source: Author's Compilation using Eviews

Channels of Monetary Policy Transmission Mechanisms

Irrespective of the monetary policy framework adopted in practice, a central banker would like to know how changes in monetary policy instrument affect inflation and output, as well as the timing and size of such effects. Traditionally, the effects of monetary policy actions are thought to be transmitted via money or credit channels—the so-called money versus credit view of monetary policy. In the former, changes in the nominal quantity of money affect spending directly, whereas in the latter case, open market operations induce changes in interest rates that affect spending; in some models, credit rationing and financial accelerator can have additional effects on output and prices as well. Most models rely on some form of nominal price or wage rigidity to draw the hypothesized links between money, interest rates, and output. We now cover in more detail how the interest and exchange rate channels works.

Contemporaneous Coefficients in Nigeria Structural models

Table 5, Matrix A is the long-run diagonal matrix of contemporaneous coefficients. The result from matrix A, revealed that all the variable are statistically significant in the long-run. Conversely, Matrix B of Table 5, shows the short-run contemporaneous coefficients and standard error in structural models for Nigeria. If monetary policy's reaction and function is evaluated, the authors figure out that β_{21} is negative in Nigeria. It means the monetary policy rate of the Central Bank of Nigeria responds positively to unexpected decrease in COP. The opposite side of the story is also true for β_{53} and β_{56} , monetary aggregate decreases with unexpected contract in GDP and an increase in the interest rate. Meanwhile, β_{61} is negative in Nigeria as an oil exporting country. It implies that monetary authority takes a contractionary monetary policy when facing oil price decline.

Conversely, β_{62} is positive which emphasizes the positive reaction of domestic interest rate to MPR. Furthermore, a positive sign of β_{31} implies that unexpected change in oil price causes GDP in Nigeria to contract. In addition, the likelihood ratio test does reject the over-identified restrictions for Nigeria. The likelihood ratio test of -8.800 does not reject the over -identification restrictions in Nigeria. Similarly, the $\chi^2(11)$ test for Nigeria is 2.165, respectively, with the corresponding p-value of 0.421.

Table 5: Structure of Nigeria Baseline Model: Contemporaneous relations matrix

Matrix A: Coefficient and Standard Errors						
COP	MPR	GDP	CPI	MS	TBR	NER
3.1153 (0.1955)	0	0	0	0	0	0
0	12.3958 (0.7778)	0	0	0	0	0
0	0	7.5494 (0.4737)	0	0	0	0
0	0	0	5.8600 (0.3677)	0	0	0
0	0	0	0	8.6980 (0.5458)	0	0
0	0	0	0	0	9.2727 (0.5818)	0
0	0	0	0	0	0	4.9624 (0.3114)

	Matrix B: Coefficient and Standard Errors						
	COP	MPR	NGDP	CPI	MS	TBR	NER
COP	1	0	0	0	0	0	0
MPR	-2.7694 (0.0887)	1	0	0	0	0	0
NGDP	0.2120 (0.0560)	0	1	5.3432 (0.3179)	0	0	0
CPI	0	0	4.5504 (0.2732)	1	0	0	0.6128 (0.0521)
MS	0	0	-2.8562 (0.3167)	10.5438 (0.6991)	1	-0.6785 (0.1286)	0
TBR	-1.9596 (0.6795)	0.7105 (0.4632)	0	0	4.0969 (1.1322)	1	6.4167 (0.4659)
NER	-0.2228 (0.0457)	0.0167 (0.0412)	7.8336 (0.5227)	-2.7379 (0.2806)	0.0285 (0.0792)	0.5415 (0.0466)	1
$X^2(11)$	13.6171 (0.0000)						
Notes: Standard errors in parentheses, $X^2(11)$ represents the LM test for over-identification restriction, the marginal significance level is in parentheses.							

Source: Author's Compilation using Eviews

Interest Rate Channel Model

Here, we interpret interest rate or monetary shock in the baseline model in the Nigerian economy. Figure 2 depicts the impulse response functions for output, price, monetary aggregate and NER. Positive innovation points out approximately by 54 in TBR, which follows monetary contraction that causes the output in Nigeria to fall.

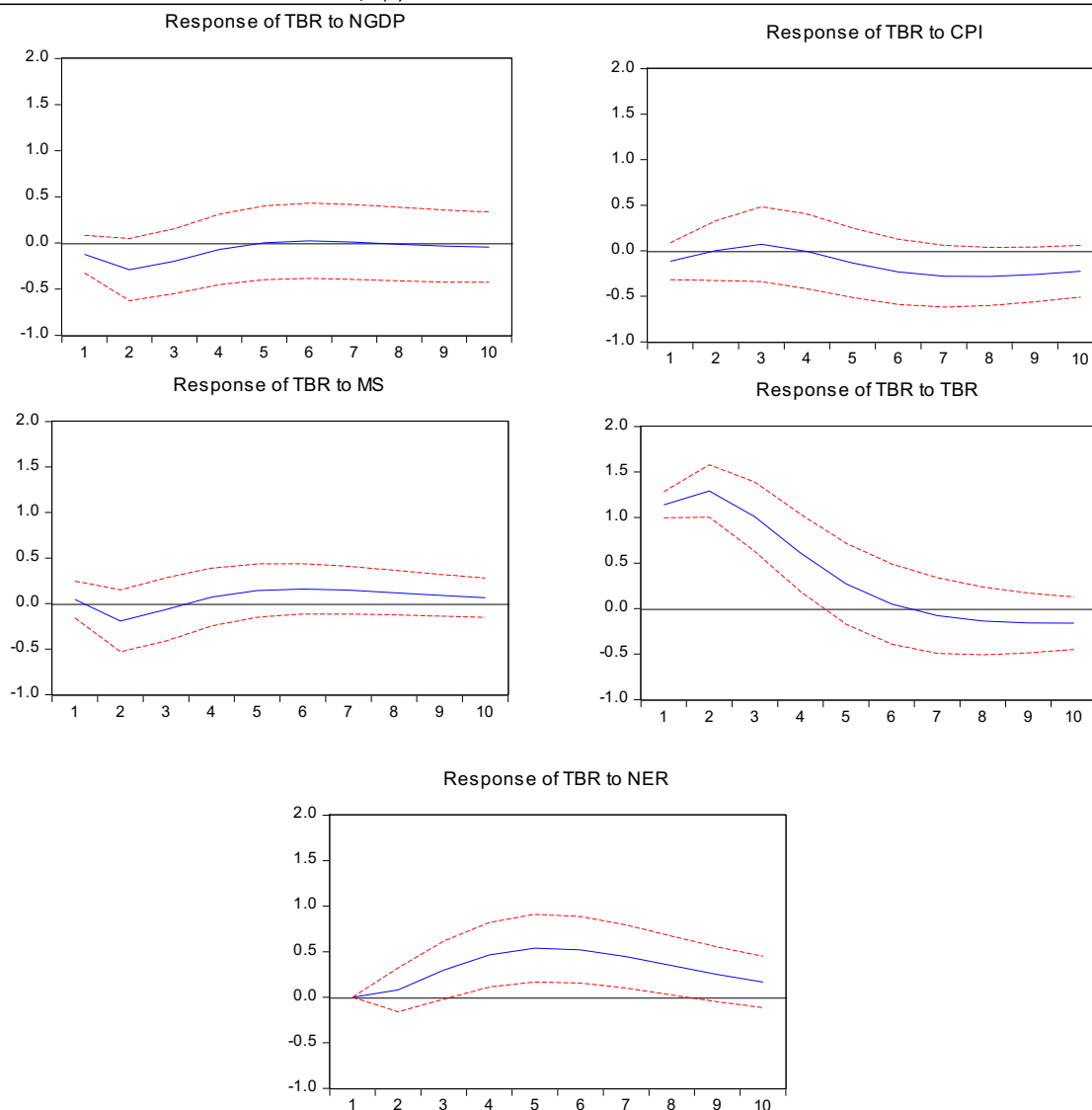


Figure 6: Responses to a positive interest rate shock

All the following Tables and Figures are estimated by the authors

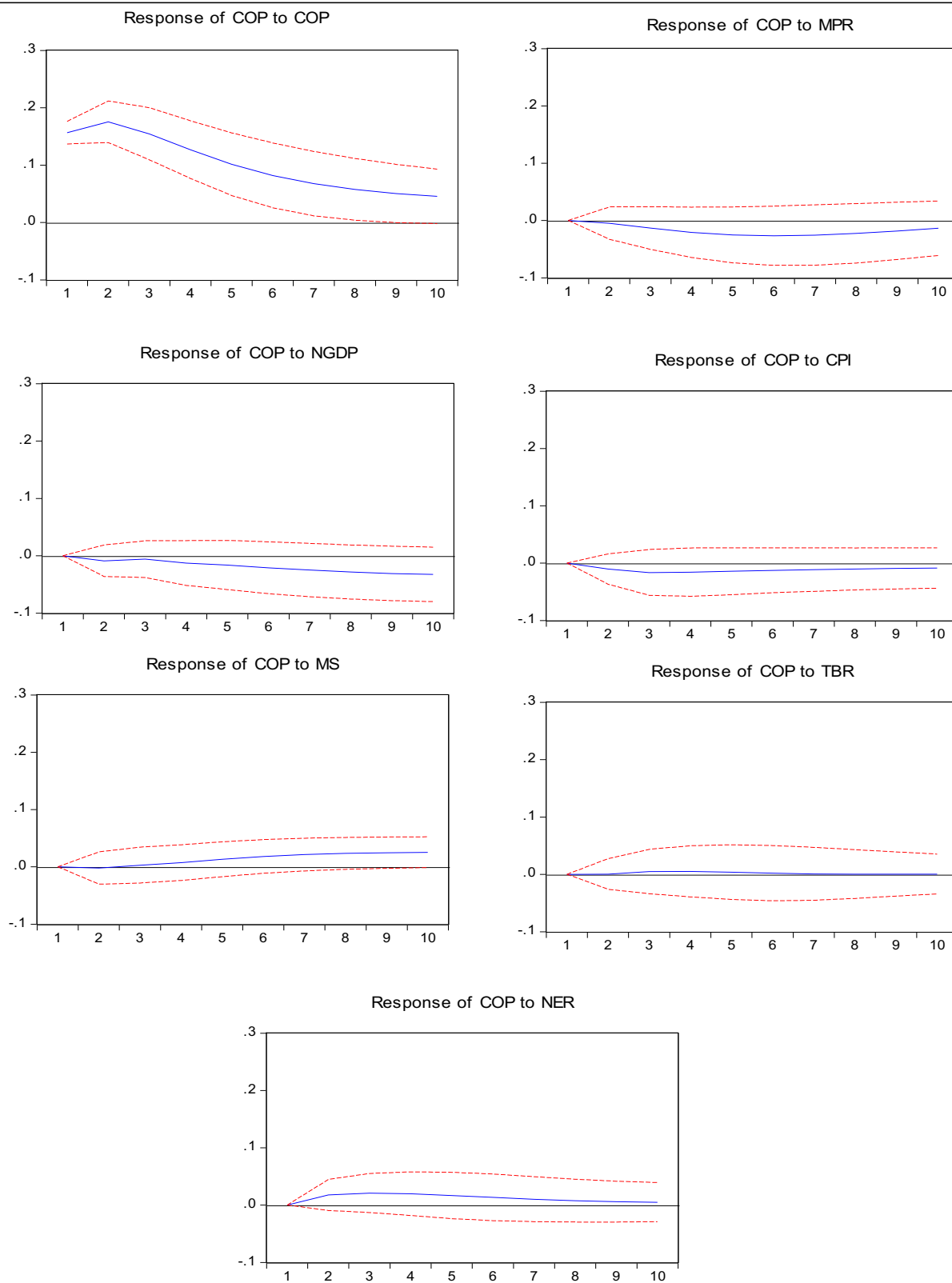


Figure 7: Responses to a negative crude oil price shocks on Nigeria

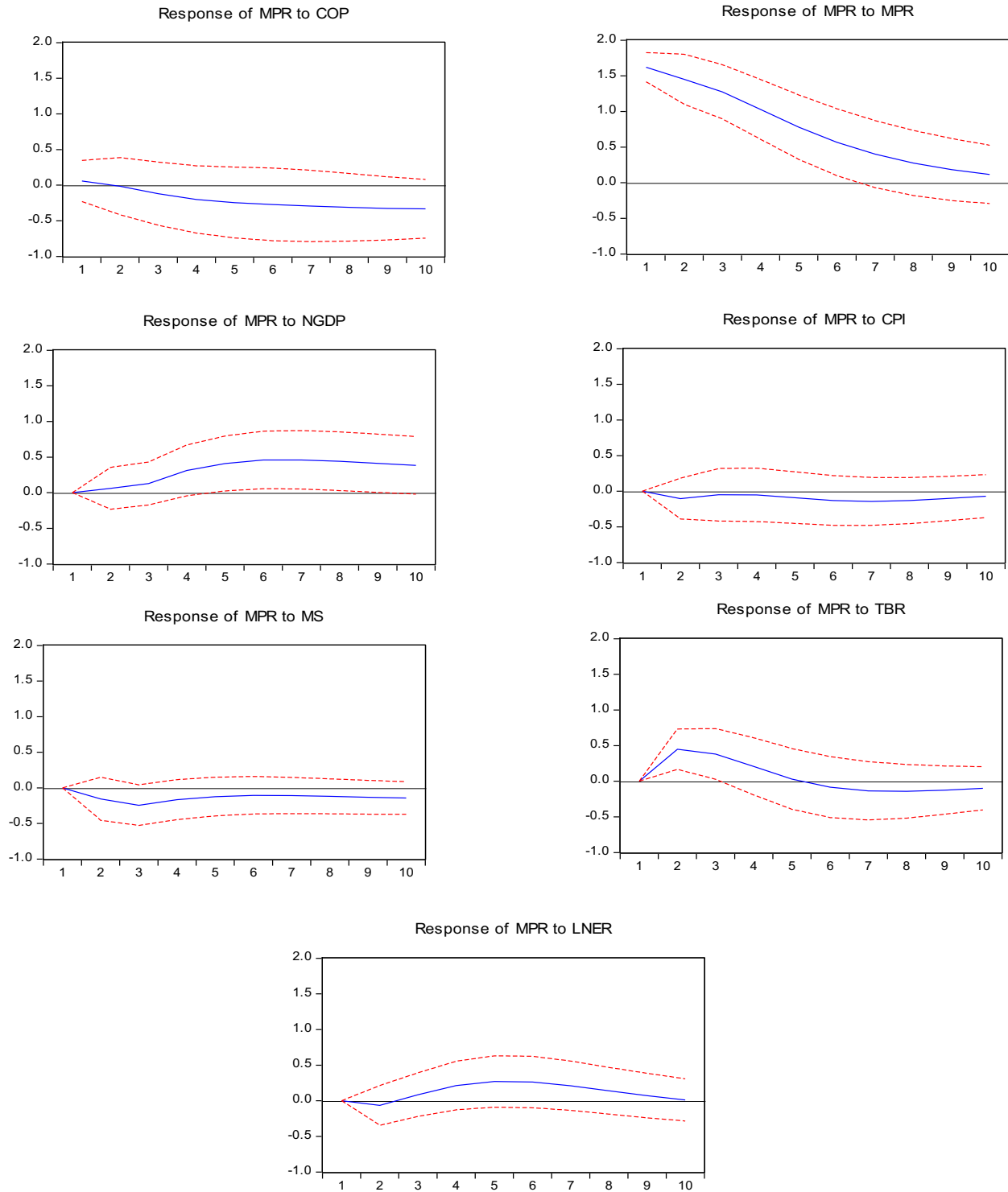


Figure 8: Responses to a positive monetary policy rate

The peak impact occurs by 1.0%, this was found after 10 quarters of the shock and the response are both long-lasting and statistically significant. The response on the price level is small, though statistically significant. Prices do not begin to decline until about two quarters and rise, before falling in a hump-shaped. The peak impact was reached after 3 quarters. In literature, the initial

positive response of prices to a tightening monetary policy shock is referred to as the “price puzzle”. Moreover, monetary aggregate falls after the shock and bottoms out just after one quarter, in addition to NER’s rising and peaking after five quarter and falls immediately.

Figure 3 shows the impulse response functions for all variables are affected by oil price shocks. Following negative oil price shock, output in Nigeria declined, the impact of oil price shock on output occurs one quarter after the shock. Also, COP has negative effects on MPR. Furthermore, price level is affected simultaneously by oil price shock, price decreases slowly one quarter after oil price shock. Oil price innovation also has negative response to TBR. Impulse response shows TBR falls due to oil price shock. Moreover, an oil price shock has both negative effects on monetary aggregate and positive effects on NER. However, MS falls and NER rises one quarter after the sock.

Figure 4 depicts the impulse response functions for all variables are affected by MPR shock. As predicted, MPR has a positive influence on TBR of Nigeria as this country is pegged to USD. Furthermore, MPR shock has negative effects on output. Twenty two basis points of MPR shock increases GDP of 0.02% at 10 quarters after the shocks. Meanwhile, MPR innovation has a negative effect on MS and CPI, and a positive effect on NER.

Table 6 reveals each variable’s variance decompositions at forecasted horizons of two through 10 quarters. Variance decompositions display percentage shares of variable movement encountering different shocks. Columns of variance decomposition show percentage changes of each variable that faced with shock and now the percentage change is adding up to 100%.

Table 6: Variance Decomposition: Interest and Exchange rate Channel

Variance Decomposition	Period	COP	MPR	NGDP	CPI	MS	TBR	NER
NGDP	2	2.22	0.02	22.28	61.68	7.50	1.42	4.89
	4	2.07	0.01	23.71	59.91	8.49	1.73	4.08
	8	1.84	0.01	26.59	56.19	9.79	2.10	3.48
	10	1.82	0.01	28.50	53.75	10.35	2.31	3.24
CPI	2	0.67	0.00	43.12	54.50	1.50	0.07	0.13
	4	0.58	0.00	46.02	51.57	1.70	0.05	0.08
	8	0.45	0.00	49.94	47.70	1.62	0.11	0.18
	10	0.36	0.00	54.60	43.08	1.37	0.17	0.42
MS	2	0.21	0.01	37.05	61.14	0.00	0.51	1.07
	4	0.15	0.01	38.37	60.00	0.00	0.45	1.03
	8	0.15	0.00	38.90	59.61	0.01	0.40	0.93
	10	0.19	0.00	37.98	60.64	0.05	0.35	0.79
TBR	2	0.05	0.05	44.75	29.18	0.21	0.49	25.27
	4	0.05	0.05	48.79	30.18	0.20	0.47	20.25
	8	0.10	0.06	46.80	31.78	1.94	0.57	18.75
	10	0.39	0.04	42.41	40.88	2.62	0.54	13.12
NER	2	0.61	0.00	44.73	52.90	0.14	1.31	0.32
	4	0.50	0.00	47.55	50.23	0.12	1.23	0.38
	8	0.45	0.00	50.65	47.14	0.11	1.13	0.51
	10	0.45	0.00	53.43	44.31	0.11	1.03	0.67

Note: Factorization – Structural, Source: Author's Compilation using Eviews

The variance decomposition result in Table 6, shows that shock to COP leads to a 222% and 207% variability, respectively of GDP after two and four quarters. Also, 1% variability of GDP related to MPR shocks after 8 and 10 quarters was experienced. Moreso, a 999% and 1035% variability of GDP owing to monetary aggregate shocks after 8 and 10 quarters. This means there was substantial variability in the movement of economic activity as a systematic response to monetary aggregate and foreign shock (i.e the world crude oil price). TBR contributes 231% and 17% of movements in GDP and CPI levels, respectively after 10 quarters. This indicates that the interest rate innovation is a relatively weak determining factor of variabilities in economic activity.

TBR also explanations 51% of monetary aggregate movements after 2 quarter and 45% after 4 quarters. Moreover, 131% and 123% variability of NER relates to TBR revolution after two and four quarters. Conversely, output, price, monetary aggregate and exchange rate shocks insignificantly contributed to the main effects on interest rate fluctuation. GDP contributes to 4879% fluctuation of TB after 4 quarters and NER accounts for 2527% movements of TB after two quarters. In addition to that, the results indicate MPR accounts for 6% and 4% fluctuation of TB respectively after eight and 10 quarters.

Comparison of Non-recursive SVAR and Recursive VAR

One of the main reasons that motivate experts to use structural VAR in the analysis of monetary studies is the different kinds of puzzles that occur in VAR evaluation. Therefore, the authors compare results achieved by recursive VAR with the result achieved by non-recursive SVAR. As shown in Figure 5, output puzzle beside the price puzzle is obvious in VAR analysis. Due to Monetary policy, shock output improved just after two quarters shocks and bottoms out after 8 quarters.

However, in SVAR analysis, output encountered by interest rate positive shock falls instantly. The other difference is that in VAR result (see Figure 5), oil price (Figure 6) and MPR (Figure 7) shocks have positive effect on TB, in contrast, SVAR result shows that oil price innovation has primary negative effects on TB. Comparison of recursive VAR and non-recursive SVAR indicates that better forecasting and estimation are obtained when SVAR methods are employed.

Response to Cholesky One S.D. Innovations ± 2 S.E.

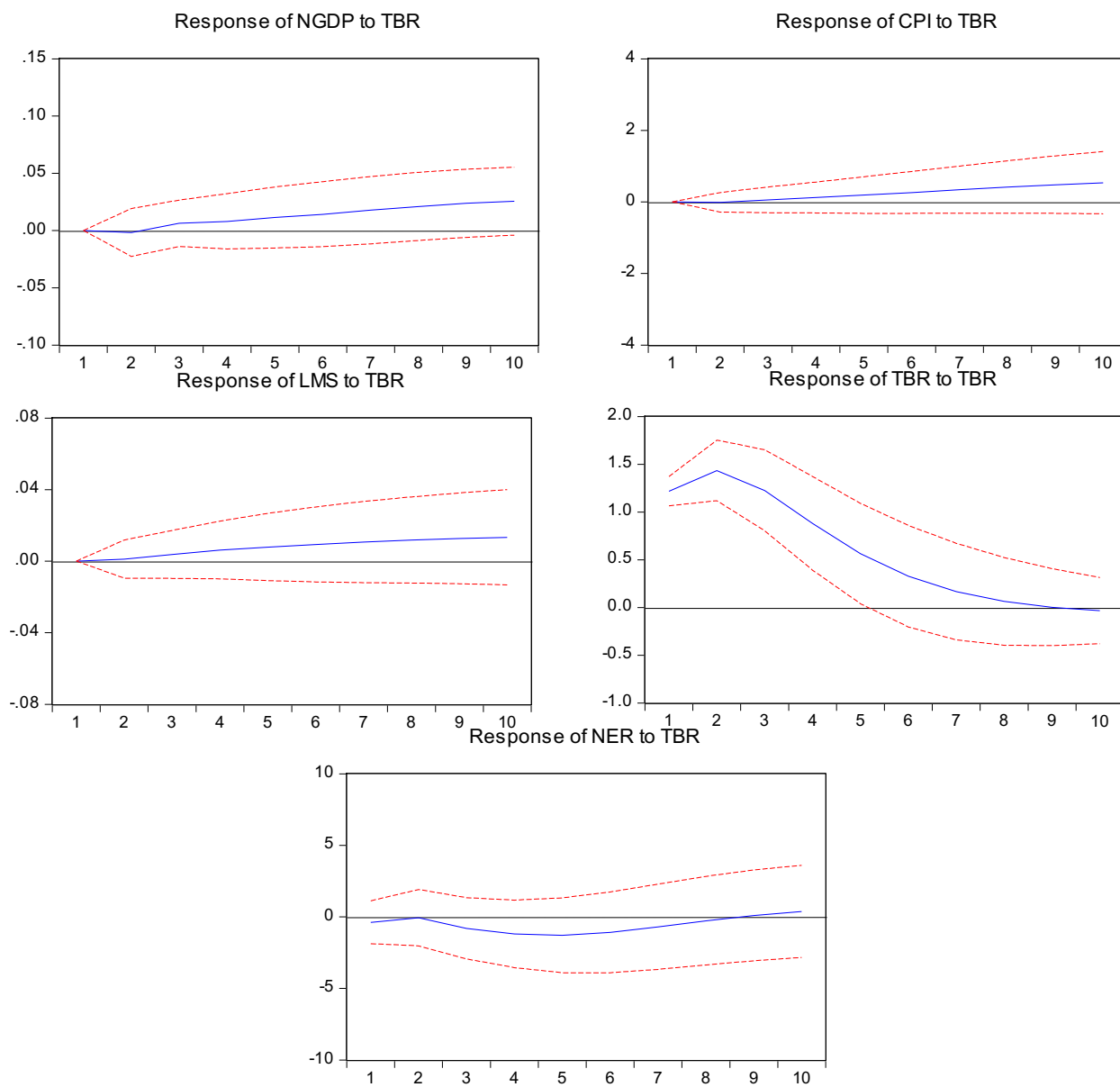


Figure 9: Responses to a positive interest rate

Response to Cholesky One S.D. Innovations ± 2 S.E.

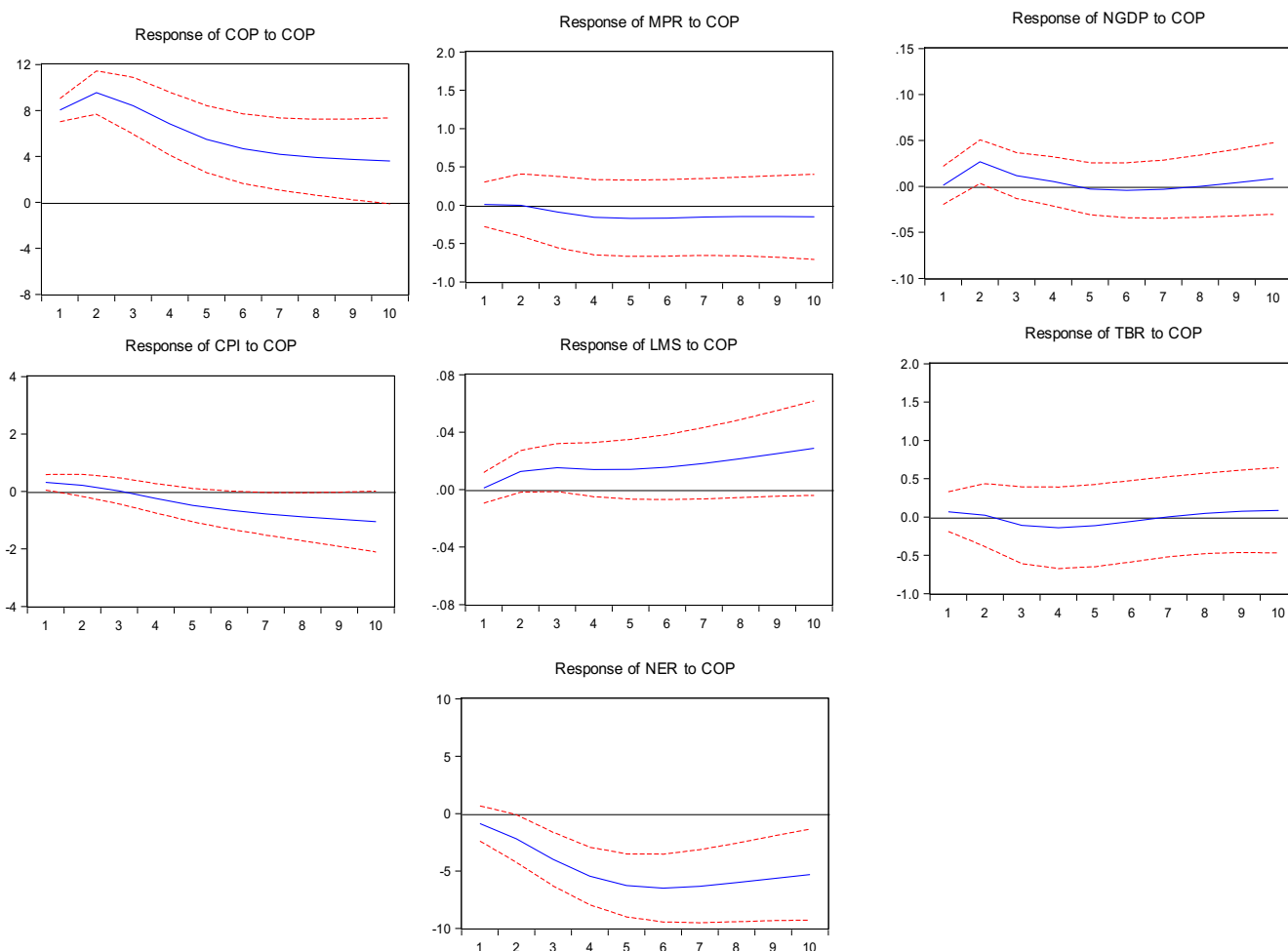


Figure 10: Responses to a negative crude oil price on Nigeria

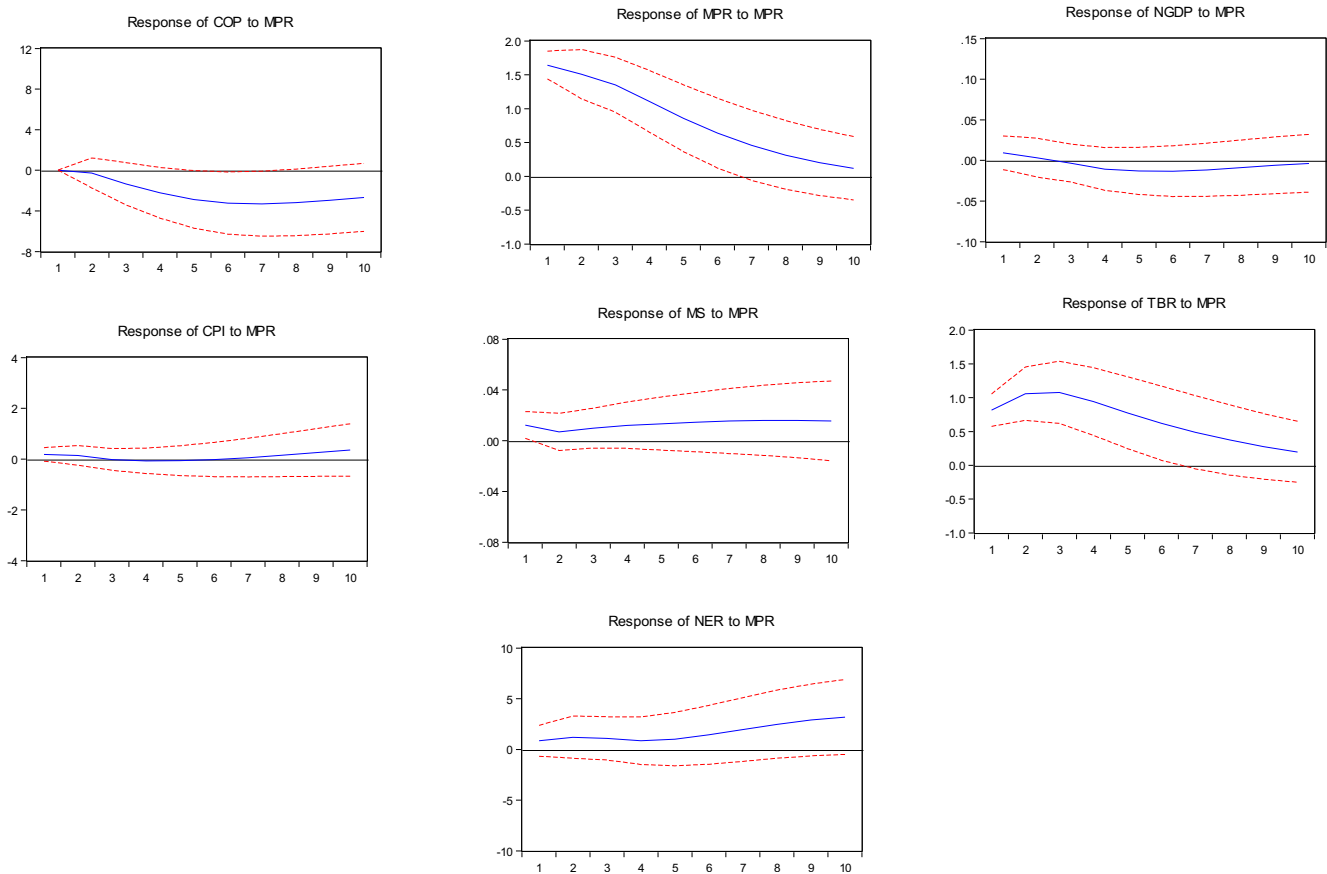
Response to Cholesky One S.D. Innovations ± 2 S.E.

Figure 11: Responses to a positive monetary policy rate on Nigeria

Exchange Rate Channel Model

In this section, the authors focus on the responses of variables to exchange rate shocks. Impacts of these shocks are illustrated in Figure 8. An appreciation shock in the NER leads to a decrease in output. Interestingly, the same shock also causes price level to be constant. However, the magnitude of the impact of the exchange shock on prices appears to be higher. Moreover, NER has a primary positive effect on TBR and MS; however, MS improves after one quarters and TBR remains constant in the 10 quarters.

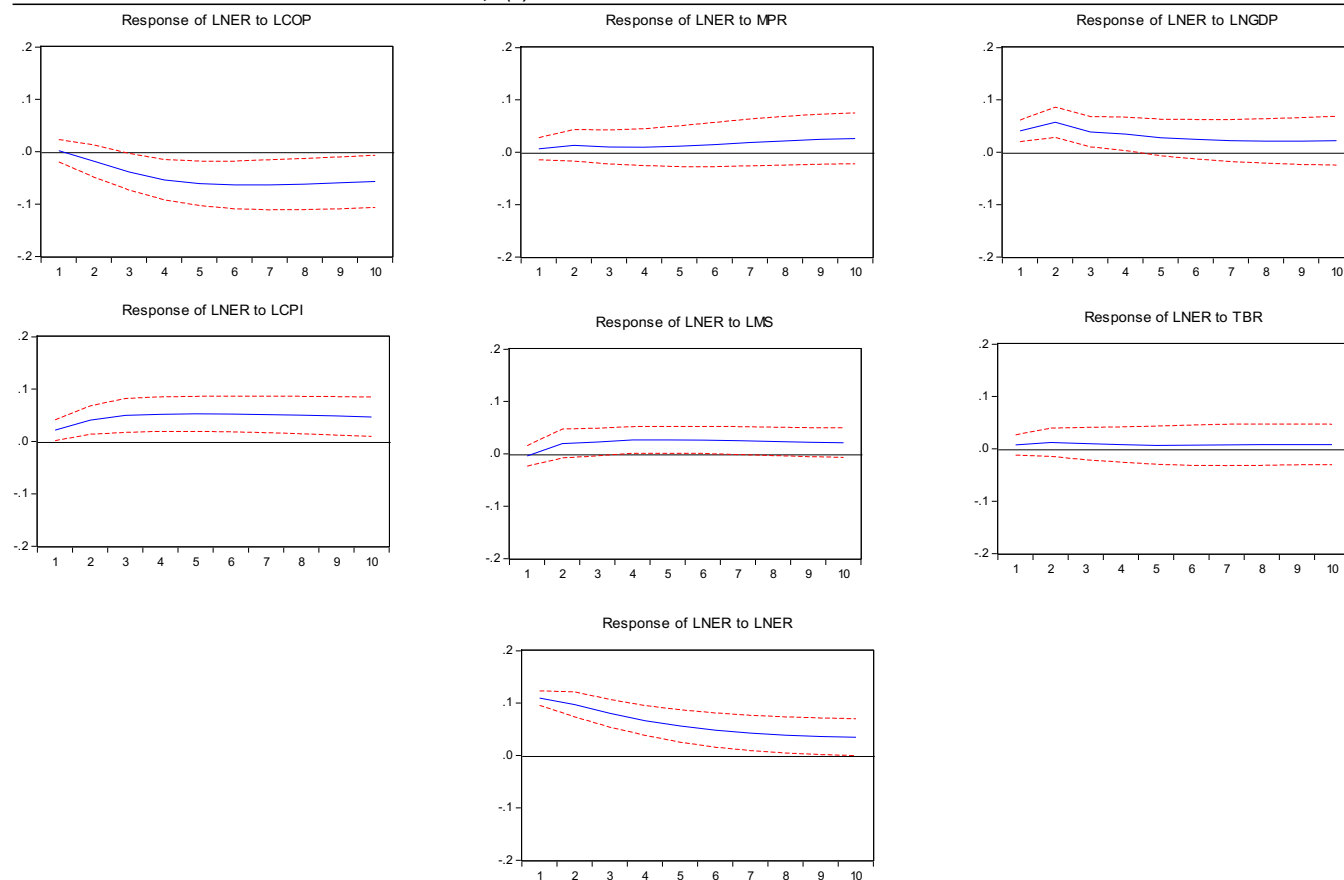


Figure12: Responses to a positive monetary policy rate on Nigeria

CONCLUSIONS

The role of the interest rate and exchange rate channel in Nigeria was assessed in this paper. The authors adopted an open-economy methodology to estimate SVAR model with contemporaneous restrictions to analyze the effects of each channel. Comparison of recursive VAR results and non-recursive SVAR results indicates that better forecasting and estimation is obtained when SVAR method is applied. Contemporaneous coefficient of monetary policy reaction reveals that Nigeria's monetary agency raises the interest rate when encountering the unexpected increases in MS, although Nigeria exchange rate is pegged to US dollar, monetary aggregate decreases with an unexpected increase in interest rates.

The analysis of the results shows that shocks to interest rate effect output, and also has a major impact on prices over the sample period. These findings are generally consistent with findings in other countries, using the similar methodology. However, significant fluctuations in movements of economic activity relating to systematic reaction to monetary aggregate and foreign stocks such as the crude oil price. The authors find that a depreciation shock in the nominal exchange rate leads to a rise or an increase in the price level, although the impact of an interest rate shock on prices is not strong in Nigeria.

However, as in many developing countries like Nigeria the exchange rate channel appears to have a stronger impact on prices. These results mean that depreciation of the NER could be an external deflationary element, particularly for Nigeria. Allowing more flexibility in the exchange rate can

strengthen the exchange rate channel for Nigeria that pegging the naira - US dollar, can open more doors for autonomy for the Central Bank of Nigeria.

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