Measuring the Vulnerability of Nigerian Macro-economy to Foreign Shocks: A Structural VAR Approach

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Abstract: *This paper employs a structural vector auto regression (SVAR) model to investigate the vulnerability of the macro-economy to foreign shocks in a small emerging open economy with Nigeria as the case study. Specifically, the paper studies how the Nigerian economy is exposed to foreign shocks. We establish identification conditions to uncover the dynamic effects of foreign monetary policy shocks on various domestic variables. By analyzing the intensity of the responses of the domestic variables to various foreign monetary shocks, we aim to examine the Nigerian monetary transmission mechanism in this era of globalization and trade liberalization. Using quarterly data from 2003 q1 to 2016 q4, a nine variable SVAR model is established to study the dynamic responses of the Nigerian economy to some domestic and foreign shocks. The study finds the incidence of delayed response of some Nigerian variables to US monetary policy shocks. It therefore recommends a closer study of the US monetary policy while implementing monetary policy in Nigeria.*
Keywords: *SVAR, Open Economy, Monetary Policy*

I. Introduction

Economic literature assumes that, monetary policy is a stabilization mechanism that steers the economy towards economic growth and price stability Raghavan and Silvapulle (2007). This notwithstanding, the impact of monetary policy resonates throughout the economy and even beyond borders, especially in the short run, through changes in the various macroeconomic aggregates. Through these aggregates, policy stimuli transmit to financial markets, economic activities and the price level.

Furthermore, in this era of globalization and trade liberalization, monetary policy has been increasingly expected not only to rein in the impacts of domestic shocks but also those of external shocks. For example, changes in interest rates in one economy would impact on trading partners, foreign direct and indirect investment as well as capital mobility. Consequently, the efficacy of monetary policy depends on the ability of policy makers to isolate and effectively manage foreign impulses in order to introduce only the necessary dose of domestic shocks to the economy. Therefore, to shove monetary policy with the appropriate force and in the right direction, policy makers need to have a clear understanding of the transmission mechanism of the monetary policy shocks and the relative importance of the various channels, namely money, interest rates and exchange rates in affecting the real sectors of the economy (Kuttner and Mosser, 2002; Clinton and Engert, 2000).

In Nigeria as in many developing countries, globalization and liberalization have brought about increased trade and hence integration into the global economy. For instance in 2004/2008, oil exports and trade openness averaged 30.1 and 66.4 per cent, respectively (CBN, 2009). The surge in trade is observable both in the formal and informal sectors. The implementation of the ECOWAS protocol on free movement of goods and persons in the sub-region fosters the growth of cross-border trade between Nigeria and other countries of the sub-region. At the formal level, international trade is fostered by efforts of both the Federal and state governments to diversify the economy by increasing non-oil export. The patterns and trends in external trade and balance of payments position underscore the level of vulnerability of Nigeria to foreign shocks. The foreign content of domestic production and consumption is very high. The foreign content of fiscal operations is equally high. Even the composition of non-oil imports has shifted in favor of consumption signifying a decline in production and increase in dependence (CBN, 2014).

Since the 1980s, due to liberalization and globalization processes, the emerging

Nigerian economy witnessed widespread changes in its conduct of monetary policy and the choice of monetary policy regimes. The chosen monetary policy regime is determined by the degree of Central Bank autonomy in the conduct of monetary policy, the choice of exchange rate regime and the degree of international

capital mobility. The Structural Adjustment program that started in the mid-1980s brought these issues to the front burner in the management of the Nigerian economy. Since then, the economy has increasingly become market oriented and thus internationally linked.

The main objective of the program was to effectively alter and restructure the consumption and production patterns of the economy as well as eliminate price distortions and heavy dependence on the export of crude oil and imports of consumer and producer goods. Major specific objectives include:

(a) Restructuring and diversifying the productive base of the economy in order to reduce the dependence on the oil sector and on imports
(b) Achieving fiscal and balance of payments viability over the period
(c) Laying the basis for a sustainable non-inflationary or minimum inflationary growth
(d) Reducing the dominance of unproductive investment in the public sector, improving the sector's efficiency and intensifying the growth potential of the private sector.

To achieve these objectives, a number of strategies were mapped out and these included

(a) The adoption of a realistic exchange rate policy coupled with the liberalization of eternal trade and the payments system;
(b) Adoption of appropriate pricing policies in all sectors with greater reliance on market forces and reduction in complex administrative controls;
(c) Further rationalization and restructuring of government expenditure and customs tariffs, CBN (1986).

The SAP lasted for nine years 1986-1995. Much as this paper is not aimed at appraising SAP, it would not be too far from the objectives if we say that SAP formed the basis for the economic management model of Nigeria since its implementation. Since SAP, Nigeria abandoned the direct monetary management framework and adopted the indirect framework. This can easily be observed in the foreign exchange market and the financial sector of the economy. However, the dependence on the oil sector continues as the much trumpeted diversification of the economy has yet to take full grip. In 2007/2008, the global economic meltdown impacted GDP, employment, wages and other macroeconomic indicators.

The reaction of the Nigerian economy to the Global Melt Down 2007/2008 was a clear manifestation of how vulnerable the economy was to foreign shocks. Worthy of note is the fact that the vulnerability increased with the greater openness of the Nigerian economy. Trade volumes are rising; foreign direct investment is also on the increase just as the volume of remittances. In deed in terms of revenue, remittances are next only to oil in Nigeria, CBN, (2015). Therefore to what extent Nigeria's macro-economy is exposed to external shocks is a pertinent question that seeks urgent answers. An answer to this question would guide policy makers on the pass through of foreign shocks to the domestic economy. It is understandable that shocks from small open economies hardly impact on developed economies but the reverse is not equally obvious (………)

The paper is divided into six chapters. After this introduction, chapter two deal with the literature review and theoretical framework. Chapter three deals with the analytical framework while chapter four discusses the results and chapter five discusses the policy implication of the results and chapter six summaries and concludes the paper

II.   Some Stylized Facts on the Nigerian Economy

Monetary policy implementation Framework: The CBN is curious about the effectiveness of monetary policy in Nigeria. In this regard it continuously evaluates its monetary policy framework to enable it respond appropriately to the ever changing economic and financial environment. In 2006 therefore the Bank introduced a new framework for monetary policy implementation that centered on an interest rate corridor approach and essentially shifted the focus of the Bank from managing reserves to managing the over-night inter-bank rates with the hope that this would affect inflation and other policy objectives through the money supply. Effectively the Bank established a Standing Facility by which it lends overnight to deposit money banks with deficits at a fixed rate and pays those with surpluses a fixed interest rate on their deposits or reserves with the CBN. Both the lending and the deposit rates are expected to form the bench marks for rates in the inter-bank market. The spread of the deposit and lending rates provide cost incentives for banks to deal among themselves rather than with the CBN. Thus, under the new framework, reserve money became the operating target complemented by the over-night inter-bank interest rate with the advent of the Monetary Policy Rate (MPR).

The MPR is therefore the nominal anchor for monetary policy in Nigeria. It influences the size and sign of other interest rates in the domestic market. Furthermore, it signals the stance of monetary policy of the monetary authority to market operators, hence guiding the way the CBN policy rate influences credit availability as a lender of last resort to DMBs. Therefore the inter-bank rate is the measure of the effect of the MPR in the economy while the MPR merely gives the signal.

The major goals of monetary policy in the period 2003 – 2016 were to boost the growth rate of output (real gross domestic product (GDP)), moderate inflation as well as build the level of foreign reserves.

Technically, the Bank targets monetary growth that is consistent with predetermined targets for GDP growth, inflation rate and external reserves by using market instruments to limit the credit creation ability of DMBs, curb excess liquidity and curtail the growth of stock above the programmed target. The market instruments used included the Open Market Operations (OMO), Reserve Requirements and Discount Window Operations.

Since the introduction of the Indirect Monetary Policy regime, the outcomes of monetary policy in Nigeria have been mixed. Inflation rate declined steadily from 57.2 per cent in 1994 to 12.0 per cent in 2012. Output growth rose from 0.8 per cent in 1994 to 6.6 per cent in 2012. In terms of targets and outcomes, output fell below target in the first decade of the operation of the indirect monetary control except in 2000 when the target was surpassed by 1.9 percentage points. In the period 2003-2012, output performance improved surpassing the targets in 2009, 2010 and 2011 but fell below targets in 2007, 2008 and 2012. With respect to prices, inflation performance also witnessed mixed outcomes. While actual inflation surpassed targets in 1993 through 1996, they were below targets in the following two years. On average between 2000 and 2012, outcomes were generally above targets except for 2006 and 2007 when outcomes of 8.5 and 6.6 per cent were realized against targets of 9.0 and 9.6 per cent, respectively.

On average, growth in broad money (m_2) since the adoption of indirect monetary control was 27.6 per cent which was above the target of 18.6 per cent. However, in 2009, 2010 and 2012 monetary growth outcomes were below the targets by 3.7, 22.3 and 10.9 percentage points, respectively.

The External Sector

In macroeconomic models, the external sector is treated according to some theoretical relationships, accounting systems and definition of variables (Mattanyane, 2005). In principle the estimation of the external sector should reflect trade flows, services flows, transfers and direct and indirect capital flows (Pauly, 2000). Pandit (2000) opined that the external sector should be discussed in terms of the disequilibrium in the sector and how it impacts on the economy. This can be achieved through the integration of the demand and supply analysis in the trade flows.

Exchange Rate Management in Nigeria

Exchange rate management in Nigeria has evolved over the years spanning various regimes. Between 1960 and 1986, the fixed exchange rate regime backed by control measures was operated. During this period, the foreign exchange market comprised the official and the parallel segments while authorization for foreign exchange disbursement rested on the Federal Ministry of Finance and the Central Bank of Nigeria (CBN). For instance, between 1960 and 1974, the Nigerian Pound was fixed at par with the British Pound. However in 1967-1974, the Nigerian Naira was pegged to the US Dollar. In 1974, due to the increase in oil revenues, the country started a policy of progressive valuation of the Naira. But in 1981 this policy was reversed to stem the deteriorating external sector position. The overvaluation of the Naira was recognized and a policy of gradual devaluation was adopted as a reaction to the outflow of foreign exchange and huge import demand (Obaseki, 1991).

In 1984, a major foreign exchange reform was carried out resulting in the decentralization of foreign exchange allocation. However this was abused by the operators and the policy was reversed the following year and the CBN was again saddled with the responsibility of directly allocating foreign exchange to end users. The Second-Tier Foreign Exchange Market (SFEM) was set up in 1986 when the determination of the naira exchange rate was left to market forces.

Following the significant improvement in the foreign exchange market resulting from the introduction of Retail DAS in 2002, the CBN further liberalized the foreign exchange market in 2006 with the introduction of the wholesale DAS (WDAS) to deepen the market and close the wide premium. Consequently, many parallel market operators were brought into the Bureau de Change (BDC) segment. The naira exchange rate stabilized and for the first time in two decades of foreign exchange management, the official and the parallel market rates converged in July 2006. At end-December, 2006, the premium marginally fell short of the internationally acceptable limit of 5.0 per cent by 0.08 per cent. With the moderation in the demand pressure at the foreign exchange market, in July 2009, Wholesale DAS (WDAS) was re-introduced and companies and government agencies were again permitted to sell foreign exchange directly to authorized dealers of their choice. Also, the CBN resumed the sale of foreign exchange to Classes "A" and "B" BDCs in April and August 2009 respectively, (CBN, 2009).

In terms of policy outcomes, the average exchange rate of the naira was N92.30 per US$ in 1999. It depreciated continuously to N133.50 per US$ in 2004. The depreciation was due mainly to the fall in foreign exchange inflow in the face of surging demand pressure. By 2006 however, the naira appreciated against the US$ to N128.70. The appreciation of the naira exchange rate and the moderation of the exchange rate volatility

were driven by the further liberalization of the market through the introduction of the Wholesale DAS, granting of approval to BDC operators to access the CBN foreign exchange window, among others.

Output in Nigeria has remained resilient over the years in spite of lingering infrastructure deficiencies. However the global financial crises of 2007/2008 took its toll on the growth rate of the economy but the economy bounced back from 6.0 per cent growth rate in 2008 to 7.9 per cent in 2010. Agriculture remained the major driver of growth accounting for about 60.0 per cent of GDP. Growth in the non-oil sector was therefore strong during this period.

Average inflation rate stood at 11.3 per cent during the period 1999-2010 indicating a significant decrease from the over 21.0 per cent level in the 1980-1990 period. It was however considered high relative to the global price trends. The annual inflation rate fluctuated between 18.9 per cent in 2001 and 15.10 per cent in 2008 averaging 11.9 and 12.1 per cent for 1999-2003 and 2004-2010, respectively. The rise in the rate of inflation in 2001 was due to the increase in the domestic pump-price of petroleum products. The domestic price level has been double digit but the single digit target inflation rate was achieved in 1999, 2000, 2006 and 2007 at 6.6, 6.9, 8.2, and 5.4 per cent, respectively. Both the cost push and the demand pull reasons contributed to the observed trends in inflation.

External reserve accumulation is determined exogenously by the international price of crude oil. With the exception of one or two years, the average price of Nigeria's reference crude, the Bonny Light 37° API, has been on steady increase since 1999. From $17.95 per barrel in 1999, it rose to more than $66.81 per barrel and the stock of external reserves rose from $5,424 million in 1999 to $10,267 million in 2001. In 2009 however, it declined marginally to $42,382 million, down from $52,823 million in 2008.

The MRR averaged 15 .0 per cent between 1999 and 2005 before it was replaced by the monetary policy rate (MPR) in December, 2006. At inception, the MPR was fixed at 10.0 per cent with a band of +/- 300 basis points, thus repositioning the CBN as a lender of last resort. The inter-bank call rate indicated a volatile movement throughout the review period. The irregular trend reflected the liquidity surfeit in the system. The increase in the inter-bank call rate in 2001 for example reflected the impact of demand pressure and tight monetary policy stance of the CBN while its decline in the following year resulted from the downward adjustment of the MPR. The banking sector consolidation of 2005 and the implementation of the new monetary policy framework generally moderated the volatility in the inter-bank rate in those years. The volatility in the interbank call rates reflects changes in some key market fundamentals which tend to impact directly on liquidity levels. These key fundamentals include: the Nigeria's National Petroleum Corporation (NNPC) fund withdrawals, FAAC disbursements, quantitative easing, "ways and means advances"", bank rescue, draw-down from excess crude account (ECA), AMCON operations, government borrowing, OMO operations, FGB Bond issues/maturities, NTB issues/maturities, discount window operations, changes in reserve requirements, capital flows and prudential regulations. The inter-bank and Open Buy Back (OBB) interest rates end to rise in eras of liquidity squeeze and fall during periods of excess liquidity. Thus experience shows that about the monthly FAAC revenue sharing, the inter-bank interest rates fall in response to excess liquidity in the system and the reverse is the case in the period of NNPC withdrawals. CBN (2015) asserts that of the identified factors that impact the money market rates, the monthly FAAC disbursement is the most dominant. It sets a monthly regular cycle of and pattern of liquidity in the money market thus explaining the monthly liquidity swings and the consequent spikes in rates of interest.

The CBN buys the oil revenue accruing to the Federation account in foreign currency and monetized same in Naira in favor of the Federation account. Monthly FAAC allocation takes place usually between 11th and 15th of the month. The monthly disbursement of the aggregate revenue (oil and non-oil) is done one month in arrears. Upon adoption of the FAAC Comunique, the Federal Government share is credited to its account with the CBN and is sterilized pending disbursement to the various Ministries, Departments and Agencies (MDAs) while the shares of the state and local governments are credited to their accounts with their deposit money banks. Consequently, the impact of the FAAC exercise is felt immediately in the banking system. Therefore the dominating sources of volatility in the short term rates are the withdrawal by the NNPC in preparation for FAAC and the and the disbursement to the various tiers of government by FAAC.

The fiscal operations of the government have essentially been characterized by continuing growth in expenditure followed by the boom burst pattern of fiscal management underpinned by the developments in the oil sector. Aggregate expenditure of the Federal government grew at an annual average of about 40.5 per cent between 1990 and 1999, while those of the sub-national governments increased at an average of about 31.9 per cent over the same period, (Idowu, 2010).

Total government expenditure grew at an annual average of about 19.9 per cent between 2000 and 2009. Similarly, the expenditure of the federal and sub-national governments grew at an annual rate of 15.5 and 35.6 per cent, respectively. The fiscal expansion and deficits of the three tiers of government in the 1990s constrained the effectiveness of monetary policy. Thus, huge fiscal operations at all levels and the inflationary financing of large budgetary deficits of the federal government vitiated monetary management particularly as

the CBN had to take up an annual average of 36.7 per cent of the federal government's fiscal deficits with the issuance of high powered money.

III. Literature Review

The concept of economic vulnerability is gaining prominence especially with regard to climate change. In general however, by a country's economic vulnerability is meant the multitude of inherent features with permanent or temporary character on which the domestic decision making cannot exercise control directly and in a decisive manner. It is about material catastrophes, extreme natural phenomena, climate change, and adverse conditions at the world level etc. Chambers and Ellis (1989) asserted that vulnerability has two sides: the internal and external sides. While the internal side captures the lack of means to cope with the consequences of external shocks without damaging loss, the external side deals with risks, shocks, stress to which an individual or group of individuals are subject to. In this regard, economic vulnerability also connotes potential dangers to an economy arising from the activities of another economy

Moser (1998) looked at a two step model of vulnerability but used the concepts of sensitivity and resilience to significantly change the focus and emphasis of Chamber's internal/external distinction. 'Analyzing vulnerability involves identifying not only the threat but also the resilience or responsiveness in exploiting opportunities and in resisting or recovering from the negative effects of a changing environment. The means of resistance are the assets and entitlements that individual households or communities can mobilize and manage in the face of hardship. Therefore vulnerability is also linked to asset ownership. The more assets a community has the less vulnerable it is and the greater the erosion of a community's assets the greater its insecurity''

Watts and Bohle (1993) views vulnerability from the perspective of space showing risk of exposure to hazards as the external side of vulnerability while capacity (risk of inadequate capacity to mobilize resources to deal with hazards) and potentially (the risk of severe consequences) from a more complex understanding of the internal side of vulnerability.

Clark et al (2000) define vulnerability 'as the risk of adverse outcomes to receptors or exposure units in face of relevant changes in climate, other environmental variables and social conditions''

The UNDP (2004) defines vulnerability as 'a human condition or process resulting from physical, social, economic and environmental factors which determine the likelihood and scale of change from the impact of a given hazard'.

Kamanou (2002) asserts that chronic exposure to risks is a crucially important source of vulnerability. Risks are varied in nature and can range from macroeconomic shocks, natural disaster, health hazards, personal insecurity and socially compulsive expenses. He added that macroeconomic shocks can be caused by changes in the external trading environment and or consequence of domestic policies.

2.2 Theoretical Literature

Literature on economic vulnerability is fast growing and the theory dates back to 1957 when Myrdal stated that economic development results in a circular causation process whereby the rich are awarded more favours and the efforts of those who lag behind are thwarted, Jhingan (2002). The author characterizes the effects of development into the backwash and the spread effects and contends that the backwash effects predominate in underdeveloped countries. He defines the backwash effects as "all relevant adverse changes…. of economic expansion in a locality……. caused outside that locality. The spread effects he defines as certain centrifugal "spread effects"' of expansionary momentum from the centers of economic expansion to other regions. Myrdal (1957) explains that the main cause of regional inequalities, has been the strong backwash effects and the weak spread effects in underdeveloped countries.

The extension of the Keynesian theory to open economies led to the Keynesian Cross which
 is the theoretical framework on which this study is based. The Keynesian theory states that in an open economy that is integrated with the rest of the world through regular trade in goods and services and in financial assets, newly produced goods and services can be exercised by foreigners such that export demand is added to domestic demand. Secondly, some of the demand exercised by domestic consumers, domestic investors and domestic government can now be channeled to goods and services produced abroad. Thus we have Y = C+I*+G+X-M. Where we characterize X-M as NX (net export) we have C+I*+G+NX. Thus an expansionary monetary policy in the US for example would reduce the rate of interest in that country and investors would move their funds to destinations with relatively higher interest rates. By so doing, monetary policy shocks in the US are transmitted to other countries. Contrarily, raising the Federal Funds Rate in the US would produce an opposite result in other countries. Where Y = Domestic output, C = private consumption, I = Investment Consumption, G = Government purchases of goods and services

Furthermore, Begg et al (2000) acknowledges that every country requires both internal and external balance. In the goods market, domestic output equals private consumption, investment

consumption, government consumption and net export. If aggregate demand for domestic output equals the level of potential output, firms produce the full employment output level and in the labour market, the demand is as much employment as workers wish to supply. The authors further assert that in the presence of sluggish wage and price adjustment, a lower level of aggregate demand would lead firms to cut back output and retrench workers. Only when wages and prices have fallen sufficiently to restore aggregate demand to its full employment level would internal balance be restored. In the same vein, in the foreign exchange market, the capital account of the Balance of Payments (BOP) must also be in balance at this point. The combination of the internal and external balance is the long-run equilibrium of the economy. Wage and price have restored output to its potential level and employment to the full employment level. When the external balance is in place, not only is the current account in balance but there is no long term pressure to alter the stock of foreign exchange reserves, nor any permanent flow on the capital account. The authors further identify several shocks that are capable of moving an economy from either external or internal balance. These include foreign slump or boom, higher or lower real exchange rate, in addition to some domestic shocks: more or less saving, and tighter or easier monetary and fiscal policy.

Consequently, the a priori expectations are as follows:

US FFR↑→ GDP_N↓, NEEXCH↓ (appreciation) INF_N↑, INT_N↓, M2↑

US CPI↑→ GDP_N↑, NEEXCH↓ (appreciation), INF_N↓, INT_N↓, M2↑

US INDPROD↑→ GDP_N↑, NEEXCH↑(depreciation), INF_N↑, INT_N↑, M2↓

WTI_P↑→ GDP_N↑, $NEEXCH_N$↑(depreciation), INF_N↑, INT_N↑, M2↑

Where GDP_N is Nigeria's Gross Domestic Product, $NEEXCH_N$ is Nigeria's Nominal Effective Exchange Rate, INFN is Inflation in Nigeria, ITBCRN is Inter-bank call rate in Nigeria, and M2 is Nigeria's Broad Money Supply, USCPI is the United States Consumer Price Index, USINDPRO is the United States Industrial Output and WTI_P is the West Texas Intermediate Price and USFFR is the United States Federal Funds Rate.

2.3 **Empirical Literature**

Many empirical studies, such as Sims (1992), Grilli and Roubini (1995), Kim and Roubini (2000), Neril and Novili, (2010), Li and Liang (2016), Mirkov (2014), Precious and Palesa (2014), Barakchian (2013), Bowman, et al.(2015), Lee and Zhu (2016) have investigated the international monetary policy transmission mechanism by using VAR models of developed and developing economies. Kim (2001), for example, suggested that U.S. monetary policy shocks on the output of the developed countries had a positive effect. Mackowiak (2007) showed that monetary policy shocks of the developed countries had a negative output effect for emerging economies. He used the structural VAR approach to study the effects of external shock on eight emerging economies. He found that the U.S. monetary shock affects the real output and price levels in emerging economies even more strongly than the real output and price levels in the U.S. The case of seven East Asian economies, namely Indonesia, Korea, Malaysia, Philippines, Singapore, Taiwan and Thailand, has been analyzed by Fung, (2002) who obtained similar outcome. Note that the United States variables were incorporated as exogenous foreign variables in the SVAR model.

Recently Barakchian, (2015) showed that the responses of the Canadian macro variables to the US monetary policy shock are very similar to the responses of the US macro variables to the same shock. He also showed that interest rate-pass-through is the major mechanism by which US monetary policy shocks are transmitted into the Canadian economy.

Subsequent empirical studies on the impact of monetary policy on asset prices have mostly involved VARs with identification imposed as restrictions mapping the reduced form shocks to structural shocks. Cushman and Zha (1997) constructed a two-country SVAR model assuming block exogeneity for the domestic variables of a small open economy (Canada) relative to the external (U.S.) variables. Their specification resolves some standard empirical puzzles, like the domestic currency depreciation following a domestic contractionary monetary policy and the 'price puzzle', but the authors found short-run deviations from uncovered interest rate parity. Kim and Roubini (2000) have used a non-recursive VAR that allows monetary policy to respond contemporaneously to exchange rate shocks and resolved partially the 'delayed overshooting' effect and the 'conditional forward premium puzzle'. Furthermore, the authors provide evidence that, in response to an unexpected increase in the U.S. monetary policy rate, the short-term interest rates of non-U.S. G7 countries increase and their currencies relative to the dollar depreciate on impact.

Faust and Rogers (2003) assessed the robustness of conclusions drawn from SVAR models relative to changes in the identifying assumptions and found that the 'delayed overshooting' result is sensitive to the assumptions adopted. In contrast, they provide evidence that deviations from uncovered interest rate parity are robust to various assumptions and, moreover, that the estimates of the share of exchange rate variance due to monetary policy shocks can take quite large values.

Furthermore, Sato *et al.*, (2009) took the same econometric framework to check if external shocks generated from the United States economy played an important role in influencing real variable movements in East Asia economies from the period of 1978 to 2007. Similar works have been also performed by Zhang and McAleer, (2009) and Gosse and Guillaumin, (2013). In addition, Mehmet and Yildirim, (2013) did the same research for the six fast growing emerging economies namely Brazil, Russia, India, China, South Africa and Turkey denoted by (BRICS-T). The overall results are quite similar, world output shocks are not a dominant source of fluctuations in those economies. In addition, Mustafa and Cengiz, (2014) have used a structural VAR model with the block exogeneity restriction to identify and analyze the impacts of some domestic and external shocks and in particular, the impacts of monetary policy shocks on macroeconomic variables in Turkey. All shocks are found to have significant effects on main economic variables. Positive interest rate shocks appreciate the domestic currency and decrease the inflation whereas positive risk premium shocks cause depreciation and an increase in inflation. Both of these shocks also cause a decrease in the domestic activity. Being an open and internationally integrated economy, Turkey is significantly affected by global shocks. Ganev *et al.*, (2002) explored the impacts of monetary shocks in ten Central and Eastern European (CEE) countries and found no evidence that suggests those changes in interest rates affect output, but found some indication that changes in the exchange rate do.

IV. Methodology

4.1 Analytical Framework

The rise in the prominence of monetary policy in the advanced economies since the 1990s has seen an equally synchronized rise in the use of the VAR technique developed by Sims (1980) to model monetary policy frameworks. Over the years, the development of structural VAR (SVAR) methodology has further facilitated the handling of various economic issues and problems concerning the identification of contemporaneous and dynamic relationships between macroeconomic variables and the policy instruments Raghavan and Silvapulle (2007). In this section, we have provided a brief description of the SVAR methodology.

A vector auto regression is a system of equations with one equation for each variable in the system. Generally, the variables in the system are selected based on economic theory and the knowledge of the economy in question. Given the variables selected, the estimation of the autoregressive system consists of a set of ordinary least squares regressions with the current value of each of the included variables being regressed on the lagged values of all the variables in the system. In SVAR models, current values of variables do not appear on the right hand side of any equation in the system. Thus, in vector auto regression all current variables are treated as endogenous while all lagged variables are predetermined variables. The number of lagged values of each variable on the right-hand side of each equation must also be determined. This study is based on the Sims model (1980, 1982, 1986) and the general model of SVAR put forward by Giannini (1992), Amisano and Giannini (1997) and as presented in Raghavan and Silvapulle (2007).

A SVAR model makes the identification of structural shocks possible while letting the different variables play off of each other. Moreover, SVAR relies on moving average representation and studies the system dynamics in terms of impulse responses triggered by each independent structural shock, Stock and Watson, (2001).Therefore, we seek to examine the effects of external shocks through impulse response and variance decomposition analyses based on SVAR using quarterly data for Nigeria from 2003: q1 to 2016: q 4.

The data used in the study were generated from the Central Bank of Nigeria's Annual Report and Financial Statements, the Central Bank of Nigeria's Statistical Bulletin, the International Monetary Fund's International Financial Statistics, and the Organisation of Petroleum Exporting Countries' Statistical Bulletin several issues. Essentially, the use of SVAR is justified under this condition because according to Gujarati and Sangeetha (2007):

i. Of the simplicity of the methodology typified by the fact that one does not need to worry about which variable is endogenous and which is exogenous

iii. The forecasts obtained from SVAR are in many cases better than those obtained from the more complicated simultaneous-equation models.

iv. It enables the bringing together of multiple time-series analysis and economic theory to determine the dynamic response of variables to various shocks that take place in the economy.

v. It is suited for situations of bilateral causality between the variables of interest.

In line with similar studies on the evaluation of monetary policy; Watson, (2003); Pandit, Mittal, Roy and Ghosh, (2006); Robinson and Robinson, (1997), Raghavan and Silverpulle, (2007), we consider a system of simultaneous equations implied in vector form as:

$By_t = \gamma_0 + A(L)y_{t-1} + ME_t$,…………………………………………………………………….3.1

Where y_t is a vector of endogenous variables, γ_0 is the fixed constant, y_{t-1} is a vector of their lagged values, E_t is a vector of random error of the disturbance terms for every variable which captures any exogenous factors in the model, B is the square matrix of dimension n×n, where n is the number of variables, and contains the structural parameters of the contemporaneous endogenous variables, A(L) is a matrix polynomial in the lag operator L of length p, and M is the square n×n matrix, which contains the contemporaneous response of the variables to the shocks (disturbances).

The first stage of structural VAR analysis is the estimation of the reduced form. As the coefficients in the matrices are unknown and the variables have temporary effects on each other, the model in this form cannot be completely identified. It is therefore appropriate to transform it into a reduced-form model by multiplying both sides of the equation by the inverse matrices of B, which brings about the standard VAR representation as:

$Y_t = \alpha_0 + D(L)y_{t-1} + e_t$ ……………………………………………………………..3.2

where, $\alpha_0 = B^{-1}\gamma_0$, $D(L) = B^{-1}A(L)$ and $e_t = B^{-1}M E_t$

The SVAR approach assumes that the structural innovations E_t are orthogonal, implying that the structural disturbances are uncorrelated and that the variance-covariance matrix $\sum$ is constant and diagonal.

Hence the error terms e_t are linear combinations of the orthogonalised shocks (E_t), such that each individual error term is serially uncorrelated with a zero mean and a constant variance. As stated in (Bernanke, 1986), the structural shocks are primitive exogenous forces that do not have common causes and hence can be treated as uncorrelated. The parameters of the SVAR model are estimated in two stages. The first stage is to obtain the reduced form equations associated with equation (3.2)

The second stage consists of identifying the contemporaneous matrix A_o and the variance-covariance matrix $\sum$ which maximizes the likelihood function conditional on the parameter estimates of the VAR obtained in the first stage.

In the SVAR system, A_o has N^2 parameters, while B has N(N+1)/2 distinct values. This leads to an identification problem as the structural model requires N(N-I)/2 number of restrictions to be imposed on the system for it to attain exact identification conditions and the system is under-identified otherwise (Raghavan and Silvapulle, 2007). Further, the residuals from the reduced VAR are transformed into a system of structural equations by imposing restrictions based on prior theories and empirical findings about monetary policy reaction functions rather than based on the commonly used Cholesky's decomposition method. This method of orthogonolizing the reduced form residuals to recover the underlying shocks is advocated by Bernanke (1986), Sims (1986) and Blanchard and Watson (1986)

Therefore without imposing a number of restrictions, the parameters in the SVAR model cannot be identified. To identify a monetary shock in Nigeria, the long and short-run parameter restrictions are applied. Identification of shocks in the system requires imposing at least N(N-1)/2 sufficient restrictions. In the short-run version of the SVAR model, restrictions are required for specific identification. Restrictions can be imposed on the structure of the vector of error terms, (e_t), on the basis of economic theory. Each equation must hold an independent structural disturbance term.

The advantage of the short-run SVAR model is that the impulse response functions can be applied to check whether the shocks have an effect on each endogenous variable as economic theory expects. In other words, the difference of this method from the Cholesky decomposition is that the Impulse Response Function and the Forecast Error Variance Decomposition effects from these short-run restrictions can present direct economic meaning from the analysis (Sims, 1980; Hamilton, 1994; Enders, (1995); and (Amisano and Giannini, (1997)

In VAR analysis the only source of variation of y_t variables is random disturbances that, in the reduced form, are indicated by a vector of white noise e_t, usually called a vector of innovations (Amisano and Giannini, 1997) and impulses or innovations or shocks (Gujarati, 2003). The SVAR framework is generally focused on how the innovations to one endogenous variable affect other endogenous variables. Also structural VAR analysis is focused on the direction of instant correlation between innovation variables. Having short-run or long-run restrictions in the model only depends on whether shocks are temporary or permanent.

4.2 . Choice of Variables and Preliminary Data Analysis
This section describes the international and domestic variables used to represent the Nigerian monetary policy framework. The choice of variables is similar to those used by

Cushman and Zha (1997) and Fung (2002) and are summarised in Table 1.

Table 1. Variables included in the Nigerian SVAR system

Variable	Definition	Abbreviation
Commodity Prices	World oil Price (West Texas Intermediate)	WTI
US Output Price Interest rate	 US Industrial Production Index, logs Consumer Price Index (SA), Logs Federal Funds rate, (percent)	 USINDPRO USCPI USFFR
Nigeria Outut Prices Money Interest rate Exchange rate	 Gross Domestic Product , (Logs) Inflation Rate (percent) Monetary Aggregate M_2 (Logs) Inter-bank Call Rate, (percent) Nominal Effective Exchange Rate, N/US$	 $LGDP_N$ INF_N LM_{2N} ITBCRN $NEECH_N$

Sources: International Financial Statistics and CBN Statistical Bulletin (2016)

Of the nine variables used in the model, four variables represent the foreign block and they are the world reference crude oil price (WTI), the US Industrial production index (USINDPRO), the US consumer price Index (USCPI) and the US Federal Funds Rate (USFFR). As discussed before, in a VAR model of an open economy, the inclusion of foreign variables is essential for correct specification, improved identification of contemporaneous relationships and for capturing underlying impulse responses of variables to various shocks. WTI is included to account for inflation expectations, mainly to capture the non-policy induced changes in inflationary pressure to which the central bank may react when setting monetary policy (see Sims (1992) and Cushman and Zha (1997)). It can also represent the terms of trade effect in small open economies. The WTI is the world reference crude oil from which the rest derive their prices. It is employed here in place of world commodity price index to reflect Nigeria's dependence on oil export and revenue for fiscal operations.

The three US variables are included to represent the open economy component of the model, and were chosen as proxy for foreign variables in the Nigerian SVAR system, and to capture the close link between the US and Nigerian economies. The US is Nigeria's largest trading partner, accounting for almost 20 per cent of total trade in 2016. Oil, Nigeria's greatest export is denominated in the US Dollar and this further strengthens the link between the two economies. Moreover the US accounts for the highest amount of remittances to Nigeria. It is also fairly common in the monetary literature of small open economies to use these US variables as proxy for foreign variables (see for example Cushman and Zha (1997), Dungey and Pagan (2000), Fung (2002), and Tang (2006)).

The remaining five variables describe the Nigerian domestic economy. The Nigerian Gross Domestic Product ($LGDP_N$) and the Inflation rate (INF_N) are taken as the target variables of monetary policy and are known as non-policy variables. In the literature, it is assumed that both the target variables of output and prices are also the non-policy variables as they do not react instantaneously to changes in the policy variables (see Bernanke and Mihov 1995).

The policy block is represented by the M_2 monetary aggregate (LM_{2N}) and the Inter-bank Call Rate (ITBCRN). The exchange rate ($NEECH_N$) represents the information market variable. As stated in Mehrotra (2005), this trade-weighted exchange rate is also believed to capture more comprehensively the movements in the exchange rate that may have inflationary consequences in the Nigerian economy. It is also common in the monetary business cycle literature to include these five domestic variables for identifying the monetary policy shocks in small open economies.

The SVAR model uses quarterly data from first quarter 2003 up to fourth quarter 2016. The sample period covers only the democratic governance and the indirect monetary management era in Nigeria. The variables are seasonally adjusted and are in logarithm except for the interest and inflation rates which are expressed in percentages.

The time series properties, including the non-stationarity and stationarity of the variables were examined by applying the Augmented Dickey Fuller and the Philips-Perron unit root tests. The results indicated that all the variables under consideration are integrated of order one. The Johansen's co-integration test also provides evidence of long run relationships among the nine variables. However, since the objective of VAR analysis in this study is to assess the interrelationships between the variables rather the parameter estimates, we concur that the VAR in level remains an appropriate measure to identify the effects of monetary shocks. It is common in the monetary literature to estimate the unrestricted VAR model at levels (for example see (Sims 1992), (Bernanke and Mihov 1996), (Cushman and Zha 1997).

Roots of Characteristic Polynomial
Endogenous variables: INFN__ ITBCRN LGDPN LM2...
Exogenous variables: C
Lag specification: 1 2
Date: 02/23/19   Time: 20:03

Root	Modulus
0.994381 - 0.055647i	0.995937
0.994381 + 0.055647i	0.995937
0.863696 - 0.211792i	0.889284
0.863696 + 0.211792i	0.889284
0.744990 - 0.430523i	0.860442
0.744990 + 0.430523i	0.860442
0.849028	0.849028
0.515450 - 0.594243i	0.786647
0.515450 + 0.594243i	0.786647
0.293551 - 0.583880i	0.653520
0.293551 + 0.583880i	0.653520
-0.045583 - 0.546218i	0.548117
-0.045583 + 0.546218i	0.548117
-0.488885 - 0.103799i	0.499783
-0.488885 + 0.103799i	0.499783
0.487215	0.487215
-0.151090 - 0.083129i	0.172449
-0.151090 + 0.083129i	0.172449

No root lies outside the unit circle.
VAR satisfies the stability condition.

Inverse Roots of AR Characteristic Polynomial
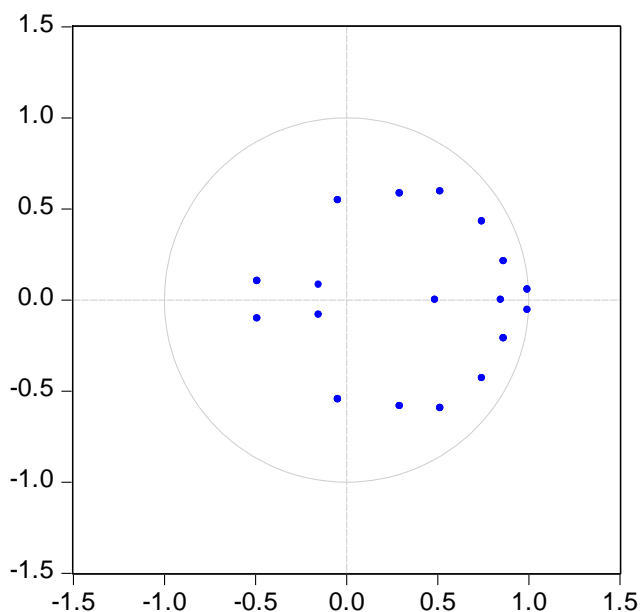
VAR Lag Order Selection Criteria
Endogenous variables: INFN__ ITBCRN LGDPN LM2N NEECH USCPI USFFR USINDPRO WTI_P
Exogenous variables: C
Date: 02/23/19   Time: 20:10
Sample: 1 56
Included observations: 52

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-1045.997	NA	3388746.	40.57682	40.91454	40.70629
1	-603.5101	714.7871	3.242085	26.67347	30.05062*	27.96819
2	-513.5267	114.2097	3.021292	26.32795	32.74454	28.78792
3	-398.6392	106.0500	1.872246	25.02458	34.48061	28.64980
4	-204.9563	111.7402*	0.195404*	20.69063*	33.18609	25.48109*

* indicates lag order selected by the criterion
LR: sequential modified LR test statistic (each test at 5% level)
FPE: Final prediction error
AIC: Akaike information criterion
SC: Schwarz information criterion
HQ: Hannan-Quinn information criterion

V. Model Structure and Identification Issues

In this section, the identification of the Nigerian SVAR model is established. A common approach in the literature is to apply identification restrictions that are consistent with economic theory and prior empirical research findings (see Buckle et al (2007), Christiano et al (2005), Dungey and Fry (2003) and Dungey and Pagan (2000)). In this paper, to establish the identification conditions, the results of Nigerian VAR studies and those of the SVAR studies of advanced small open economies are used to guide us in obtaining the appropriate restrictions to be imposed on the contemporaneous and the lagged structure of the Nigerian SVAR model.

5.1 Block Exogeneity Restrictions

It is well-known that the shocks to small open economies have very little impact on major foreign countries and therefore it is proper to treat the foreign variables as exogenous to domestic economic variables. To capture this phenomenon, the Nigerian SVAR system is divided into foreign and domestic blocks, Raghavan and Silvapulle (2007). To describe the reduced VAR system for a small open economy first, the set of variables Yt is divided into two blocks as follows:

$$Y_t = (Y_{1,t} \quad , \quad Y_{2,t}) \tag{9}$$

$$Y_{1,t} = (USCPI_t, \ USFFR_t, USINDPRO_t, \ WTI\_P_t) \tag{10}$$
$$Y_{2t} = (LGDP_{N,t}, \ INF_{N,t}, \ LM2_{N,t}, \ ITBCR_{N,t}, \ REECH_{N,t}) \tag{11}$$

where $Y1,t$ represents the foreign block, while $Y2,t$ represents the domestic block. The VAR in (3.2) can now be represented as follows:

$$Y_t = \begin{bmatrix} Y_{1,t} \\ \vdots \\ Y_{2,t} \end{bmatrix} \qquad B(L) = \begin{bmatrix} B11(L) & \cdots & B12(L) \\ \vdots & \ddots & \vdots \\ B21(L) & \cdots & B22(L) \end{bmatrix} \qquad v_t = \begin{bmatrix} v_{1,t} \\ \vdots \\ v_{2,t} \end{bmatrix}$$

The two blocks, B11 (L) and B12 (L) contain the coefficients that correspond to the foreign economy while B21(L) and B22(L) contain the coefficients that correspond to the domestic economy. Similarly, the Ao matrix in equation (1) can be decomposed as follows:

$$A_0 = \begin{bmatrix} A_{0,11} & \cdots & A_{0,12} \\ \vdots & \ddots & \vdots \\ A_{0,21} & \cdots & A_{0,22} \end{bmatrix}$$

It is assumed that the foreign variables in the Nigerian VAR system are predetermined and the domestic variables do not Granger cause the foreign variables. Hence, a block exogeneity is imposed by excluding all domestic variables from the foreign block of equations both contemporaneously and in the lag structure of the

reduced form VAR by imposing the following restrictions, $A_o,12 = 0$ and $B12(L) = 0$ respectively. In the context of a small open economy, the block exogeneity restrictions have clear benefits as it allows for a larger set of international variables to be included into the model, while reducing the number of parameters to be estimated.

5.2 Restrictions on Contemporaneous and Lagged Dynamics
In addition to foreign block exogeneity restrictions imposed on the model, restrictions on the contemporaneous and lagged matrices are also imposed. The variables entering into each equation of the SVAR system in (1) are summarized in Tables 2 and 3. Table 2 highlights the restrictions on the contemporaneous relationships among the variables, while Table 3 highlights the restrictions on the lag dynamics.

Table 5. 2. Restrictions on the Contemporaneous Structure – A_o

Dependent Variables	Explanatory Variables								
	INFN	ITBCRN	$LGDP_N$	$LM2_N$	$NEECH_N$	USCPI	USFFR	USINDPRO	WTIP
INFN	1	0	0	0	0	0	0	0	0
$ITBCR_N$	NA	1	NA	0	0	0	0	0	0
$LGDP_N$	NA	0	1	0	0	0	0	0	0
$LM2_N$	NA	NA	NA	1	0	0	NA	0	NA
$NEECH_N$	NA	NA	NA	NA	1	NA	NA	NA	NA
USCPI	0	0	0	0	0	1	0	NA	0
USFFR	0	0	0	0	0	NA	1	NA	0
USINDPRO	0	0	0	0	0	0	0	1	0
WTI_P	0	0	0	0	0	0	0	0	1

Our assumption is based on "successive relationship", where the relationship between the variables are determined in a block recursive way. The use of identifying restrictions on the contemporaneous matrix is reasonably common in the monetary literature and in this case, the over-identifying restrictions are specified. The restrictions on the lag matrices however are less common and so far in the existing Nigerian monetary literature, no such restrictions have been imposed.

Table 5.3. Restrictions on the Lag Structure – B(L)

Dependent Variables	Explanatory Variables								
	INFN	ITBCRN	LGDPN	LM2N	NEECH	USCPI	USFFR	USINDP	wtip
INFN	Na	na	Na	na	Na	0	0	na	Na
ITBCRN	Na	na	Na	na	Na	0	0	0	Na
LGDPN	Na	na	Na	na	Na	0	0	0	Na
LM2N	na	na	Na	na	Na	0	Na	0	Na
NEECH	Na	na	Na	Na	Na	Na	Na	na	Na
USCPI	0	0	0	0	0	Na	Na	na	Na
USFFR	0	0	0	0	0	Na	Na	na	Na
USINDPRO	0	0	0	0	0	Na	Na	na	Na
WTI_P	0	0	0	0	0	0	0	0	Na

5.2.1 Identification of the Foreign Sector
The foreign block constitutes USCPI, USFFR, USINDPRO and WTI_P and is characterized by the block exogeneity assumption described in section 5.1. The USCPI is assumed to be completely endogenous to all the other foreign variables in the model and affected only by its own lags. As shown in Table 2, the three US variables are identified recursively, with the assumption that the US output is contemporaneously exogenous to all other variables in the model, while the price level is assumed to be contemporaneously affected only by demand driven fluctuations in output.

The specification of the Federal Reserve's monetary policy is assumed to follow the "Taylor Rule" where its primary concern is to maintain output growth and price stability (see Taylor (2000) and McCallum (1999)). Referring to Table 3, apart from the block exogeneity restrictions, no other restrictions on the lag structures of the US variables are imposed, thus allowing for feedback among the three variables and with the reference crude price.

5.2.2 Identification of the Domestic Sector
The domestic block is divided into three sub-blocks. The first sub-block, known as the non-policy block is represented by domestic output and prices. These two variables are assumed to be contemporaneously unaffected by other domestic variables in the system. In the domestic output equation, LGDPN is assumed to be contemporaneously exogenous to all variables in the SVAR system. The Nigerian output however is assumed to depend on the lagged WTI_P, US output and all domestic variables. The US output is used as proxy for overseas

economic conditions, while the world reference crude price represents foreign price pressure and trade effects, and finally the domestic variables to represent the domestic economic and policy conditions. Similar to US price equation, the Nigerian price is also assumed to be contemporaneously affected only by the Nigerian output activities. The commodity price and all the domestic variables are included in the lags of the price equation.

The second sub-block, known as the policy block is represented by the central bank's policy instruments of money and interest rates. The money demand equation LM2N, is assumed to be contemporaneously affected by the domestic output and price levels. Though in several studies in the monetary literature, interest rates are assumed to contemporaneously affect the money (see Cushman and Zha (1997) and Leeper and Zha (1999)), in this paper, we assume interest rates affect money only in the lag structure. Tang (2006) has also made a similar assumption when modeling the Malaysian monetary policy. The commodity prices and all the domestic variables are included in the lags of the money demand equation.

The monetary policy reaction function is represented by the interest rate (MPRN) equation.

The contemporaneous identification includes the crude oil prices, foreign interest rates proxied by the US Federal Funds Rate (USFFR), domestic output, prices and money. The contemporaneous inclusion of output and prices gives the reaction function a similar form to that of the Taylor rule identification, while the commodity price represents external inflationary pressure in the economy and the monetary aggregate as part of the transmission process.

From the results of the other studies, we found that it was necessary to include the Federal Funds rate for correct identification as a foreign monetary policy influence (see, for example Fung (2002) and Tang (2006)). The commodity prices, Federal funds rate and all the domestic variables are included in the lags of interest rate equation.

Finally, the third block is the information market variable. The exchange rate equation is seen as an information market variable that reacts quickly to all relevant economic disturbances and hence is contemporaneously affected by all the variables in the SVAR system. The lag structure is left unrestricted. The exchange rate, while contemporaneously being affected by all other variables in the system, is assumed not to have any instantaneous effects on these variables (see Eichenbaum and Evans (1995), Christiano, Eichenbaum and Evans (1998) and Dungey and Pagan (2000). Through the exchange rate equations, the foreign variables are allowed to indirectly influence the domestic variables.

VI. Empirical Results
The parameters of the SVAR are estimated in two stages as outlined in Section 5.2. In the first stage, the restrictions given in Table 3 were imposed and the OLS residuals of reduced-form VAR are obtained. As for the number of lags in the model, the standard information criteria of Akaike (AIC) and Hannan-Quinn (HQC) chose an optimal lag length of two, while Schwarz (SC) suggested lag length 1

However, the lag length identified by the information criteria is found to be inadequate to capture the underlying dynamics of the system as it is not sufficiently long to eliminate the autocorrelations present in the residual series. Subsequently, the Portmanteau and LM-test for residual autocorrelation were carried out, and this test identified the lag length of four. Hence a common VAR (4) is used in this analysis. In the second stage, the contemporaneous matrix $A0$ defined in Section 3 is identified using the sets of restrictions given in Table 2.

If there are no restrictions imposed on B(L) coefficients, then an efficient estimation of the reduced form VAR can be achieved by the separate applications of OLS to each equation. The single equation estimation of the VAR in (5) however, yields consistent but asymptotically inefficient parameter estimates. The loss in efficiency arises from the zero restrictions imposed on the lag structure.

6.1 Impulse Response Function
The impulse response function examines the dynamic responses of the variables to various shocks within the SVAR system.

6.1.1 Impulse Responses of Nigerian Inflation Rate to Foreign Shocks
A positive shock to the US consumer price index (USCPI) affects the Nigerian inflation rate after about half the quarter of the policy action. When the inflation rate eventually responds it falls sluggishly up to the fourth quarter at what point the decline accelerates and attains the lowest point in the sixth quarter. It then begins to rise in the seventh through to the tenth quarter.

This agrees with the apriori expectation as a rise in US CPI brings about a fall in Nigeria's import from the United States. Nigeria's imports from the United States in last decade is composed more of luxury consumer goods and these are more price elastic. As we noted earlier, the foreign content domestic production and consumption is very high thus making the economy very vulnerable to foreign

shocks. There have been shifts in the composition of non-oil imports in the last decade in favour of consumer goods indicating a decline in domestic production and an increase in dependence. CBN (2010)

A positive shock to the US consumer price index tends to cause a sharp fall in Nigeria's Inter-bank call rate in the second quarter of policy action and a sharp rise that more than compensates for the decline. It begins a sluggish decline in the third quarter which intensifies from the fifth quarter down to the eight before it begins to rise through the ninth to the tenth quarter.

This also agrees with a priori expectation. However the inter-bank call rate has been found to be very volatile in its response to some key fundamentals in the domestic economy. The influence of the US CPI on the Inter-bank call rate could boost or restrain the call rate depending on the sign of the impact. High inflation in the US could increase the inflation tax and so drive dollars out of America to foreign economies including Nigeria. These new investments would increase the money supply and so lower interest rates. Kim and Roubini (2000) have used a non-recursive VAR that allows monetary policy to respond contemporaneously to exchange rate shocks and provide evidence that, in response to an unexpected increase in the U.S. monetary policy rate, the short-term interest rates of non-U.S. G7 countries increase.

Nigeria's GDP would tend to rise as a result of an unanticipated increase in the US CPI. This also agrees with the a priori expectation. As dollars leave the high inflation in the American economy for Nigeria, the broad money supply rises leading to a fall in the rate of interest, a rise in investment and aggregate demand and the gross domestic product.

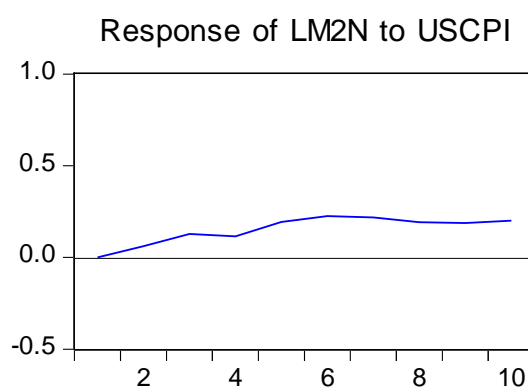# Response to Cholesky One S.D. Innovations
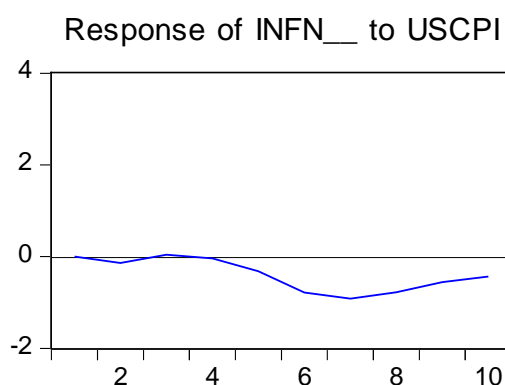
Response of INFN__ to USCPI

Response to Cholesky One S.D. Innovations

Response of ITBCRN to USCPI

Response to Cholesky One S.D. Innovations

Response of LGDPN to USCPI
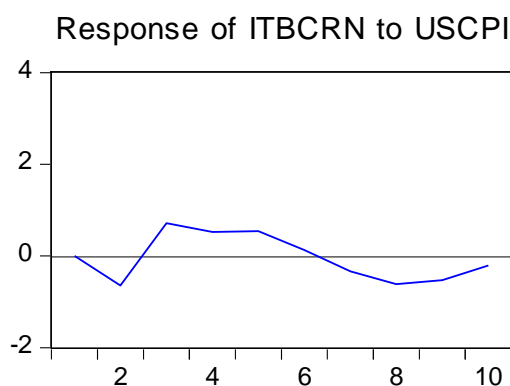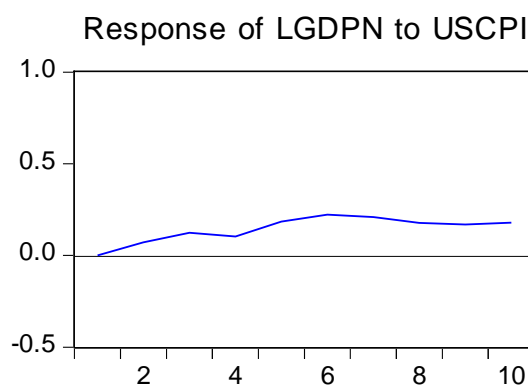
The broad money supply M2 rises from the middle of the first quarter of an unanticipated rise in the US CPI declines moderately in the third quarter before rising again in the fifth and remaining stable from the seventh through the tenth quarter. This is in accord with apriori expectations as has been reported above that a rise in US inflation would drive the dollar to foreign economies increasing the money supply.

Response to Cholesky One S.D. Innovations

Response of LM2N to USCPI

Response to Cholesky One S.D. Innovations

Response of NEECH to USCPI
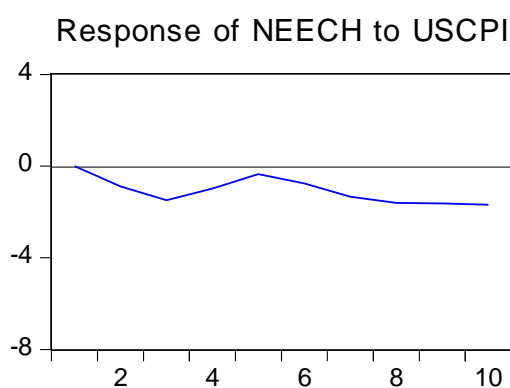
The Nominal Effective Exchange Rate in Nigeria begins to respond to an increase in US CPI in the middle of the first quarter of policy action by falling sharply in the first through the third quarter and rising also sharply through to the fifth quarter. It then declines more intensively from the fifth through to the eighth quarter before it smoothens out to the tenth. An increase in the nominal effective exchange rate indicates a depreciation of the Naira. But a rise in the US CPI appreciates the Naira as dollars leave the US

for Nigeria and other foreign economies where the inflation rate is relatively stable or lower thereby offering higher real interest rates. This would tend to bring about a supply pressure on the naira exchange rate and the naira would appreciate. The fluctuation in the nominal effective exchange rate in the third through to the eighth quarter may be as a result of Central Bank interventions in the foreign exchange market.

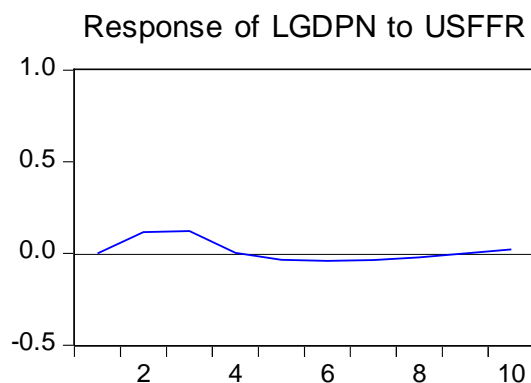# Response to Cholesky One S.D. Innovations

Response of INFN__ to USFFR

Response to Cholesky One S.D. Innovations

Response of ITBCRN to USFFR
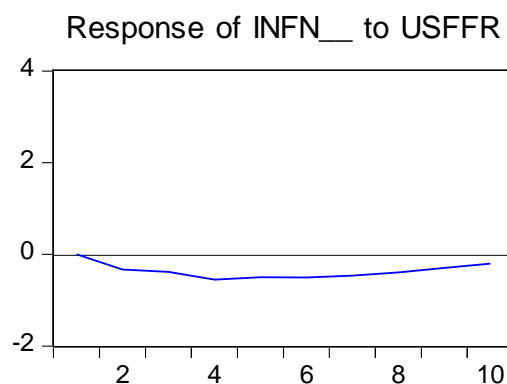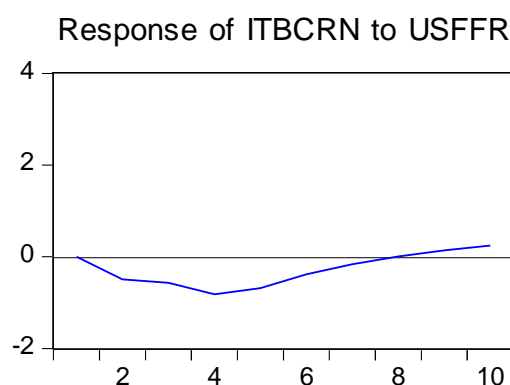
In response to an unexpected increase in the United States Federal Funds Rate the inflation rate in Nigeria falls with effect from the middle of the first quarter of the policy action. It however begins to rise sluggishly from the sixth through to the tenth quarter. An increase in the Federal Funds Rate would trigger capital flight from Nigeria to the US and this would tend to reduce money supply in Nigeria and hence inflation.

An increase in the Federal Funds Rate triggers a decline in the Inter-Bank Call Rate in Nigeria from the middle of the first quarter of policy action till the fourth quarter. Thereafter, it begins to rise through to the tenth quarter. This disagrees with the a priori expectation as the rise in the Funds Rate in the US would tend to cause capital flight from Nigeria which is expected to reduce money supply in Nigeria and hence raise the rate of interest. But according to Keynesian postulation, money held for speculative purposes is determined by income and the rate of interest. Capital flight from Nigeria would bring about demand pressure on the Naira exchange rate. The domestic currency would depreciate and thus moderate temporarily the effect of the capital flight on the inter-bank call rate.
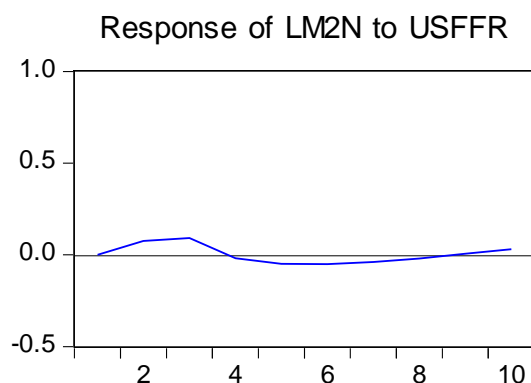
Response to Cholesky One S.D. Innovations

Response of LGDPN to USFFR

In response to the positive shock to the US Federal Funds Rate, there would occur capital flight from Nigeria which would cause domestic currency depreciation. Imports would become more expensive in Nigeria thereby encouraging domestic production leading to an increase in domestic output from the first quarter to the third. Between the second and the fourth quarters, domestic output stabilizes but falls in the fourth quarter through to the tenth. In the face of rigidities in domestic production, output fall in the fourth quarter.

Response to Cholesky One S.D. Innovations

Response of LM2N to USFFR

Response to Cholesky One S.D. Innovations

Response of NEECH to USFFR
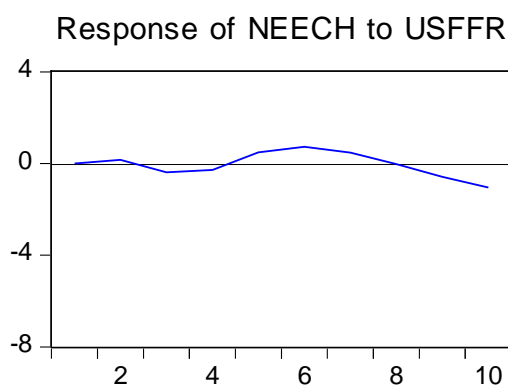
In response to the increase in the US Federal Funds Rate, Nigeria's broad money supply rises starting from the second half of the first quarter of policy action. This disagrees with the a priori expectation as the impact is expected to reduce money supply. As the Federal Funds Rate rises while

interest rates in Nigeria remain constant, capital flight in Nigeria would begin and money supply would tend to fall. So it is a puzzle that money supply rises instead.

The effect on the Nominal Effective Exchange Rate in Nigeria of a rise in the Federal Funds Rate is delayed till the end of the second quarter of policy action. The exchange rate then falls but begins to rise in the fourth quarter. It peeks in the sixth quarter and falls through to the tenth quarter. For about half a quarter of policy action, the naira exchange rate remains constant before it appreciates, depreciates and appreciates again. This is contrary to a priori expectation and may be explained by the dirty float exchange rate regime in Nigeria in the review period.

Response to Cholesky One S.D. Innovations

### Response of INFN__ to USINDPRO
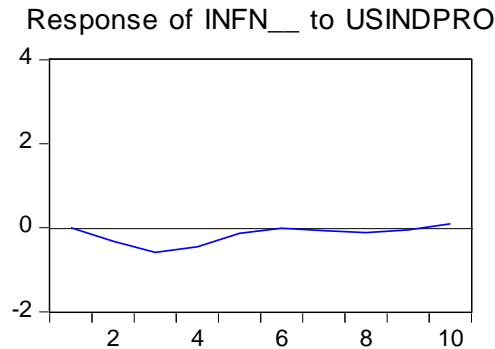
An increase in the US industrial production tends to cause inflation in Nigeria to decline effective the middle of the first quarter of policy action. By the third quarter inflation rate begins to rise and by the sixth quarter it stabilizes through to the tenth quarter. This agrees with the a priori expectation as increased industrial production in the US tends to reduce the cost of imports from America and so forces down prices in Nigeria. The rate of inflation rises and stabilizes as the Nigerian industrial output fails to leverage on the relatively cheap imports in the face of infrastructural challenges in Nigeria.
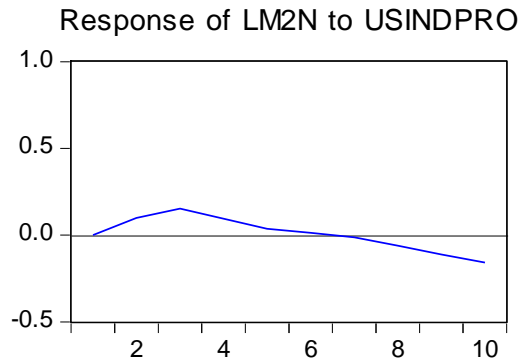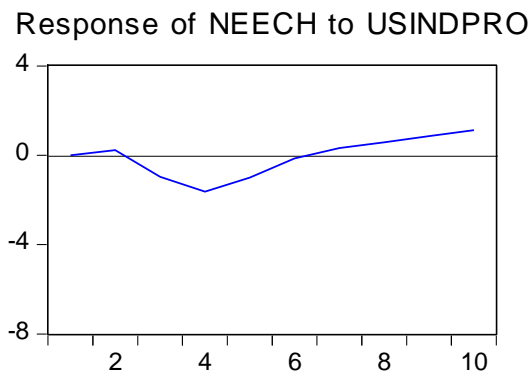
Response to Cholesky One S.D. Innovations
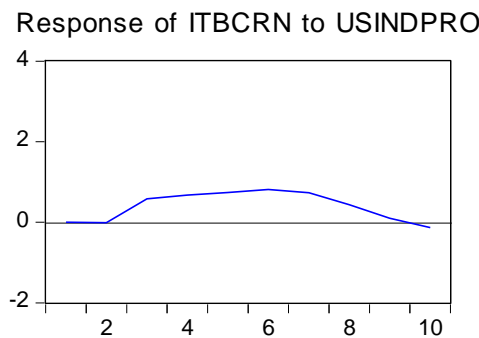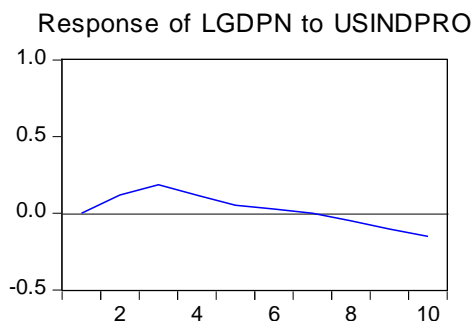
Response of ITBCRN to USINDPRO

Response to Cholesky One S.D. Innovations

Response of LGDPN to USINDPRO

Response to Cholesky One S.D. Innovations

### Response of LM2N to USINDPRO

Response to Cholesky One S.D. Innovations

Response of NEECH to USINDPRO

From the middle of the first quarter of policy action, Nigeria's money supply rises in response to an increase in the industrial production in the United States. It however declines in the third quarter and falls through to the tenth quarter. An increase in industrial production in the US would tend to boost economic activities in Nigeria and so money supply rises but as the infrastructural challenges begin to adversely affect industrial production in Nigeria, money supply and indeed economic activity begins to decline. The nominal effective exchange rate in Nigeria rises in response to the increase in the industrial production in the US. The Naira appreciates initially and then begins to depreciate. This agrees with the a priori expectation as increased industrial production tends to trigger demand pressure on the dollar leading to an appreciation of the Naira. This would be short lived as the combined effects of government intervention in the forex market and the infrastructural challenges in Nigeria tend to restrain the appreciation of the Naira.

# Response to Cholesky One S.D. Innovations

Response of INFN__ to WTI_P
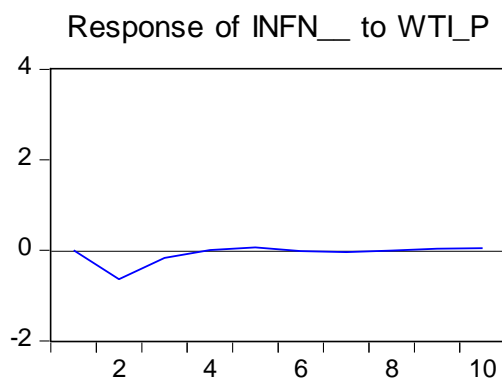
In response to a rise in the price of crude oil, inflation rate in Nigeria declines sharply in middle of the first quarter of policy action. It also sharply rises in the second quarter and remains stable from the fourth to the tenth quarter. This agrees with a priori expectation as the increase in oil revenue increases money supply through the Net Foreign Asset of the Central Bank of Nigeria and this raises the Money supply in the face of rigidities in production. In the middle of the first quarter of policy action, inflation rate falls due to the delay in the sharing of the monthly FAAC occasioned by the time inconsistency in the receipt of oil revenue and the FAAC. The NNPC withdraws its contribution to the Federation account from the DMBs and this slows down economic activity before FAAC boosts borrowing from DMBs.
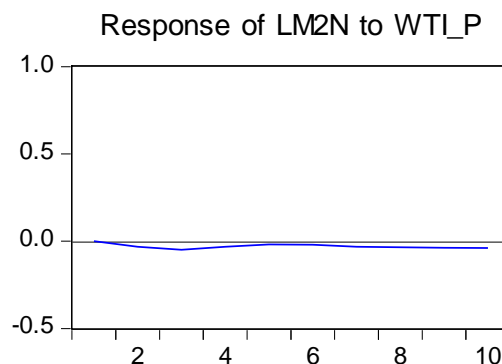
Response to Cholesky One S.D. Innovations

Response of ITBCRN to WTI_P

Response to Cholesky One S.D. Innovations

Response of LGDPN to WTI_P
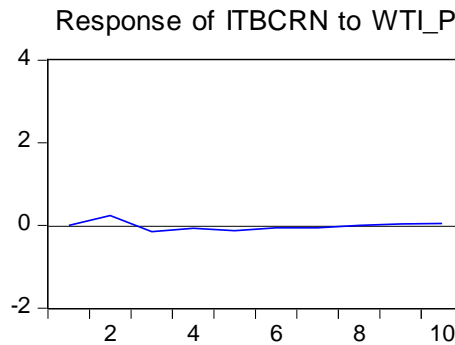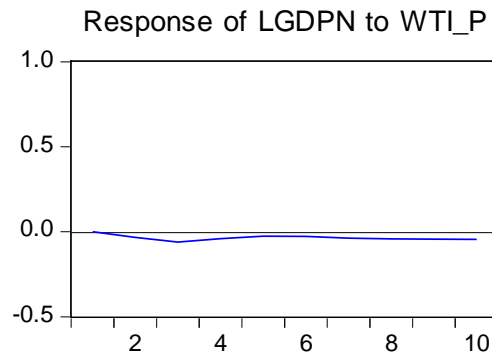
The increase in the crude oil price appears to have minimal effect on the inter-bank call rate and the domestic output. The rate of interest rises in the middle of first quarter of policy action but fallsin the second quarter and stabilizes from the third quarter through to the tenth. The GDP on the other hand falls marginally and stabilizes in the fourth quarter.

Response to Cholesky One S.D. Innovations

Response of LM2N to WTI_P

Response to Cholesky One S.D. Innovations

Response of NEECH to WTI_P
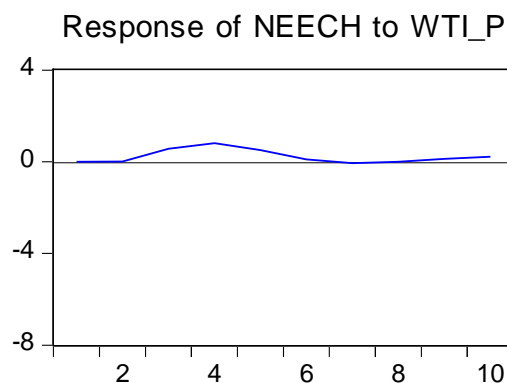
The response of the nominal effective exchange rate in Nigeria to the increase in oil price is delayed to the second quarter of policy action. It eventually rises and peeks in the fourth quarter before declining to the sixth quarter and thereafter stabilizing to the tenth quarter. The depreciation in the exchange rate in the second quarter of the policy action is as a result of the increase in the revenue of the government which promotes imports and intervention in the foreign exchange market.

Policy Implications of Findings

The results of the study show that some Nigerian macro-economic variables respond to foreign policy impulses particularly American policy impulses. Specifically while inflation in Nigeria has a delayed response to a positive shock to US consumer price index, it shows an early response to the US Federal Funds Rate by falling briefly and stabilizing. Inflation in Nigeria also responds early to industrial production in the US by falling and then stabilizing. These responses imply that policy makers should study the various responses in order to find ways of complementing or counteracting the foreign shocks.

Of note is the similar responses displayed by the Nigeria's GDP and the broad money supply to shocks to US CPI and the US Industrial Production and the US Federal Funds Rate. The similarity reinforces the relationship between money supply and the real sector of the Nigeria economy.

The rate of interest and the exchange showed wide swings in response to changes in the US CPI.

The responses are generally delayed by about half of the first quarter of the policy action. The responses are varied in their magnitudes and duration thus calling for greater scrutiny by the policy makers. The US Consumer Price Index and the US Federal Funds Rate appear to have the most effect on the Nigerian variables while the Crude Oil Price has the least effect.

VII. Summary, Conclusion and Recommendations

This study attempts to uncover the relationship between some Nigerian macroeconomic variables and some foreign variables using the structural vector auto-regression methodology. The study found that there are both positive and negative relationships between foreign and domestic variables. The responses are not immediate but come with a lag. Some of the responses are minimal showing little direct relationship between the Nigerian variable and the foreign one.

Conclusion

In this paper, we employed the SVAR methodology to model and investigate the vulnerability of Nigerian macro-economy to foreign monetary policy shocks. We establish identification conditions to uncover the dynamic effects of monetary policy shocks on various domestic variables in the period of the study. The orthogonal policy shocks obtained from the SVAR model are used to assess by how much some Nigerian variables (such as output, prices, interest rates and exchange rates) are affected by foreign (US) monetary policy shocks.

A nine-variable-SVAR model with quarterly data from 2003 q1 to 2016 q4 is used to study the responsiveness of Nigerian macro-economy to foreign shocks. This sample period covers only the democratic governance period in Nigeria which period propitiates economic and financial reforms in Nigeria relative to the period of military dictatorship. Both the domestic and foreign (US) variables were used to capture the dynamic responses of the Nigerian economy to foreign shocks. The foreign block exogeneity and the contemporaneous and dynamic restrictions on the domestic block are imposed to provide some economic structure to the Nigerian SVAR model.

Results showed that trade balance grows worse significantly and domestic currency appreciated following monetary expansion shocks of the U.S., but domestic real output is positively affected by the external monetary policy shocks over time. These results imply that it is important to respond appropriately to changes in exchange rates in order to reduce unexpected negative influence due to the external shocks especially in the small open economies like Nigeria's.

Recommendations

In view of the huge response displayed by the Nigerian variables to the foreign shocks, it is recommended that greater attention be paid to developments in some foreign economies in the implementation of monetary policy in Nigeria. The four foreign variables: the US CPI, US FFR, USINDPRO and the WTI-P, particularly the first three elicit significant responses from the Nigerian macro-economic variables. These variables therefore should be monitored in the process of monetary policy implementation to ensure that where necessary, the impact of foreign shocks are leveraged upon or counteracted where necessary.

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