Monetary Policy Options in the Context of Secular Stagnation and Financial Uncertainty in Nigeria

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Abstract

This paper examined the phenomenon of secular stagnation in the face of financial uncertainty, with a view to determining the most appropriate monetary policy instrument(s) that could be employed to quicken the pace of output gap recovery in Nigeria. A threshold regime-switching vector autoregressive (VAR) technique was applied on quarterly data for the 2000Q1-2018Q4 period. The response of the output gap to shocks to the various monetary policy variables and the relative contribution of each of the policy variables to output gap recovery, were obtained for financial uncertainty regime and the "normal times" regime. The findings revealed that exchange rate policies were the most effective in engendering output growth during the financial uncertainty regime. In contrast, interest rate policies were less effective in stimulating output growth under conditions of financial uncertainty compared with "normal times". The paper highlights the need for further research on the relative effectiveness of conventional and unconventional monetary policy in boosting the recovery of output growth in Nigeria, given the notion that the use of unconventional monetary policy to stimulate output growth during a crisis could be more effective.

Keywords: Monetary policy, Financial uncertainty, Output gap, Threshold regime-switching VAR, Secular stagnation

JEL Classification: E32, E52, G01

I. Introduction

The efficacy of conventional monetary policy was challenged in the wake of the Global Financial Crisis (GFC) that culminated in the Great Recession of 2007-2009. This led most central banks to adopt unconventional monetary policy measures – mainly quantitative easing (QE) – to complement traditional interest rate adjustments, in order to stimulate the recovery of output growth. In spite of these efforts, many advanced economies (including the U.S., Japan and the EU) continued to experience protracted sluggish growth (secular stagnation), as actual GDP growth consistently fell short of potential levels, leading to negative output gaps many years after the crisis (Baldwin & Teulings, 2014; Reinhart & Rogoff 2014; Summers, 2016; and Funashima, 2020).

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Several studies have attempted to examine the potency of monetary policy in addressing the phenomenon of secular stagnation and uncertainty, arising from financial crisis (Summers 2014; Wolff, 2014; Blanchard et al., 2014; Summers, 2016; and Funashima, 2020). For instance, Summers (2014 and 2016) argues that the negative natural rate of interest and the ensuing limited impact of monetary policy, in a situation of a zero lower bound, are related to the recent secular stagnation in advanced economies. In the face of available monetary policy options, he surmises that monetary authorities will have to rely substantially on unconventional monetary policy, given that in the next recession, interest rates could be much lower than they were in the previous ones, suggesting that conventional monetary policy may not have much of a role to play.

Funashima (2020) investigates how monetary policy could avoid sluggish economic recovery in response to financial shocks in the U.S. He concludes that a protracted sluggish response of an output gap to financial shock is triggered by inflation targeting, without considering interest rate variation. However, in a speed limit policy, the output gap recovers rapidly regardless of the central bank's approach to interest rate variations. On the whole, there is no consensus on the effectiveness of conventional monetary policy during a financial crisis. Furthermore, output gap recovery appears to respond differently to different monetary policy objectives in normal and crises regimes. In their study of recessions and recoveries using evidence from 100 episodes of systemic banking crises, Reinhart and Rogoff (2014) reveal that the protracted and sluggish nature of the recovery was a major cost of the financial crises, indicating that it takes about eight years to reach the pre-crisis levels of income. Their finding seems to partially explain why secular stagnation has persisted long after the recession following the GFC.

Although, the phenomenon of secular stagnation, following a financial crisis, is common in advanced economies, Nigeria's economy experienced a descent into secular stagnation following the 2014 oil price shock that resulted in the 2016 recession. Output growth not only remained sluggish since the exit from the recession, but it was a far cry from the pre-recession levels. The output gap also widened despite the continued downward revisions of the economy's potential GDP[2].

From the foregoing, an investigation into the appropriate monetary policy response that could quicken the pace of the output gap recovery and bolster

[2] See potential GDP growth rates in various issues of CBN's Monetary Policy Circulars on "Monetary, Credit, Foreign Trade and Exchange Policy Guidelines"

robust economic growth in Nigeria seems justified. Consequently, the paper sets out to examine which monetary policy scenario would be most effective for output gap recovery in the face of perceived secular stagnation in the Nigerian economy.

Accordingly, the rest of the paper is organised as follows: Section II reviews the theoretical and empirical literature on the subject. Section III covers the methodology, while Section IV discusses the results of the empirical analysis. Lastly, Section V concludes the paper with some policy implications.

II. Literature Review

II.1 Theoretical Review

The need to explain the sources of protracted slow growth and low interest rate, a phenomenon commonly referred to as secular stagnation, has been a concern among Classical and New Keynesian Economists (Hansen, 1939; Curdia and Woodford, 2009; Woodford, 2003; Williams, 2012; Summers, 2014 and 2016, Eggertsson & Mehrotra, 2014; and Kleczka, 2015).

The secular stagnation hypothesis advanced by Hansen (1939), infers that declining birth rate and shortfall in investment could usher-in an era of sustained unemployment and economic stagnation, restraining the economy from its full potential. His prediction was consistent with the Keynesian perspective where slowdowns were attributed to declining aggregate demand and domestic investment, associated with low real interest rate. Hansen's proposition was however confounded owing to increased post-war deficit spending, war-time credit control and rationing; and unexpected baby boom in the 1940s (Summers, 2016). The combined effect of these factors corrected the savings-investment bias, increased demand and reduced unemployment.

Summers (2014) reignited the secular stagnation hypothesis, when he expressed the concern that developed economies could be suffering from a profound constraint of slow growth similar to the late 1930s, owing to the aftermath of 2008 global financial crisis. He used the hypothesis to explain the long-term decline in the potential output of Western economies. The hypothesis is intrinsically underpinned by developments around the natural real rate of interest (the rate at which savings equals investment under full employment) ascribed to Wicksell (1898).

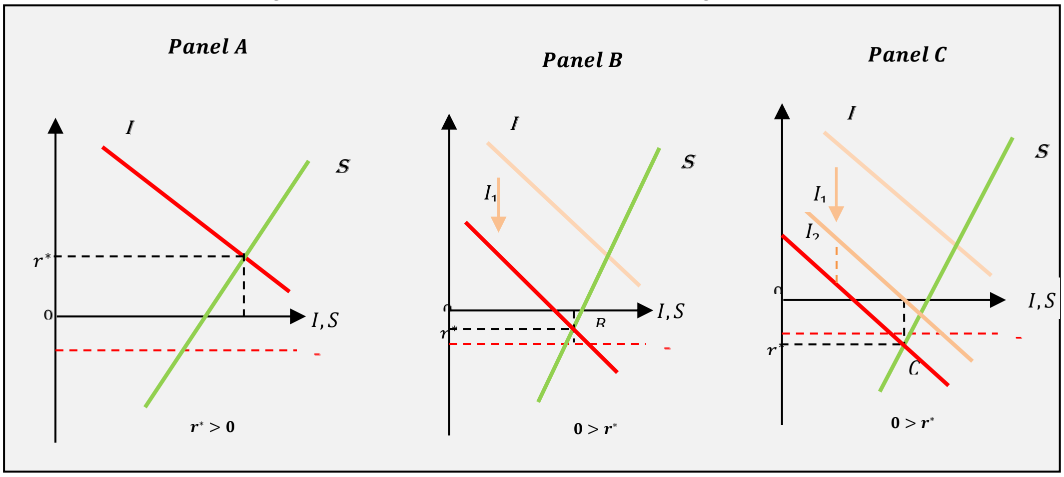
Summers explained low interest rate as the result of an increase in the propensity to save and a decline in the propensity to invest, which causes the equilibrium of savings and investment to occur at a low interest rate and higher output level.

The dynamics of the real interest rate around its long-run level have implications for growth. For instance, if the equilibrium or natural real rate is expected to lie above the real interest rate, the economy is assumed to be strong. The reverse relationship suggests a sluggish economy.

The mechanism of secular stagnation could be demonstrated using the loanable fund model (Kleczka, 2015; and Eggertsson & Mehrotra, 2014). The hypothesis has a lot in common with the liquidity trap hypothesis as acknowledged by Krugman (2014). However, the former is protracted. In Figure 1 (panel A, B and C) S and I represent savings and investment in the economy. Under full employment, $S = I$ and real interest rate (r) equates the natural rate of interest (r*) at these intersections. π denotes the targeted inflation rate in the economy. In Panel A, assuming that r*> 0 and that r* and π are correctly estimated, the monetary authority can set a nominal interest rate that clears the loans market.

On the other hand, Panel B depicts a decline in investment demand, triggered by a financial crises or dearth in profitable investment opportunities. Consequently, S and I equilibrate at point B where r* is less than zero, but above the inverted inflation rate (π) (deflation), in which case the nominal interest rate can still be positive, and conventional monetary policy, deployable.

Figure 1: Mechanism of Secular Stagnation



However, if investment demand declines further, from I_1 to I_2 and the natural rate of interest declines below the inverted inflation rate, as indicated in Panel C, the nominal interest rate is constrained by the zero lower bound (ZLB), and it is impossible to achieve a real interest rate that equilibrates S and I. Consequently, conventional monetary policy becomes inadequate in stimulating the economy, resulting in deflation, slow growth, and expansion of the output and unemployment gaps.

Although the resurgence of secular stagnation in recent times has been attributed to the aftermath of the global financial crisis (Williams, 2012; Summers, 2014; and Funashima, 2020) and the puzzles around the stagnation in Japan that has lasted for over two decades, Dadush (2016) identifies technological exhaustion and demographic changes as the underlining factors. He argued that secular stagnation is a phenomenon peculiar to industrialised economies but admitted that due to the interconnectedness of the global economic and financial systems, spill-overs from secular stagnation could be transmitted to developing economies. Nevertheless, he opined that growth in developing economies is largely dependent on domestic factors.

The key challenge of an extremely low interest rate, as is the case of a liquidity trap, is its rendering of monetary policy ineffective. The inability to reduce the nominal interest rate beyond the zero level bound restriction incapacitates the use of conventional monetary policy to stimulate demand and economic growth. Unlike regular business cycles, secular stagnation is not self-reverting, and as such, requires deliberate policy actions to redeem growth and employment.

Although, there is no consensus on the optimal policy response, literature identifies four alternative policy options in addressing this challenge. These include: (i) raising inflation target to accommodate a negative natural rate of interest (ii) forward guidance (e.g. a promise to keep rate low to induce private spending) (iii) Qualitative easing, and (iv) negative interest rate (Eggertsson et al., 2017; Summers, 2014; and Woodford, 2003). In addition to these, fiscal stimuli and structural reforms could also be helpful (Kleczka, 2015).

In addition to ensuring stable inflation and growth, monetary policy plays a critical role in mitigating the effect of financial uncertainty, stimulating investment and economic growth. Williams (2012) modelled optimal policy under conditions of financial uncertainty and in 'normal times. He circled in on the capacity of monetary policy to mitigate the effect of financial crisis and how uncertainty, in turn, affects the appropriate policy response. The objective of monetary policy in this model is price stabilisation. The model simulations supported the notion that the presence of financial crisis inhibits the ability of monetary policy to achieve its objective.

Building on the frameworks of Curdia and Woodford (2009), Williams (2012) and Funashima (2020) developed an agent-based model that includes a Markov-Switching process to accommodate financial uncertainty. The framework models the private sector and the central bank and included the possibility of the central bank implementing alternative policy instruments – inflation targeting and speed limit policy. The objective of the central bank was to minimise its 'loss function' by observing how alternative monetary policy performs in stimulating economic recovery in the presence or otherwise, of financial uncertainty. He submitted that regardless of financial uncertainty, the rule-based interest rate variation policies (speed limit policies) performed better in inducing recovery, compared to inflation targeting associated with slow recovery.

II.2 Review of Related Studies

This section provides a review of relevant studies which examined the relationship between financial uncertainty, monetary policy and output growth.

Williams (2012) examined the optimal monetary policy design under occasional financial crisis and assessed the impact of such crisis on the monetary policy transmission mechanism. The Markov jump-linear-quadratic (MJLQ) model developed by Svensson and Williams (2007) was adopted and extended to include forward looking variables. Based on the New Keynesian Framework, this model was for a policymaker and a private sector. In order to account for optimal policies, a recursive saddle point method developed by Marcet and Marimin (1998) was used to augment the estimated Markov jump-linear-quadratic model. The study established that uncertainty about financial crises cause significant changes in optimal monetary policy. However, such changes are mainly a result of the crisis and not the uncertainty. The paper recommends the use of the MJLQ framework in determining best way to manage uncertainties that policymakers face.

Carriere-Swallow and Cespedes (2013) examined the extent to which financial uncertainty drives investment and consumption in a group of forty advanced and emerging economies over the period 1990 - 2011. Within the framework of vector autoregressive (VAR) models, financial uncertainty was represented by implied volatility generated from stock market options. The study provides three major conclusions: (i) the median fall in investment in emerging economies is four times the size of developed economies; (ii) countries express heterogeneity in recovery time; with emerging economies taking longer time; (iii) emerging market economies experience a significant decline in private consumption after uncertainty shocks.

Reinhart and Rogoff (2014) investigated the cost of financial crises from a sample of 63 crises in advanced economies and 37 crises in emerging market economies over the period 1857 to 2013. They constructed a severity index, constituting of the depth and duration of each crisis to achieve their objective and to determine whether the impact of crises is significantly different between country groups. The depth or amplitude of a crisis was defined as the percentage change in output from peak to trough, while duration referred to the number of quarters from peak to trough (recession) or from trough to peak (expansion or recovery). The difference between the duration and depth formed the severity index. The findings of the study established that the depth of financial crises in emerging markets is 5 percentage points larger than that in advanced economies. The results also showed that there was no statistically significant difference in the duration of crises between the country groups. The study recommended that advanced economies employ the eclectic policy measures adopted by emerging economies to speed up recovery from crises.

Popp and Zhang (2016) assessed the macroeconomic implications of uncertainty shocks in the U. S. economy over the period 1962 to 2014. They employed a smooth-transition factor-augmented vector autoregressive (ST-FAVAR) model, using 141 economic and financial indicators. Uncertainty was incorporated using three different proxies: a measure of implied volatility of stock market returns - the Chicago Board Options Exchange VXO index; volatility of the S&P 500 returns; and the Jurado *et al.* (2015) index of uncertainty. To measure the varying effect of uncertainty shocks during recession and non-recession regimes, regime dependency was also incorporated into the model. Their findings suggested that financial uncertainty shocks exert significant impact on numerous macroeconomic indicators. Specifically, unexpected increase in uncertainty negatively affects economic activity, with output declining by 0.20 standard deviation below trend four months after the shock. The increase in uncertainty reduces inflation for periods less than ten months in normal times and less than twenty months in recessions. The results obtained from the ST-FAVAR were also corroborated with those obtained from an ST-VAR model. The paper recommends further study on the transmission channels of uncertainty shocks.

Funashima (2020) outlines the targets policymakers should adopt in order to prevent secular stagnation following a financial shock by comparing inflation targeting and speed limiting policies as well as measures the impact of financial uncertainty. The paper adopted a Markov jump-linear-quadratic approach developed by Svensson and Williams (2007). Its model was based on the New Keynesian framework with financial uncertainty, made up of the private sector and a central bank. Financial uncertainty was represented by a dummy, which took the value of 2 during the financial crisis and 1 during normal regime. The parameters used in the model calibration for the behaviour of the private sector and the central bank were adapted from Williams (2012). Their findings from the impulse responses indicated that inflation targeting, when interest rate variations are not considered, leads to sluggish output gap response. However, speed limiting polices were found to improve output gap recovery, irrespective of the interest rate variations. The paper recommends further studies on the mechanisms of demand and supply side interactions, such as, the impact of investment hangover on the supply side.

Bakas and Triantafyllou (2018) empirically examined the impact of observable and unobservable financial uncertainty shocks on the volatility of fourteen commodity prices over the 1985 – 2016 period. Observable uncertainty was represented by stock-market volatility (VXO), while the unobservable economic uncertainty was captured by the Jurado *et al.* (2015) index. They used a multivariate (6-factor) VAR model comprised of industrial production index, employment rate, uncertainty index, interest rate spread, S&P index and returns of commodities price index. The findings of this study indicate that a one percentage point hike in financial uncertainty, increases the variance of commodity prices by 0.4 per cent in the first five months and the effect remains positive and significant for about 14 months. The paper recommends further research on the ability of economic uncertainty to predict the volatility of commodity prices.

Most of the studies reviewed were interested in examining the optimal policy action under financial uncertainty in advanced economies. These studies used a number of methods ranging from VAR, ST-VAR, ST-FAVAR to Markov jump-linear-quadratic models and used implied volatility of stock market returns to proxy financial uncertainty. Their results suggested that the impact of policy actions was markedly different during regimes of financial uncertainty, relative to "normal times". Similar to most of the reviewed studies, this paper intends to identify the different regimes of financial uncertainty with the use of TAR model, which highlights non-linearity in the financial uncertainty series. Unlike the reviewed studies, this paper focuses on the variations in impact of different policy actions under different uncertainty regimes within the context of an oil-exporting developing economy.

III. Methodology

III.1 Theoretical Framework

The theoretical framework for this study follows Williams (2012) and Funashima (2018). The model derives from the standard New Keynesian model and consists of a private sector with credit market restrictions, and a central bank under financial uncertainties.

III.1.1 Financial Uncertainty Model

The model specifies two structurally dynamic regimes for a dynamic variable, Z_t. The values of Z_t depends on an unobservable (Bernoulli random) state variable

s_t, which takes the value 1 in 'normal times' and 0 in a financial crisis at time $t \; and \; t+1$. Regime s_t is assumed to follow a Markov process depicted in the $2 \, x \, 2$ transition matrix:

$$P\begin{bmatrix} Prob(s_{t+1}=1|s_t=1) & 1-Prob(s_{t+1}=1|s_t=1) \\ 1-Prob(s_{t+1}=2|s_t=2) & Prob(s_{t+1}=2|s_t=2) \end{bmatrix} \quad (1)$$

This paper deviates slightly from Williams (2012) and Funashima (2018) by using a variant of the Markov-Switching model – the *'Threshold model'* – which also admits two dynamic structures, but presumes s_t is taken as an indicator variable $1_{\lambda_t \leq C}$, such that $s_t = 0 \; or \; 1$, depending on whether λ_t is less than the threshold value (c).

III.1.2 Private Sector Model

Funashima (2020) specified a private sector model based on the New Keynesian I-S equation and incorporated credit market restrictions, inflation, π_t and output gap, y_t

$$\pi_t = \omega_{fjt}E_t\pi_{t+1} + (1-\omega_{fjt})\pi_{t-1} + \gamma_t y_t + \xi_{jt}\Omega_t + C_{\pi jt}\varepsilon_{\pi t} \quad (2)$$

$$y_t = \beta_{fjt}E_t y_{t+1} + (1-\beta_{fjt})[\beta_{yjt}y_{t-1} + (1-\beta_{yjt})y_{t-2}] - \beta_{rjt}(i_t - E_t\pi_{t+1})\theta_{jt}\Omega_t + \emptyset_t\omega_t + C_{yjt}\varepsilon_{yt} \quad (3)$$

E_t is the conditional expectation based on available information in period t, i_t represents nominal interest rate, while $\varepsilon_{\pi t}$ and ε_{yt} are the mutually uncorrelated random shocks of inflation and output gap with the features:

$$\begin{bmatrix} \varepsilon_{\pi t} \\ \varepsilon_{yt} \end{bmatrix} \sim i.i.d. N(0,1) \quad (4)$$

ω_t is the interest rate spread between borrowers and savers; while Ω_t is the marginal utility gap. Ω_t is assumed to be endogenous and ω_t exogenous and follows an AR(1) stochastic process:

$$\Omega_t = \delta E_t\Omega_{t+1} + \omega_t \quad (5)$$

$$\omega_t = \rho_{jt}\omega_{t-1} + C_{\omega jt}\varepsilon_{\omega t} \quad (6)$$

Where $\varepsilon_{\omega t}$ is the shock to interest rate spread, and it is mutually uncorrelated with $\varepsilon_{\pi t}$ and ε_{yt}. A key assumption in the private sector model is that the 'normal times' regime is nested in the 'financial crisis' regime, such that:

$$\xi_1 = \theta_1 = \emptyset_1 = 0$$

This simplifies equations 2 and 3 by eliminating the 4th term in equation 2, and 4th and 5th terms in equation 3.

III.1.3 Central Bank model

Two frameworks were considered for the central bank:

a. Inflation targeting

$$L^{IT}(\pi_t, y_t, i_t, i_{t-1}, j_t) = \pi_t^2 + \lambda\pi_t^2 + v(i_t - i_{t-1}) + \varphi_{jt} i_t^2 \quad (7)$$

b. Speed limit policy

$$L^{SLP}(\pi_t, y_t, y_{t-1}, i_t, i_{t-1}, j_t) = \pi_t^2 + \lambda(y_t - y_{t-1})^2 + v(i_t - i_{t-1})^2 + \varphi_{jt} i_t^2 \quad (8)$$

The 3rd term ($v(i_t - i_{t-1})^2$) is the penalty for interest rate smoothing, while the 4th term in both equations (7 and 8) represents the penalty for interest rate volatility.

$w.r.t.$ the instrument, i_t the central bank's objective is to minimise the intertemporal loss function in inflation targeting and speed limit policy, respectively:

$$E_t \sum_{r=0}^{\infty} \beta^T L^{IT}(\pi_{t+r}, y_{t+r}, i_{t+r}, i_{t+r-1}, j_{t+r},) \quad (9)$$

and

$$E_t \sum_{r=0}^{\infty} \beta^T L^{SLP}(\pi_{t+r}, y_{t+r}, y_{t+r-1}, i_{t+r}, i_{t+r-1}, j_{t+r},) \quad (10)$$

In Nigeria, the monetary authority does not target inflation, and speed limit policies are limited to the Taylor-rule. Consequently, the framework was modified to accommodate monetary policy channels such as the interest rate, money supply, exchange rate and the cash reserve ratio, informing the specification in equation 11 below:

$$\bar{y}_t = f(X_t, Z_t) \quad (11)$$

Where X is a vector of monetary policy variables, and Z, a vector of other factors that have implications for both the output gap ($\bar{y}_t$) and X.

Owing to the inherent trade-off among these instruments, the objective of monetary policy would be to minimise the losses, while simultaneously stimulating growth and containing inflation.

III.2 The Model and Data Description

To achieve the objective of this study, a regime switching vector autoregressive (VAR) method was adopted. This method was comprised of a threshold autoregressive (TAR) model and two unrestricted VAR models. Since non-linearities exist in financial series (Jurado et al., 2015; Popp & Zhang, 2016; Funashima, 2018; among others), a TAR model was estimated to identify the threshold, which was used to split the financial series of interest into the regime of financial uncertainty and normal times. The volatility in stock market returns was used as proxy for financial uncertainty variable. Thus, the regime of financial uncertainty was comprised of the periods with uncertainty above the threshold established by the TAR model, while "normal times" were associated with periods below the threshold level. Other relevant variables were correspondingly split into these two regimes. The unrestricted VAR models - financial uncertainty regime VAR and normal regime VAR- were estimated to examine the most effective monetary policy instruments in promoting output growth recovery during periods of financial uncertainty and otherwise.

The variables used for the analysis were short-term interest rate, represented by the 3-month Treasury Bill rate (tbr); exchange rate (exr) proxied by the Bureau de Change (BDC) rate; cash reserve ratio (crr); broad money supply (M2g); real gross domestic product (ryg); and the All Share Index (ASI) to capture activities in the Nigerian Stock Exchange. The variables span the period 2000Q1-2018Q4 and were sourced from the Central Bank of Nigeria (CBN) Statistical Bulletin and the National Bureau of Statistics (NBS) database.

Among the measures of nominal interest rate, the 3-month treasury bills rate (TBR) was selected because of its high sensitivity to monetary policy rate (MPR), and changes in the money and financial market fundamentals. The BDC rate was chosen as the nominal exchange rate measure because it is a reliable indicator of foreign exchange market conditions in Nigeria. Money supply growth rate represents changes in the stock of money supply. In addition, the CRR was introduced as an indicator of liquidity conditions in the economy, which could be used by the monetary authority to influence bank lending behaviour.

Two key variables in the analysis – the output gap ($\overline{ryg_t} = ryg_t - ryg_t^*$) and financial uncertainty - were derived variables. The output gap ($\overline{ryg_t}$) measures the deviation of the actual GDP (ryg_t) from the potential GDP(ryg_t^*). Series for the potential GDP were obtained using the Hodrick-Prescott (HP) filter, which separates a given series into its trend and cyclical components. The output gap is the main variable of interest, and its response to changes in the other endogenous variables determines their relative importance vis-à-vis output growth recovery.

With regards to *a priori* expectations, an increase in interest rate (r) is expected to have a positive or negative effect on the output gap ($\overline{ry_{gt}}$). The net effect of a rise in interest rate depends on the relative importance of domestic and foreign investments in the economy. We expect $\overline{ryg_t}$ to have a negative relationship with exr and crr , but a positive relationship with $m2g$.

The financial uncertainty variable (fu), on the other hand, consists of a volatility series extracted from the All-Share returns, using a Generalised Autoregressive Conditional Heteroskedasticity (GARCH) model. Justification for using the volatility in stock market returns as a proxy for financial uncertainty is connected with the perspective that fluctuations in stock market returns mirror developments in the financial markets (Chulia et al., 2015).

III.3 Estimation Technique

III.3.1 The Threshold Model

A threshold autoregressive (TAR) process was estimated to split the financial uncertainty series into two regimes, based on the identified threshold, in line with Enders (2015), where;

$$fu_t = \begin{cases} a_1 fu_{t-1} + \varepsilon_{1t} \; if \; fu_{t-1} > \delta \\ a_{2\,fu_{t-1}} + \varepsilon_{2t} \; if \; fu_{t-1} \leq \delta \end{cases} \tag{12}$$

fu_t, represents the proxy of financial uncertainty. If $fu_{t-1} = \delta$ represents the threshold, then one side of the threshold is dependent on an autoregressive process, and the other side on another autoregressive process. The switch in regimes is caused by shocks to the errors ($\varepsilon_{1t} and \; \varepsilon_{2t}$).

III.3.2 Unrestricted VAR Model

After using the TAR model to split the financial uncertainty series into two regimes (upper and lower), two VAR models were estimated to capture the financial uncertainty regime (upper regime) and "normal times" (lower regime).

Thus, we begin with the simple VAR representation specified as:

$$Y_t = aY_{t-1} + v_t \tag{13}$$

Where, Y_t is a vector of endogenous variables $y_t = [\Delta tbr, \Delta crr, \Delta lexr, m2g, ryg]$; v_t is the vector of structural disturbances, and a is a matrix that includes all the coefficients describing the relationships among the endogenous variables.

Transforming equation (3.2) to a typical reduced-form VAR as proposed by Sims (1980), in a system of equations can be written in the form:

$$Y_t = A(L)Y_{t-1} + \varepsilon_t \qquad (14)$$

Where Y_t is the column vector of observations at time *(t)* on all variables and is known as the vector of endogenous variables. $A(L)$ is a matrix polynomial in the lag operator L and represents the coefficient matrix of contemporaneous effects to be estimated, and the symbol ε_t represents the column vector of random disturbances or innovations assumed to be non-autocorrelated over time.

To examine the effectiveness of monetary policy tools during non-crisis periods and periods of financial uncertainty, impulse responses and variance decompositions were generated from both the upper regime VAR (financial uncertainty regime) and the lower regime VAR (normal times) and the results analysed.

IV. Empirical Results and Analysis

IV.1 Pre-Estimation Analysis

IV.1.1 Descriptive Statistics

Table 1 presents the summary statistics of all variables used in the model. The dispersion around mean was substantially wide for all the variables, except the cash reserve ratio (crr), treasury bill rate (tbr) and real GDP growth (ryg), as indicated by their standard deviations. Real GDP growth exhibited the least degree of variation among the series indicating minimal episodes of considerable shocks to growth, over the period of analysis. Conversely, the large standard deviation and significant variations in the central tendency measures of the output gap variable ($\overline{ryg_t}$), shows that actual GDP in Nigeria was considerably below its potential value for the most part of the analysis period. The Jarque-Bera statistic revealed that cash reserve ratio (CRR), treasury bills rate (tbr), and real GDP growth (ryg) were normally distributed, while the all-share index (ASI), growth in money supply (m2g), financial uncertainty (fu) and exchange rate (exr), were not, suggesting the likelihood of outliers in the data.

Table 1: Descriptive Statistics

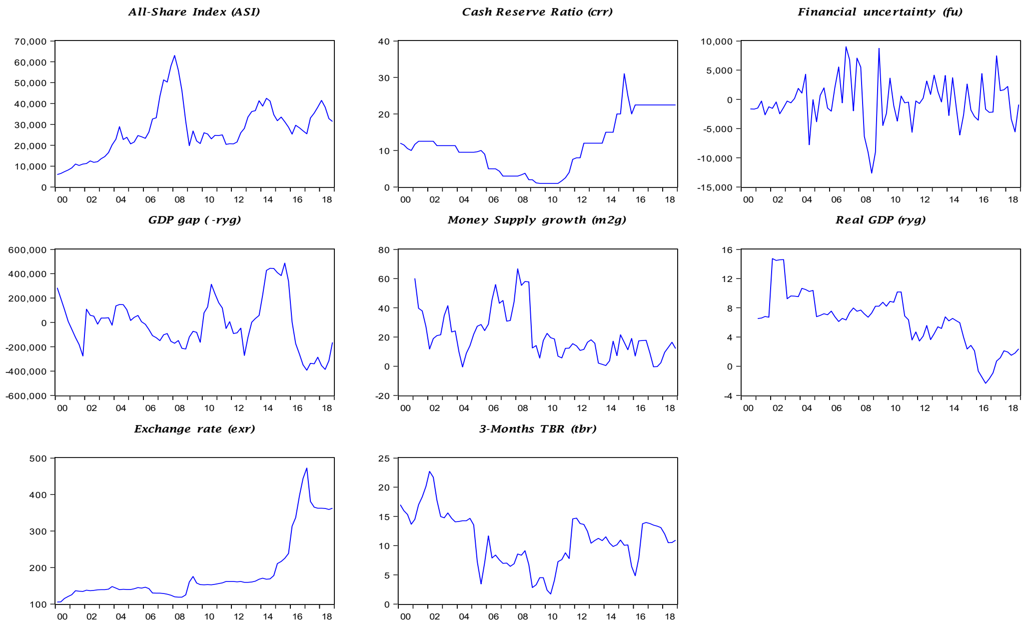
	ASI	*crr*	*Fu*	$\overline{ryg_t}$	*m2g*	*ryg*	*exr*	*tbr*
Mean	28,472.9	11.2	-387.9	-19,803.8	21.2	6.3	189.0	10.7
Median	26,163.9	11.3	-584.1	-35,235.3	17.5	6.7	153.5	10.7
Max	63,016.6	31.0	9,014.7	487,936.4	66.7	14.8	472.4	22.7
Min	9,159.8	1.0	-12,641.4	-393,418.8	-0.5	-2.3	118.8	1.7
Std. Dev.	11,600.0	7.7	4,077.1	212,545.3	16.1	3.8	89.0	4.5
Jarque-Bera	6.8	4.1	1.5	3.0	13.5	0.2	44.1	0.6
Prob.	0.03	0.1	0.5	0.2	0.0	0.9	0.0	0.7
Obs.	72	72	72	72	72	72	72	72

Source: Authors' computation

IV.1.2 Unit Root Tests

Before conducting unit root tests, the graphical plots of the series were first examined. The graphs on Figure 2 show the fluctuating pattern of the series and that all except the proxy for financial uncertainty and exchange rate were not mean-reverting, indicating that only these two maybe stationary at levels. However, formal stationarity tests were carried out to ascertain the order of integration (see Table 2).

Figure 2: Patterns and Trends in Actual and Derived Variables



Source: Authors' computation

Table 2 presents the results of stationarity tests of the variables at levels and first difference, using both augmented Dickey-Fuller (ADF) and Phillips-Peron (PP) unit root tests.

Table 2: Augmented Dickey-Fuller (ADF) and Philips-Perron (PP) Tests

	LEVELS				FIRST DIFFERRENCE			
Variable	ADF1	ADF2	PP1	PP2	ADF1	ADF2	PP1	PP2
FU	-7.09***	-7.05***	-7.08***	-7.03***	-10.25***	-10.19***	-20.94***	-20.83***
TBR	-2.08	-2.02	-2.26	-2.20	-7.30***	-7.28***	-7.09***	-7.52***
CRR	-0.62	-1.45	-0.47	-1.37	-9.62***	-9.62***	-9.65***	-9.78***
LEXR	-0.54	-1.66	-0.29	-1.42	-5.95***	-5.95***	-5.91***	-5.90***
M2G	-3.39**	-3.54**	-3.51**	-3.75**	-7.30***	-7.30***	-8.92***	-8.82***
RYG	-1.60	-3.41	-1.76	-3.60**	-8.42***	-8.39***	-8.42***	-8.39***

Source: Authors' Computation
ADF1 and PP1 referred to unit root tests conducted with intercept, while ADF2 and PP2 were conducted with intercept and trend. The asterisk *** and ** indicated statistical significance at 1% and 5% levels, respectively.

The ADF test suggested that only the growth rate of money supply (m2g) and the proxy of financial uncertainty (fu) were stationary at levels, while all the other variables were stationary at first difference. The PP test on the other hand suggested that fu, m2g and output gap were stationary at levels while tbr, crr and lexr were stationary at first difference. It is therefore, taken that tbr, crr and lexr are first difference stationary, while fu, m2g and ryg are stationary at levels.

IV.2 Threshold Autoregressive (TAR) Model Results

The estimated TAR model produced a threshold value of -1,961.307. The series was therefore split into two regimes with the lower regime (below the threshold) having 23 observations, while the upper regime had 51 observations above the threshold.

Table 3 Discrete Threshold Specification

Threshold variable: FU(-1)
Estimated number of thresholds: 1
Threshold data value: -1,961.307
Adjacent data value: -2,020.951
Threshold value used: -1,961.307

Source: Authors' computation

Analysis of the threshold value revealed that the periods selected by the models as periods of financial uncertainty coincided with periods such as the Global Financial Crisis (GFC), the recession in Nigeria, Brexit, and uncertainty around the US-China trade relations.

The CUSUM test was used to assess the stability of the model and the results suggested that the model was stable (see Appendix A).

IV.3 VAR Results

IV.3.1 Optimum Lag Length and Stability Tests

To ensure reliability of the results, optimum lag length and stability tests were conducted on both the normal time regime VAR model and financial uncertainty regime VAR model. In the financial uncertainty VAR, an optimal lag length of one was selected, similar to the normal time VAR (see appendix B). In relation to the stability tests, both models were found to be stable as none of the roots were outside the unit circle (see appendix C).

IV.3.2 Results of Financial Uncertainty versus No-Crisis Regimes

This section presents and discusses the estimation results, focusing on the relative effectiveness of monetary policy variables under conditions of financial uncertainty and "normal times."

a. Money Supply

The performance of the money supply channel in stimulating output recovery, is similar for both periods of financial uncertainty and 'normal times'. Although money supply growth induced a decline in the levels of actual GDP within the first and second quarters, it thereafter transited, inducing a permanent recovery in the output gap. The forecast error variance decomposition of the output gap, under conditions of financial uncertainty, shows that changes in money supply contributed the most to variations in the output gap, compared with any other instrument of monetary policy, within the first period. This outcome is expected given that economic agents tend to prefer money-holdings to stocks, which are inherently riskier in uncertain financial times, with offsetting distributional effects. This impact, however, deteriorated over time as shown in Figure 4.3 panels A and Figure 4.3 panels (b) and (c).

b. Interest Rate

We also examined the efficacy of the interest rate as an instrument of monetary policy under conditions of financial uncertainty and 'normal times'. Under financial uncertainty, the use of interest rate appears to be ineffective in inducing recovery in the output gap and this negligible effect persists for the entire duration of financial uncertainty, as depicted in the IRF and variance decomposition outputs in Figure 4.2a and Figure 4.3, panels (a) and (b). The inefficacy of interest rate in stimulating growth during the periods of financial crisis is not out of place. As noted in the literature, output recovery could be insensitive to changes in the policy rate owing to the diminishing effects of financial dislocations (Mishkin, 2009). Conversely, in 'normal times', the interest rate increasingly contributed positively and significantly to output recovery over the periods.

c. Exchange Rate

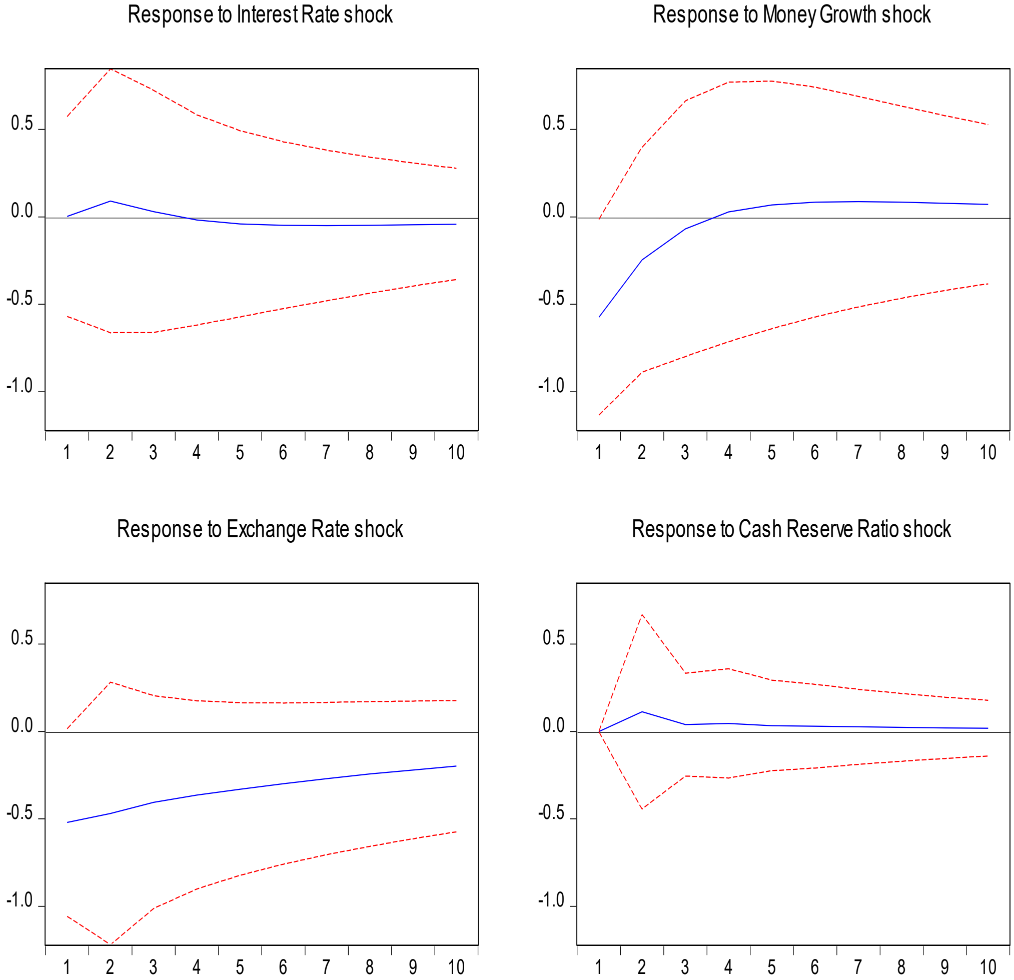
Exchange rate exerted the largest impact on output gap, both in the presence of financial uncertainty and in 'normal times', as can be observed from the IRFs and forecast error variance decomposition results. Its impact on output was significant and more prominent in periods of a relatively stable financial environment. On average, during the financial uncertainty episodes, exchange rate contributed 7.8 per cent to variations in the output gap, compared to 34.8 per cent in 'normal times'. The observed effect is in line with *a priori* expectation and the realities of the Nigerian economy. Given that the Nigerian economy is largely import-dependent and relies heavily on foreign exchange inflow from crude oil exports, exchange rate policies tend to have direct effects on producers and consumers' prices, as well as, government expenditure which has substantial implications for growth.

d. Cash Reserve Ratio

The IRF results reveal that cash reserve ratio had a small, short-lived but positive effect on the output gap. The observed relationship, however, confounds theoretical expectation as liquidity tightening associated with CRR increase is generally more effective in curtailing inflation than in stimulating growth. Regardless of the size of its impact on output, the results suggest that adjustments in CRR as a prudential measure, appeared to be prominent in its influence on output in periods of financial uncertainty compared with 'normal times'.

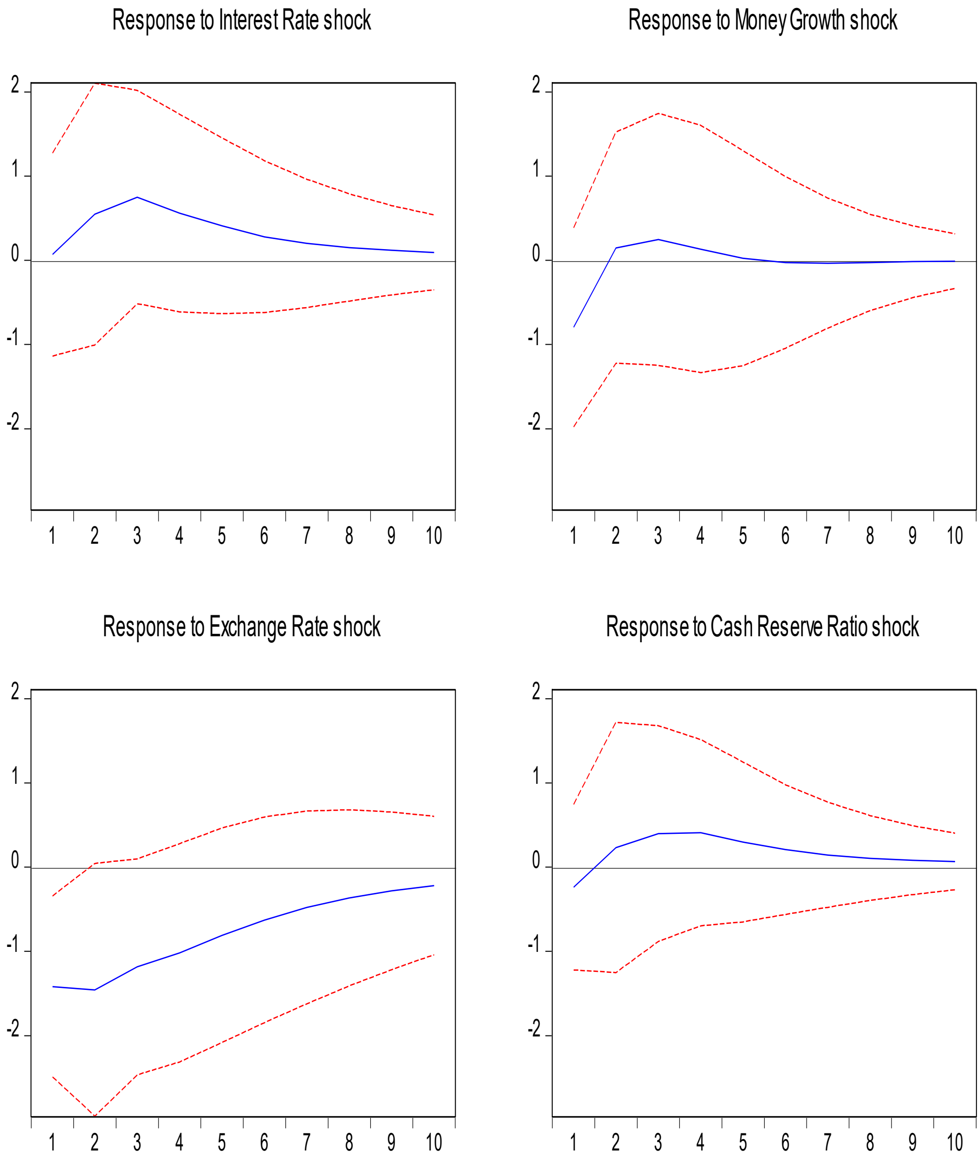
Figure 3: Response of Output Gap to Cholesky One Standard Deviation (d.f. adjusted) innovations ± 2 S.E.

A. <u>Under Financial Uncertainty</u>



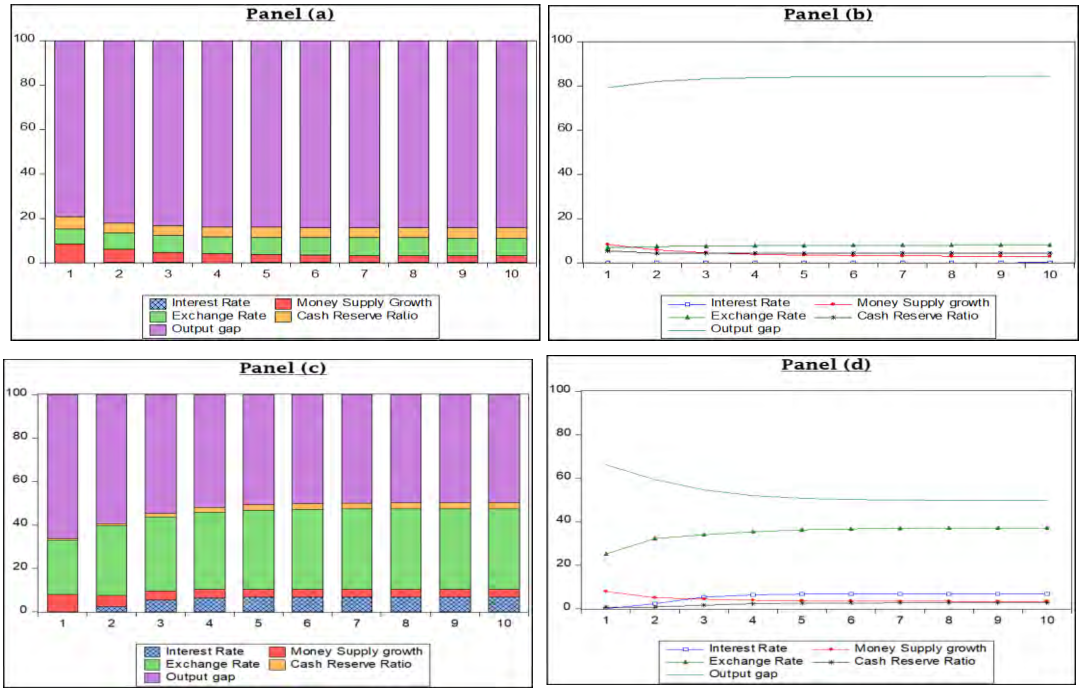
Source: Authors' computation

B. <u>Normal Times</u>



Source: Authors' computation

Figure 4: Forecast Error Variance Decomposition of Output Gap Under
Uncertainty and 'Normal Times'[3]

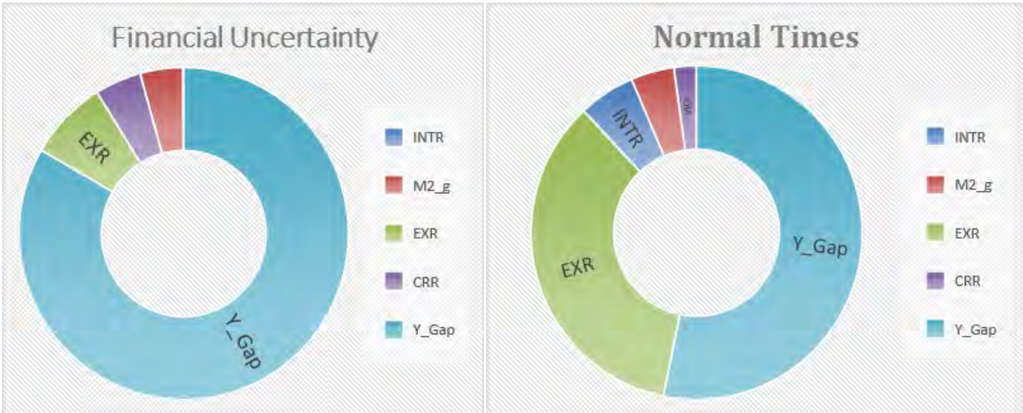


Source: Authors' computation

The summary of the findings is that interest rate policies are less effective in stimulating growth, in periods of financial uncertainty relative to other periods. However, exchange rate policies and policies on liquidity management, including money supply targets and CRR, are more effective in boosting output growth during financial turbulence as shown in Figure 5. Although money supply policies appear to be more effective in initial periods, the impact wears out over time. Generally, exchange rate policies seemingly exert the greatest influence on the path of actual output in Nigeria, and this is not unconnected with the economy's significant dependence on imports and foreign reserves accretion from oil exports.

[3] Panels (a) and (b) are variance decomposition of the output gap under financial uncertainty; while Panels (c) and (d) are the variance decomposition of output gap in 'normal times'.

Figure 5: Average Relative Contributions of Monetary Policy Instruments to Output Gap Variation



Source: Authors' computation

V. Summary, Policy Implications and Conclusion

This paper examined the phenomenon of secular stagnation in the face of financial uncertainty, with a view to determining the most appropriate monetary policy instrument that could be deployed to speed up output gap recovery. A regime-switching VAR technique comprised of a threshold autoregressive (TAR) model and two unrestricted VAR models was applied on quarterly time series for the period 2000Q1-2018Q4. This allowed the analysis of the response of the output gap to shocks to the various monetary policy variables, as well as, the relative contribution of each of the policy variables to output gap recovery.

Results were obtained for both the regimes of financial uncertainty and "normal times". The findings revealed that exchange rate policies exerted the largest impact on output gap, relative to other instruments of monetary policy. Liquidity management policies, including money supply targets and cash reserve requirements, were also noted to be more effective in periods of financial uncertainty; while interest rate policies were less effective under financial uncertainty.

Based on the findings, a key policy implication is the need for the monetary authority to deploy the instruments in its monetary policy arsenal based on their relative effectiveness under different conditions. In times of financial crisis or turbulence, monetary policy should explore exchange rate policies through strategic interventions in the foreign exchange market to mitigate the impact of externally induced financial crises on the Nigerian economy, to bolster a recovery of the output gap. In addition, the paper recommends that liquidity management instruments such as the CRR, liquidity ratio, open market operations, among others should also be explored in times of financial uncertainty given their relative impact on growth in such times. In 'normal times', however, the paper is of the view that interest rate and exchange rate policies would best serve the objective of stimulating output growth.

Although some conventional monetary policy instruments (money supply and CRR) were effective in both uncertainty and normal times, though unequally (see figure 5), interest rate policies were ineffective under financial uncertainty. This may not, however, be attributed to secular stagnation, as the monetary policy authority in Nigeria is not confronted with a zero lower bound (ZLB) challenge. This, therefore, strengthens the notion that unconventional monetary policy could be more effective in stimulating growth during a crisis. However, the relative efficacy of unconventional monetary policy was not tested in the current study, and thus, presents an important area for further research.

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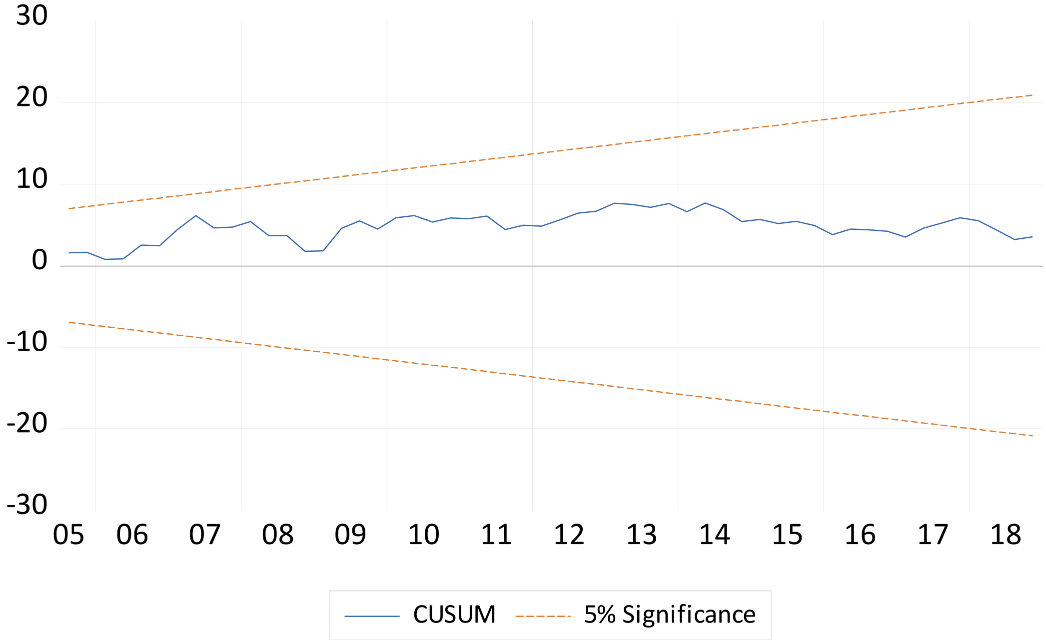
Appendices

Appendix A: CUSUM Test



Appendix B: Lag Length Criteria

Normal Time VAR

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-204.7908	NA	327.3572	19.98008	20.22877*	20.03405
1	-171.8473	47.06218*	166.6600*	19.22355*	20.71573	19.54739*
2	-151.8408	19.05383	440.2723	19.69912	22.43477	20.29283

* 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

Financial Uncertainty VAR

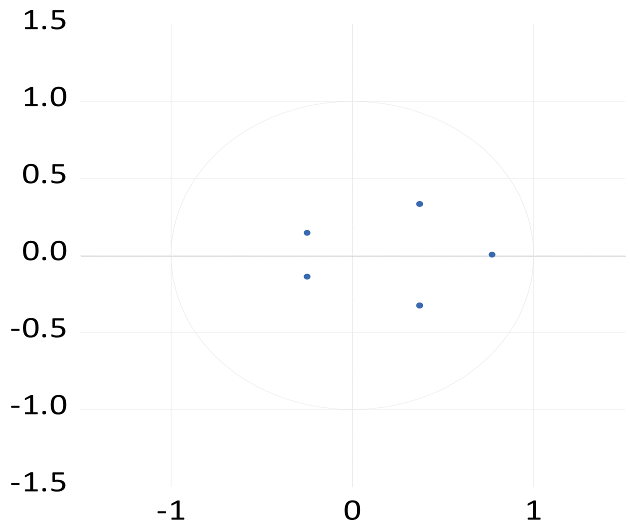
Lag	LogL	LR	FPE	AIC	SC	HQ
0	-416.5923	NA	144.5957	19.16329	19.36604	19.23848
1	-354.5399	107.1815	27.06516	17.47908	18.69558*	17.93022*
2	-335.2771	28.89416	36.76737	17.73987	19.97010	18.56695
3	-298.4447	46.87757*	24.21529*	17.20203*	20.44601	18.40506
4	-281.9261	17.26946	45.59978	17.58755	21.84528	19.16652
5	-264.2645	14.45042	100.8116	17.92111	23.19258	19.87603

* 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

Appendix C: Stability Tests

Normal Time VAR

Inverse Roots of AR Characteristic Polynomial



Financial Uncertainty VAR

Inverse Roots of AR Characteristic Polynomial