



Impact of Exchange Rate Volatility Regime Switching on Inflation in Nigeria

Abdulrahman Abdullahi Nadani ^{1*}, Simon Yusuf²

Received 14/01/2025

Accepted: 23/04/2025

Published: 30/06/2025

<https://doi.org/10.52919/arebus.v6i01.75>

ABSTRACT

This study utilises a markov switching model, and quarterly data spanning from 1980 to 2023 to analyse the regime-switching responses of inflation in relation to exchange rate volatility. Findings show a greater possibility of transitioning from less volatile to high volatile system, the model stays in the low volatility system for an average of 4 quarters and the high volatility for 7 quarters. In addition, volatility in the exchange rate indicates unfavourable influence on output, as evidenced by the statistically significant negative influence observed in each regime. Additionally, interest rates are negatively impacted by exchange rate fluctuations in the two regimes; this relationship is glaring when volatility is low but not when it is high. Moreover, there is a favourable correlation—albeit not a statistically significant one—between inflation and exchange rate volatility in the low and high volatility systems, respectively. Finally, the Toda-Yamamoto demonstrate a unidirectional influence running from exchange rate volatility to economic growth and inflation but no causal relation with the interest rate in either direction. The study highlights the importance of exchange rate stabilisation, curbing inflationary trends, and the promotion of sustainable growth.

Keywords: Economic Growth, Exchange Rate Volatility, Inflation, Interest Rate, Regime Switching, Regression.

JEL Classification: C24, F31

How to cite this article

Nadani , A. A., & Yusuf, S. (2025). Impact of Exchange Rate Volatility Regime Switching on Inflation in Nigeria. *Advanced Research in Economics and Business Strategy Journal*, 6(1), 101-117. <https://doi.org/10.52919/arebus.v6i01.75>

^{1*}  Department of Economics and Development Studies, Federal University of Kashere, Gombe State Nigeria, email: nadaniabdul@gmail.com

²  Department of Economics and Development Studies, Federal University of Kashere, Gombe State Nigeria wamyasy@gmail.com

1. INTRODUCTION

Following the break-down of the Bretton Woods structure in 1970s, many (developed) countries have transitioned to a floating exchange rate arrangement, highlighting its significance as a component or driver of business activity. Following the liberalisation of capital markets in 1980s, developing nations were added to the list in the subsequent two decades. The advent of the flexible/floating exchange rate arrangement has caused rapid deviations, which has prompted researchers to look into how volatility in exchange rate affects economic variables (Sugiharti, et al. 2020). The term “exchange rate volatility” is arbitrary, because it does not specifically define the “equilibrium” resulting from either appreciation or depreciation of the exchange rate. Consequently, there is a sustained consensus in the literature indicating significant fluctuations in exchange rates leading to serious economic disequilibria, and in order to correct this, depreciation would be necessary. This is mostly based on the notion that rising exchange rate volatility breeds uncertainty, which could be detrimental to macroeconomic factors, including inflation. These macroeconomic factors lead to exchange rate volatility and unanticipated risks to both imports and exports (Ibrahim, et al., 2024). Besides, a stable exchange rate facilitates growth. As demonstrated by earlier study of (Ostfeld & Rogoff, 1995) volatility in the exchange rates have a considerable influence on prices via importations in open economies, with monetary policy shock serving as the primary driver of this effect. Similarly, developing countries—of which Nigeria is one—are primarily dependent on imports and confront major obstacles resulting from volatility, which impacts inflation and economic growth (Yunusa, 2020, Olamide, et al., 2022 and Nadani & Sulaimain, 2024).

The Central Bank of Nigeria (CBN) oversaw a fixed exchange rates arrangement before 1986, which was subsequently halted because of overvaluation of the domestic currency and depleting reserves (Ogiogio, 1996). Nigeria introduced the Structural Adjustment Programme (SAP) and the domestic currency was depreciated following the implementation of the Second-Tier Foreign Exchange Market (SFEM) (World Bank, 1994). Significant volatility occurred resulting from the switch to a flexible exchange rates system, with import costs serving as the main driver which in turn triggered an increase in inflation of nearly 40 percent. The anticipated adverse effects of inflation, which peaked in 1995 at 72.8 percent, led the CBN changed to a double arrangement between 1994 and 1998. These include an official rate and a parallel rate expressing real fluctuations in supply and demand. Volatility continued to rise because of distortions and speculative activity brought about by the divergent between operated exchange rate systems. In 1999, the CBN launched the Interbank Foreign Exchange Market (IFEM) in an effort to harmonise exchange rates through implementing a manage-float exchange rate regime, inflation modestly decrease to about 6.6 percent. The Naira depreciated in 2016 due to Nigeria’s economic recession, which was accompanied by an inflation rate of about 18 percent. This resulted the CBN to intervene in the Forex market by floating the Naira, and establishing the Investors and Exporters (I&E) window, during which inflation averaged 16.5 percent in 2017. The CBN further implemented foreign exchange controls and restricted access for specific imports; while depreciating the Naira numerous times. This increased speculation and heightened volatility (CBN, 2018).

Therefore, it is clear Nigeria's exchange rate systems—which comprised of managed float, fixed, and flexible arrangements—have seen varying inflationary pressures. In spite of the CBN measures, such as the SAP and the creation of the I&E window, inflation continue to be a persistent issue, specifically as domestic currency depreciation and speculative behaviour amid dual nature of exchange rate arrangements triggering volatility. Consequently, a better understanding is necessary given how narrow the scope is in the literature. In light of this context, this study investigates how inflation is impacted by volatility in the exchange rate using a markov switching model.

However, unlike other findings on volatility in currency rate and inflation in Nigeria, this study uses Markov switching model, which improves precision by accounting for changes in economic regimes that linear models might not be able to capture. Furthermore, the Markov switching model captures volatility clustering, a characteristic that currency rate in Nigeria commonly displays, and provides a robust measure between exchange rate volatility and inflation (Oaikhenan & Aigheyisi, 2015). The Toda-Yamamoto test is incorporated into the study to ascertain the course of causation between variables under investigation.

The remainder of the research is organised as follows. The literature is discussed in the subsequent part, followed by the methodology and data in section 3, the findings in section 4, and a conclusion and policy recommendations in section 5.

2. LITERATURE REVIEW

2.1 Theoretical framework

The link regarding volatility in exchange rate and inflation remains a key subject in macroeconomics, with numerous theoretical viewpoints defining how exchange rate volatility affects inflation. For example, the concept of “purchasing power parity” (PPP) introduced by (Cassel, 1918) defined the PPP as either the ratio of price levels between countries (known as absolute PPP) or the disparity in exchange rate between countries which should be proportionate to their difference in inflation rates. In the PPP theory, the equilibrium of the exchange rate is defined in two ways. Firstly, is the short run equilibrium which account for divergences in the exchange rates that would prevail in a flexible exchange rate arrangement. Secondly, is the long run equilibrium where fixed rates achieve balance of payment equilibrium over a period of time after accounting for cyclical changes resulting from domestic and foreign business cycles while presuming no specific measures or policies in place to avert balance of payment disequilibrium. According to the PPP theory's further assertions, the short-term equilibrium depends on the long-term equilibrium, meaning that the former has a tendency towards the latter. Furthermore, the PPP is either the primary factor influencing the long-term equilibrium or its core determinant.

Another viewpoint is the menu cost and price stickiness. This suggests that menu cost might result in enough price rigidity to have a significant impact on businesses or businesses may postpone price changes if they believe the exchange rate change is only short-lived, which could reduce the inflation response to exchange rate volatility (Mankiw, 1985). It was proposed by (Akerlof & Yellen, 1985) that businesses are unlikely to adjust prices because of bounded rationality except the reward is more than insignificant. Because of the inertia that results from this bound rationality, actual wages and prices could vary while output remains fixed.

Additionally, the exchange rate pass through showed that fluctuating exchange rates have an impact on both import and export pricing, leading to appreciation/depreciation in the domestic currency which either makes businesses pay more or less for foreign goods. The magnitude of market competitiveness determines how much of this pass-through occurs (Ha, et al., 2020). This pass through is either partial or full. The former indicates marginal impact on consumers prices whereas the latter happens when exchange rates are fully reflected in consumer pricing, frequently resulting in goods becoming more or less expensive based on fluctuations in domestic currency (Burststein & Gopinath, 2014). The degree to which changes in exchange rates impact rising prices is frequently determined by the pass-through threshold. Domestic currency driving consumer goods rise swiftly in countries with a significant exchange rate pass through because firms will often pass on the increased cost of imports to customers sooner rather than later. This may cause inflation to grow more quickly, especially in business sectors that depend significantly on imported commodities (Valogo, et al., 2023).

2.2 Empirical literature

Some studies have revealed that the empirical literature on the link amid inflation and volatility of exchange rates have a favourable influence on inflation. while it has also been found to have a negative or insignificant influence in other studies. These findings were based on variations in their countries of study, data, and techniques adopted. The literature specifically focuses on emerging economies and developing countries.

In light of this, recent research has shown that currency volatility significantly and favourably influences inflation. (For instance, (Ejaz & Khalid, 2024; Musa, 2021; Keefe, 2020; Miyajima, 2020; Yabu & Kimolo, 2020; Osabuohien et al., 2018; Viola, et al., 2017 and Adeniji, 2013). (Musa, 2021) demonstrated that the volatility in exchange rate and selected variables cointegrate. The findings further indicated the supply of money and exchange rate significantly impact inflation. According to (Keefe, 2020), advanced as well as emerging countries can achieve their inflation targeting objectives while currency volatility is below 1 percent, but if it exceeds the threshold of 1, they are either inept or tentative to react to changes in the inflation gap. (Miyajima, 2020) suggests that increased volatility in exchange rates in South Africa contributes to hike in inflation, although only to a moderate level. Finding supports the notion of floating the rand as a buffer against shocks. (Yabu & Kimolo, 2020) found a positive insignificant influence on inflation in Tanzania, Kenya, and Uganda. (Obuohien, et al., 2018) state that although currency rates fluctuation has a substantial influence on inflation over the long-run, parallel market volatility only has a short-run effect on prices, while the official rates fluctuations have a long-run effect on prices. (Viola, et al., 2017) utilised the (GARCH) and the (EGARCH) to investigate the effect of currency rate volatility on inflation in Brazil. The two models indicated high persistence volatility on inflation.

According to a few research, inflation's reactions to exchange rate fluctuation were either negative or insignificant. (For example, (Ejaz & Khalid, 2024; Shafique, et al., 2022; Gidigbi, et al., 2018; Inam, 2015; and Mulwa, 2013). According to (Ejaz & Khalid, 2024), in countries like Pakistan, India, Indonesia, the Philippines, and Turkey currency rate volatility is quite significant. However, volatility tends to have inverse and insignificant influence on inflation in economies like Malaysia, Poland, Hungary, Georgia, and Egypt. (Shafique, et al., 2022) did not find a cointegrating relationship among inflation and exchange rate volatility. According to

their findings, Pakistan's inflation and currency rate volatility are negative and insignificantly correlated. (Gidigbi et al., 2018) found no connection between exchange rates fluctuations and inflation in the short-run, however, there is a short-term positive correlation between inflation and money supply in Nigeria. Another study by (Inam, 2015) showed inflation rate is impacted negatively insignificant by exchange rate fluctuation. The study's granger causality further indicates the absence of relationship by demonstrating no causation between the variables.

3. DATA AND METHODOLOGY

3.1 Data

Data are obtained on quarterly basis for all variables from 1980 to 2023. This includes the real exchange rate (exr_t) indicating fluctuations in Naira's value in relation to US dollars. It is the variable of interest the study seeks to analyse its volatility on inflation. Inflation (π_t) proxied by consumer price index. Additional variables are included as control variables based on relevant research and theory, such as: interest rate (i_t) which represents the rate, CBN grants credit to financial institutions. It acts as a benchmark for commercial banks as they set their interest rates for loans and deposits to their customers' while the GDP (y_t) is the most widely used metric to determine the size of an economy. It calculates the total final output produced by the economy over a specific time period. The time period that was picked is pertinent to the study since it encompasses Nigeria's exchange rate liberalisations and was chosen based on data that were readily available, which is sufficient to yield reliable results. The data is downloaded from the IMF which is publicly accessible at <https://data.imf.org/IFS>.

3.2 Methodology

Exchange rate volatility is estimated based on ARCH/GARCH model following (Bollerslev, 1986) defined as:

$$\sigma_t^2 = \alpha_0 + \sum_{i=1}^p \alpha_i u_{t-i}^2 + \sum_{i=1}^q \beta_i \sigma_{t-i}^2 \quad (1)$$

Where: σ_t^2 = the variance at time t , α indicates the constant, α_i is the ARCH term (u_{t-i}^2) coefficient and β is the GARCH term (σ_{t-i}^2) coefficient.

A baseline VAR is specified as follows:

$$x_t = \alpha + \sum_{i=1}^q \beta_i x_{t-i} + u_t \quad (2)$$

Here, equation (2) indicates a VAR system of endogenous variables where x_t is volatility in the exchange rates, policy rates, inflation rates and RGDP whereas u_t is the stochastic error term. Since equations (2) presume a linear relationship between the variables and justify for structural fluctuations, the Markov switching autoregressive MS-AR(p) approach is utilised because it is a nonlinear time-series model that accounts for structural breaks in the data series introduced by (Hamilton, 1990) specified as follows:

$$x_t = \alpha(s_t) + \left[\sum_{i=1}^q \sigma_j (x_{t-i} - \alpha(s_{t-i})) \right] + \delta(s_t)u_t \quad u_t \sim NID(0, \delta^2) \quad (3)$$

Here, x_t indicates the exchange rate volatility, α and δ are determined by the regime (s_t) at time t , α is AR(p) model and u_t is the error term. In addition, (s_t) and (s_{t-i}) takes the value of 1 and 2 indicating a high volatility and low volatility, respectively.

Furthermore, (Krolzig, 1997) subsequently broadened the MS-AR(p) proposed by (Hamilton, 1990) to multivariate MS-VAR model which is specified as extension of equation (3):

$$\begin{aligned} exrvol_t = & \beta_{st} \sum_{i=1}^q \beta_1(st) exrvol_{j-q} + \sum_{i=1}^q \beta_2(st) \pi_{j-q} + \sum_{i=1}^q \beta_3(st) i_{j-q} + \sum_{i=1}^q \beta_4(st) y_{j-q} \\ & + \omega(st) u_{exrvol,t} \end{aligned} \quad (4)$$

$$\begin{aligned} \pi_t = & \lambda_{st} \sum_{i=1}^q \lambda_1(st) \pi_{j-q} + \sum_{i=1}^q \lambda_2(st) i_{j-q} + \sum_{i=1}^q \lambda_3(st) exrvol_{j-q} + \sum_{i=1}^q \lambda_4(st) y_{j-q} \\ & + \omega(st) u_{\pi,t} \end{aligned} \quad (5)$$

$$\begin{aligned} i_t = & \sigma_{st} + \sum_{i=1}^q \sigma_{1j}(st) i_{j-q} + \sum_{i=1}^q \sigma_{2j}(st) \pi_{j-q} + \sum_{i=1}^q \sigma_{3j}(st) exrvol_{j-q} + \sum_{i=1}^q \sigma_4(st) y_{j-q} \\ & + \omega(st) u_{i,t} \end{aligned} \quad (6)$$

$$\begin{aligned} y_t = & \delta_{st} + \sum_{i=1}^q \delta_1(st) y_{j-q} + \sum_{i=1}^q \delta_2(st) \pi_{j-q} + \sum_{i=1}^q \delta_3(st) i_{j-q} + \sum_{i=1}^q \delta_4(st) exrvol_{j-q} \\ & + \omega(st) u_{y,t} \end{aligned} \quad (7)$$

Where $exrvol_t$ is the fluctuations in the exchange rates, π_t implies inflation, i_t indicate interest rates and y_t is the real GDP. $u_t \sim NID(0,1)$ in equation (4) to (7) defined as the stochastic error term. (st) is a random regime variable with a covariance matrix $\omega(st)$ determined by regime (st). Equations (4) through (7) above describe how the state variable (st), is assumed to be an ergodic q-state Markov process, causes the behaviour of the dependent variables to move from one regime to another. This suggests that a current regime (st) is dependent on an earlier regime, (s_{t-1}). Transition probability between states uses the following notation:

$$P_r(s_t = j | s_{t-1} = i, s_{t-2} = k, \dots) = P_r(s_t = j | s_{t-1} = i) = P_{ij} \quad (8)$$

The transition probability is distinct by a ($q \times q$) matrix denoted as:

$$P = \begin{bmatrix} P_{11} & P_{12} & \dots & P_{1q} \\ P_{21} & P_{22} & \dots & P_{2q} \\ \vdots & \vdots & \dots & \vdots \\ P_{q1} & P_{q2} & \dots & P_{qq} \end{bmatrix}, \sum_{j=1}^q P_{ij} = 1, \text{ with } i = 1, 2, \dots, q \text{ and } 0 \leq P_{ij} \leq 1. \quad (9)$$

Moreover, the anticipated duration to remain in a specific regime is provided by the transition probabilities stated as:

$$E(D) = \frac{1}{1-P_{ij}}. \quad i = 1, 2 \text{ and } j = 1, 2 \dots \quad (10)$$

D indicates the anticipated period expected to stay in a regime.

To ascertain if the fluctuations in exchange rates is an imperative indicator of inflation in Nigeria, the study advance to employ (Toda & Yamamoto, 1995) causality test, which is an improvement over the standard (Granger, 1969) causality analysis. In order to perform the test, augmented VAR model ($q + dmax$) is estimated. $dmax$ is the optimum integrated order and q is the ideal time lag from the initial VAR model presented as follows:

$$\begin{aligned} exrvol_t = & \alpha_0 + \sum_{i=1}^q \beta_i exrvol_{t-i} + \sum_{i=q+1}^{q+dmax} \beta_i exrvol_{t-i} + \sum_{i=q+1}^q \delta_i \pi_{t-i} + \sum_{i=q+1}^{q+dmax} \delta_i \pi_{t-i} \\ & + \varepsilon_t \end{aligned} \quad (11)$$

$$\begin{aligned} \pi_t = & \theta_0 + \sum_{i=1}^q \lambda_i \pi_{t-i} + \sum_{i=q+1}^{q+dmax} \lambda_i \pi_{t-i} + \sum_{i=1}^q \sigma_i exrvol_{t-i} + \sum_{i=q+1}^{q+dmax} \sigma_i exrvol_{t-i} \\ & + \varepsilon_t \end{aligned} \quad (12)$$

Whilst $exrvol_t$ π_t are defined, $\alpha, \beta, \delta, \theta, \lambda$ and σ are coefficients of the model. $\varepsilon_t \sim N(0, \sum \varepsilon_t)$ is the residual in equation (11) and (12). The null hypothesis of no causality is examined against the alternative of causality from volatility in exchange rates to inflation and vice-versa.

4. EMPIRICAL FINDINGS

4.1 Descriptive result

Descriptive result is exhibited in Table 1 in their raw form. It is shown that the mean exchange rate volatility is 2.14 percent, whereas the average real GDP is approximately 114.39 billion. Whilst inflation is given as 3.01 percent, interest rate is roughly 17.12 percent on average. One can infer that approximately half of the observations have zero or no volatility from the median exchange rate volatility of 0. With a real GDP median of 110.85, half of the values fall below and half rise over this threshold. While the median interest rate is 17.10 percent, the median inflation rate is 3.58 percent. The highest exchange rate volatility observed is 6.58 percent. Furthermore, the highest recorded real GDP is 460. The maximum inflation rate is 6.11 percent whereas 34.87 percent is the highest short-term interest rate. In addition, exchange rates have the lowest volatility at -7.30 percent, which suggests negative volatility and could indicate appreciation. Real GDP must be at least 0.53 billion. Deflation is shown by the lowest rate of inflation, which is -0.97 percent. At 8.03 percent, the interest rate is at its lowest. A moderate dispersion around the mean is shown by the exchange rate fluctuation with a deviation

of 1.40. With high standard deviation (SD) of 120.30, real GDP indicates a substantial amount of data volatility. There is a substantial amount of variance from the mean, as indicated by the inflation standard deviation of 2.14. The 5.01 standard deviation of interest rates indicates some volatility. For asymmetry, real GDP and interest rate distributions are positively skewed, whereas the currency rate volatility and inflation distributions are less symmetrical. The kurtosis of exchange rate volatility is leptokurtic, implying a heavy-tailed distribution. The distribution of real GDP and interest rate appears to be mesokurtic, or close to normal, based on its kurtosis value of 3. The distribution of inflation is flatter and has fewer extreme values when its kurtosis is low (platykurtic). According to the Jarque-Bera statistic, Real GDP, inflation, and exchange rate volatility all substantially vary from the normal distribution, The interest rate, however, follows a normal distribution.

Table 1: Descriptive statistics

Variables	<i>exrvol</i>	<i>y</i>	π	<i>i</i>
Mean	0.021426	114.3894	3.013296	17.11752
Median	0.000000	110.8500	3.579975	17.09667
Maximum	6.579296	460.0000	6.111939	34.86667
Minimum	-7.298837	0.533561	-0.969759	8.033333
Std. Dev.	1.396942	120.2970	2.135872	5.009308
Skewness	-0.080773	1.078653	-0.455799	0.380765
Kurtosis	11.02221	3.346605	1.842736	3.718496
Jarque-Bera	461.4037***	34.21441***	15.55361***	7.855838
Probability	0.000000	0.000000	0.000419	0.019685
Sum	3.685263	19674.97	518.2869	2944.213
Sum Sq. Dev.	333.6973	2474603.	780.0935	4290.932

*** indicates significance at 1 percent level.

In order to determine whether multicollinearity exists, the correlation analysis examines the strength and scope of the parameters. The results are presented in Table 2. The correlation matrix in Table 2 exhibits a negative correlation between real GDP, inflation, interest rates and the volatility of the exchange rates. Furthermore, the correlation is statistically insignificant.

Table 2: Correlation analysis

Variables	<i>exrvol</i>	<i>y</i>	π	<i>i</i>
<i>exrvol</i>	0.229366			
	1.000000			

y	-1.2801008	1.109221		
	(-0.004957)	1.000000		
	0.9173	-----		
π	-0.022381	3.83E+10	1.693458	
	(-0.023638)	(0.887182)	1.000000	
	0.7952	0.0000	-----	
i	-14043356	-3.27E+18	-21583422	3.509341
	(-0.07510)	(-0.145309)	(-0.063286)	1.000000
	0.7769	0.0567	0.4868	-----

Note: The values in parenthesis are the t-statistics and the associated probability values are presented underneath. The notations *exrvol*, y , π , and i represent exchange rate volatility, economic growth, inflation, interest rate respectively.

4.2 Unit root test

In order refrain from employing non-stationary series in the study, unit root tests are carried out. As a result, this study conducts and reports the findings of the Augmented Dickey Fuller (ADF), Phillip-Perron (PP), and Kwiatkowski-Phillips-Schmidt-Shin (KPSS) tests given in Table 3. The results demonstrate that the variables are stationary at first difference, with the exception of exchange rate volatility, which is stationary at level based on the ADF test. Thus, while the other variables are initially differenced, exchange rate volatility is evaluated in level form.

Table 3: Unit root testing

Variable	ADF Test		PP Test		KPSS Test	
	Level	First Diff.	Level	First Diff.	Level	First Diff.
<i>exrvol</i>	3.3124*	-0.6022***	3.2124*	-12.1106***	0.1103	0.0903***
π	2.2131	-4.1419***	2.1312	-8.1141***	0.1123	0.3502***
y	2.4531	-11.6369***	2.5313	-11.6128***	0.1234	0.7852***
i	2.9784	-12.6836***	2.7831	-12.6834***	0.1210	0.1590***

Note: that the significance levels at 1%, 5%, and 10% are denoted by the symbols ***, **, and *. The critical values for the KPSS test are 0.739000, 0.463000, and 0.347000, or 1%, 5%, and 10%, respectively, while the critical values for the intercept without trend are -3.479, -2.883, and -2.578.

4.3 Markov-switching VAR result

Table 4 illustrates the Markov switching VAR model of exchange rate volatility, which is categorized into two regimes: low- and high-volatility, defined as regimes 1 and 2, respectively. It is evident that the first regime is less volatile than the second regime given their standard deviations of 0.076 and 0.336, respectively. Further, regime 1 low exchange rates volatility is anticipated to last for an average of three to eight quarters, while regime 2 high volatility is expected to last for an average of eight to fourteen quarters.

The influence of exchange rates fluctuations on prices is positively statistically insignificant. Whilst the volatility can create some pressure for inflation, a positive insignificance in the exchange rate volatility exhibits a weak relationship or that it is moderated by other factors, such as zero pass through of exchange rate or significant government regulation and subsidies. In the alternative the CBN can be acting on other margins, which makes the effects of inflation less visible. The findings further indicate the degree of the exchange rates fluctuations on inflation is higher in the first regime (i.e., low volatility) than that of the second regime (i.e., high volatility). This is due to the possibility that businesses and consumers won't anticipate large fluctuations in the exchange rate (i.e., regime 1). As a result, these economic agents may overreact because they anticipate stability, any little swings in the exchange rate could result in considerable inflationary pressures. According to a different perspective, given Nigeria's heavy reliance on imports, exchange rate changes may result in considerable price increases during periods of low volatility, as regime 1 demonstrates. To lessen the effects, firms and consumers may have hedged during period of high volatility as indicated in regime 2.

Furthermore, the interest rate is negatively influence by exchange rate volatility in both regimes. However, whilst the second regime (high volatility) is statistically insignificant, the first regime (low volatility) is significant at 5 percent level. That could be because individuals and businesses are getting used to the low-volatility environment, which would give the CBN room to keep interest rates lower while not having to worry so much about exchange rate pressure pushing up inflation. The statistically significant negative relationship in the first regime (low volatility) indicates that when volatility is minimal, low interest rates can effectively enhance price stability. However, in the second regime (high volatility), variables including stickiness in prices or regulation may prevent the exchange rate from rapidly translating into inflation. The absence of statistical significance further reinforces the insignificant influence of the exchange rates on inflation, and may suggest excessive exchange rates volatility does not put enough strain on inflation to induce the CBN to hike rates.

With respect to economic growth, the relationship with exchange rate volatility is similar to (Olamide, *et al.*, 2022 & Barguelli, *et al.*, 2018), which revealed negative significant influence exchange rates fluctuations on real GDP in both regimes. Indicating an unfavourable influence of exchange rates volatility on Nigeria's GDP. This finding implies that the economy appears to be more susceptible to exchange rates fluctuations because of its excessive reliance on imports, particularly for capital goods, raw materials, and products involving refined petroleum. Given Nigeria's economy reliant on the export of crude, its decline could weaken the foreign exchange reserves further depreciating the home currency, increasing volatility. Notwithstanding the fact that a weaker Naira can increase export-related efficiency,

the aforementioned variable does not seem to have contributed significantly to growth given the structural obstacles to the economy. Not only that, but non-oil exports are yet underdeveloped, so the theoretical benefits of a falling exchange rate are not realised.

Table 4: MS-VAR Model

Variable	Std. Dev.	Coeff.	Standard Error	Z-Statistic	Probability
Regime 1:					
Log(Sigma)		-3.397996	0.112586	-30.18122	0.0000
Standard Deviation	0.075654				
P11		-0.398262	1.998550	-0.199276	0.8420
Average Duration	7.838853				
Correlation					
Regime 2:					
Log(Sigma)		0.464230	0.073089	6.351542	0.0000
Standard Deviation	0.336191				
P21		8.808856	2.761616	3.189747	0.0014
Average Duration	14.45230				
Correlation					
Transition Matrix Parameters					
P11- y		-0.026676	0.011447	-2.330472	0.0198
P11- i		-0.500462	0.201895	-2.478828	0.0132
P11- π		1.145420	0.620063	1.847263	0.0647
P21- y		-0.012685	0.008261	-1.535489	0.0247
P21- i		-0.122903	0.106487	-1.154153	0.2484
P21- π		0.652022	0.433730	1.503287	0.1328

In addition, the anticipated time of stay in both regimes were given by the expected duration = $\left(\frac{1}{1-P_{ij}}\right)$. Therefore, the anticipated period in the both regimes is 1.66185 and 7.1685, respectively. This result implied that there is 45 percent chances of staying in the regime 1 for a duration of 4 quarters equivalent to 12 months. Also, there is 86 percent probability of staying in regime 2 for a duration of 7 quarters equivalent to 28 months, indicating an extended period of domestic currency instability in Nigeria. This finding is further evident by the Markov's time-varying expected durations in Figure 1 and Figure 2 below.

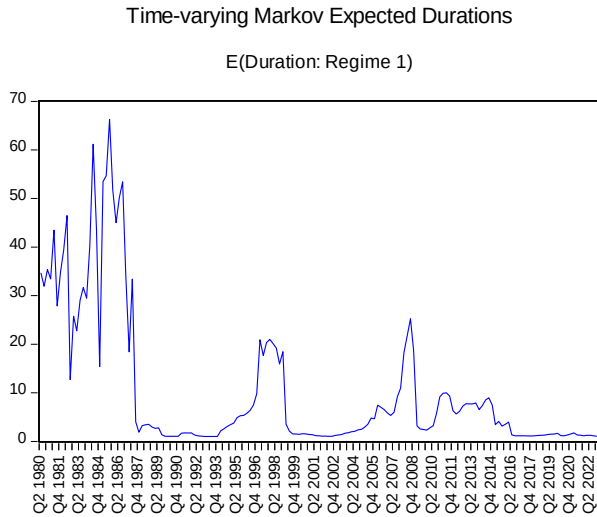


Fig. 1: Time-varying markov expected duration regime 1.

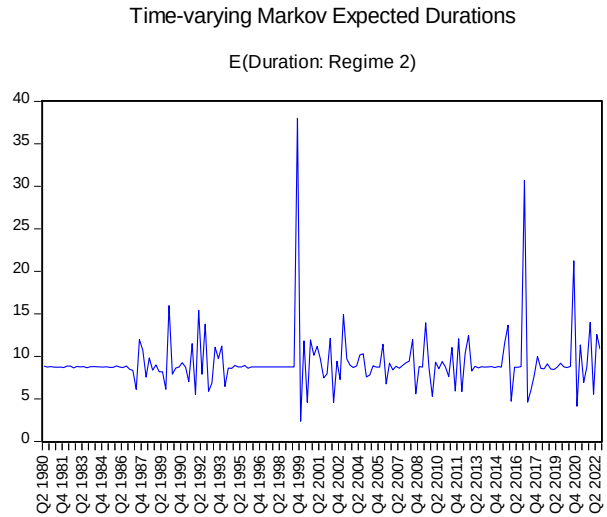


Fig. 2: Time-varying markov expected duration in regime 2.

Furthermore, the probabilities of shifting from low volatility system to high volatility system is given as:

$$P_{ij} = \begin{bmatrix} P_{11} & P_{12} \\ P_{21} & P_{22} \end{bmatrix} = \begin{bmatrix} 0.398262 & 0.6004491 \\ 0.139541 & 0.860459 \end{bmatrix}$$

Therefore, $P_{11} = 0.398262$ and $P_{22} = 0.860459$, indicates a low probability of staying in the low volatility phase for about 4 quarters and the likelihood of remaining in high volatility phase for about 7 quarters, respectively. Nonetheless, the possibility of changing from the low volatility phase to the high volatility phase is greater than that of changing from the high volatility to the low volatility phase. This highlights Nigeria's vulnerability to external factors, institutional ineffectiveness, and the challenges in sustaining stable long-term exchange rates.

Additionally, the findings further present the filtered and smoothed regime probability for the high volatility in Figures 3 and Figure 4. The probability clearly exhibits rapid switches between 0 and 1, signifying regimes of low and high volatility, respectively. It also shows that the low volatility phase is typically more resilient as opposed to the high volatility phase. Nonetheless, from 2004 to 2007, 2011, 2015, and 2019, high volatility persisted throughout the sample. This may be explained by external shocks, specifically changes in global oil prices. Also, these periods coincide with election years, which could heighten volatility of exchange rates during these periods.

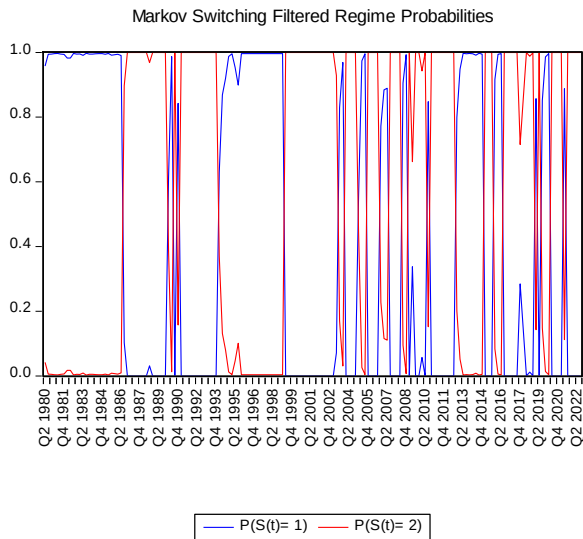


Fig. 3: Filtered regime Probability

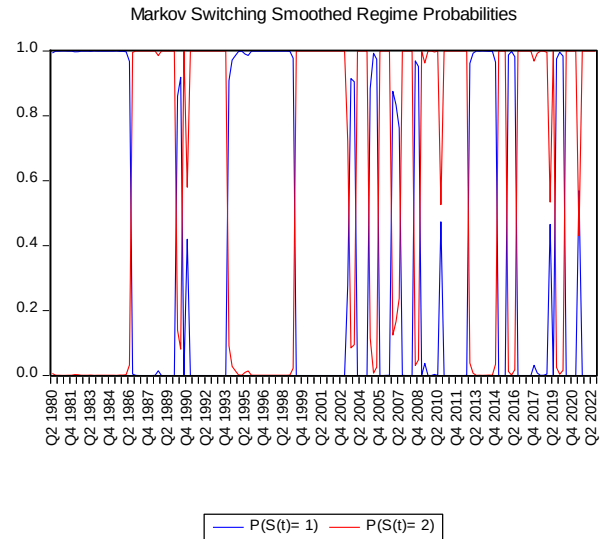


Fig. 4: Smoothed regime Probability

Lag Selection criteria

Prior to estimating the (Toda & Yamamoto, 1995) test, the study presents the appropriate information selection criteria in Table 5. Consequently, the least number of the chosen information criterion determines the ideal lag. This means that the lower the selected statistics the better the model fits the data. Hence, lag four is chosen, centered on the Schwarz criteria as oppose to the other selection criterion that selects lag of seven.

Table 5: Appropriate lag selection measure

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-290.9239	NA	2.135639	3.596633	3.672240	3.627326
1	-270.1326	40.31491	1.677689	3.355275	3.449783	3.393642
2	-268.0809	3.953179	1.656333	3.342450	3.455860	3.388490
3	-262.3534	10.96621	1.563570	3.284797	3.417108	3.338510
4	-250.3018	22.92737	1.366458	3.150022	3.301235*	3.211408
5	-249.1433	2.189765	1.363865	3.148089	3.318204	3.217149
6	-247.9774	2.189663	1.361164	3.146066	3.335082	3.222799
7	-245.2580	5.074095*	1.332986*	3.125097*	3.333015	3.209504*
8	-244.3350	1.710911	1.334319	3.126036	3.352856	3.218116

4.4 Toda-Yamamoto causal effect between exchange rate volatility and selected variables

Based on the modified Wald (MWALD) test, the Toda-Yamamoto causality is presented in Table 6, to demonstrating the null hypothesis of Granger non causation between exchange rates volatility and economic growth (GDP) at the 5 percent significant level. However, the analysis is unable to disprove the null hypothesis, which holds that exchange rate volatility is not caused by real GDP. This suggests a unidirectional causal influence between real GDP and

exchange rates fluctuation. Additionally, the study shows a unidirectional causal relationship between inflation and exchange rate volatility at a significance level of 5 percent. Nonetheless, there is absence of causality between interest rates and exchange rates instability.

Overall, given that trade and investment uncertainties are likely to influence exchange rates which in turn will reduce output and business activities in Nigeria hence it becomes a factor that can exacerbate the significant effect of exchange rate fluctuations on real GDP. Equally, volatile exchange rates in an economy reliant on imports leads to price fluctuations which results in causality from exchange rate fluctuations to inflation rather than the other way around. Given the absence of causality in either direction between monetary policy rates and exchange rate volatility, it is likely the CBN uses other policy instruments to manage exchange rates fluctuations.

Table 6. Toda-Yamamoto test

Null hypothesis	Chi-square	df	Probability	Decisions
$exrvol \neq y$	67.99	2	0.0000	Reject H_0
$y \neq exrvol$	0.24	2	0.8858	Accept H_0
$exrvol \neq \pi$	20.93	2	0.0022	Reject H_0
$\pi \neq exrvol$	1.21	2	0.5449	Accept H_0
$exrvol \neq i$	0.46	2	0.7927	Accept H_0
$i \neq exrvol$	1.39	2	0.4986	Accept H_0

Note: $\neq$ indicating no granger causality

5. CONCLUSION AND RECOMMENDATIONS

A Markov switching model with two regimes—first regime (low volatility) and a second regime (high volatility)—is used to investigate the effect of volatility in exchange rates on inflation in Nigeria utilising quarterly data traversing from 1980 to 2023. The model demonstrates regime-switching behaviour, as evidenced by the findings, with a smaller likelihood of staying in the first regime (low volatility) for four quarters (12 months) than in the second regime (high volatility), where the model persists for seven quarters (28 months). Moreover, there is a greater possibility of going from first regime (low volatility) to second regime (high volatility).

This implies that during phases of low volatility (first regime), interest rates are more impacted exchange rate fluctuations. Furthermore, high exchange rate volatility fuels inflation even though the relationship is not statistically significant. In furtherance, the Toda-Yamamoto causality revealed that fluctuations in exchange rates exhibits a causal relationship with economic growth and inflation rates but not with interest rate.

To lessen existing volatility and promote growth, the following policy measures are suggested in light of the findings obtained. First, exchange rate volatility may nonetheless trigger inflationary pressures despite the fact its statistically insignificant. Therefore, the CBN should keep a careful eye on inflation and pursue policies like inflation targeting to manage

inflation expectations and import substitution to lessen the long-term influence of exchange rate fluctuations on prices.

Second, the CBN ought to take more caution when altering interest rates amid periods of lower exchange rate volatility because interest rates are negatively influenced by exchange rate fluctuations, especially in the low-volatility regime. These measures could include gradualism in interest rate hike to avoid sudden shock, and effective future monetary policy communications regarding market expectations.

Third, volatility in exchange rates have a detrimental effect on growth, therefore, the CBN ought to give priority to measures that stabilise the exchange rate. These could include keeping sufficient foreign exchange reserves, a greater diversified economy would promote economic growth, reduce dependency on oil exports, and be less vulnerable to fluctuations in exchange rates, and putting policies that encourage an increasingly flexible exchange rate system.

There are some major drawbacks to the study. First of all, high frequency data provide a more instantaneous and detailed picture of exchange rate volatility, allowing for more precise volatility estimation and improved reactions to quick changes in the market. Nevertheless, the study's medium-frequency data might not provide a more accurate picture of its impact on inflation. Additionally, Nigeria is the exclusive focus of this paper. As a result, the results cannot be applied to other contexts. Therefore, panel studies of different country groups may be carried out as a direction for future research.

REFERENCES

- Adeniji, S. (2013). Exchange rate volatility and inflation upturn in Nigeria: Testing for vector error correction model. <https://mpr.ub.uni-muenchen.de/id/eprint/52062>
- Akerlof, G. A., & Yellen, J. L. (1985). Can Small Deviations from Rationality Make Significant Differences to Economic Equilibria? *The American Economic Review*, 75(4), 708–720. <http://www.jstor.org/stable/1821349>
- Barguelli, A., Ben-Salha, O., & Zmami, M. (2018). Exchange rate volatility and economic growth. *Journal of Economic Integration*, 33(2), 1302-1336 <http://dx.doi.org/10.11130/jei.2018.33.2.1302>
- Bollerslev, T. (1987). A conditionally heteroskedastic time series model for speculative prices and rates of return. *The review of economics and statistics*, 542-547. <https://doi.org/10.2307/1925546>
- Burstein, A., & Gopinath, G. (2014). International prices and exchange rates. In *Handbook of international economics* (Vol. 4, pp. 391-451). Elsevier. <https://doi.org/10.1016/B978-0-444-54314-1.00007-0>
- Cassel, G. (1918). Abnormal deviations in international exchanges. *The Economic Journal*, 28(112), 413-415.
- CBN, (2018). Central Bank of Nigeria Statistical Bulletin, Abuja, Nigeria
- Ejaz, M., & Khalid, Q. (2024). Empirical analysis of pass through of exchange rate and its volatility to inflation in selected emerging economies. *Pakistan Journal of Applied Economics*, 34(1), 39-70.
- Gidigbi, M. O., Babarinde, G. F., & Lawan, M. W. (2018). Inflation and exchange rate volatility pass-through in Nigeria. *Journal of Management, Economics, and Industrial Organization*, 2(3), 18-40. <http://doi.org/10.31039/jomeino.2018.2.3.2>

- Granger, C. W. (1969). Investigating causal relations by econometric models and cross-spectral methods. *Econometrica: journal of the Econometric Society*, 424-438. <https://doi.org/10.2307/1912791>
- Ha, J., Stocker, M. M., & Yilmazkuday, H. (2020). Inflation and exchange rate pass-through. *Journal of International Money and Finance*, 105, 102187. <https://doi.org/10.1016/j.jimonfin.2020.102187>
- Hamilton, J. D. (1990). Analysis of time series subject to changes in regime. *Journal of econometrics*, 45(1-2), 39-70. [https://doi.org/10.1016/0304-4076\(90\)90093-9](https://doi.org/10.1016/0304-4076(90)90093-9)
- Ibrahim, K. H., Handoyo, R. D., Kristianto, F. D., Kusumawardani, D., Ogawa, K., Zaidi, M. A. S., ... & Sarmidi, T. (2024). Exchange Rate Volatility and COVID-19 Effects on Indonesia's Food Products' Trade: Symmetric and Asymmetric Approach. *Heliyon*. doi: [10.1016/j.heliyon.2024.e32611](https://doi.org/10.1016/j.heliyon.2024.e32611)
- Inam, U. S. (2015). Exchange rate volatility and inflation in Nigeria: An empirical investigation (1970-2011). *Exchange*, 5(16).
- Keefe, H. G. (2020). The impact of exchange rate volatility on inflation targeting monetary policy in emerging and advanced economies. *International Finance*, 23(3), 417-433. <https://doi.org/10.1111/infi.12368>
- Krolzig, H.M. (1997) Markov Switching Vector Autoregressions Modelling: Statistical Inference and Application to Business Cycle Analysis. Springer, Berlin. <https://doi.org/10.1007/978-3-642-51684-9>
- Mankiw, N. G. (1985). Small menu costs and large business cycles: A macroeconomic model of monopoly. *The Quarterly Journal of Economics*, 100(2), 529-538. <https://doi.org/10.2307/1885395>
- Miyajima, K. (2020). Exchange rate volatility and pass-through to inflation in South Africa. *African Development Review*, 32(3), 404-418.
- Mulwa, B. D. (2013). *The effect of exchange rate volatility on inflation rates in Kenya* (Doctoral dissertation, University of Nairobi).
- Musa, N. (2021). Impact of exchange rate volatility on inflation in Nigeria. *Journal of Contemporary Research in Business, Economics and Finance*, 3(1), 26-38. DOI: [10.33094/26410265.2021.31.26.38](https://doi.org/10.33094/26410265.2021.31.26.38)
- Nadani, A. A., & Sulaimain, U. A. (2024). Exchange Market Pressure, and the Magnitude of Exchange Market Intervention Index in Nigeria. *African Journal of Economic Review*, 12(4), 109-124.
- Oaikhenan, H.E., & Aigheyisi, O. S. (2015). Factors explaining exchange rate volatility in Nigeria: theory and empirical evidence. *Economic and Financial Review*, 53(2), 3.
- Obstfeld, M., & Rogoff, K. (1995). Exchange rate dynamics redux. *Journal of political economy*, 103(3), 624-660.
- Ogiogio, G. (1996). *A statistical analysis of foreign exchange rate behaviour in Nigeria's auction*. AERC.
- Olamide, E., Ogujiuba, K., & Maredza, A. (2022). Exchange rate volatility, inflation and economic growth in developing countries: Panel data approach for SADC. *Economies*, 10(3), 67. <https://doi.org/10.3390/economies10030067>
- Osabuohien, E., Obiekwe, E., Urhie, E., & Osabohien, R. (2018). Inflation Rate, Exchange Rate Volatility and Exchange Rate Pass-Through Nexus the Nigerian Experience. *Journal of Applied Economic Sciences*, 13(2).

- Shafique, A., Hassan, M. U., Shahzad, A., Ali, Q. M., & Saqlain, M. (2022). Exchange Rate Volatility And Its Relationship With Macroeconomic Variables In Pakistan. *Bulletin of Business and Economics (BBE)*, 11(1), 121-131. <https://doi.org/10.5281/zenodo.6412579>
- Sugiharti, L., Esquivias, M. A., & Setyorani, B. (2020). The impact of exchange rate volatility on Indonesia's top exports to the five main export markets. *Heliyon*, 6(1). <https://doi.org/10.1016/j.heliyon.2019.e03141>
- Toda, H. Y., & Yamamoto, T. (1995). Statistical inference in vector autoregressions with possibly integrated processes. *Journal of econometrics*, 66(1-2), 225-250. [https://doi.org/10.1016/0304-4076\(94\)01616-8](https://doi.org/10.1016/0304-4076(94)01616-8)
- World Bank. (1994). Nigeria–Structural adjustment program: policies, implementation, and impact.
- Valogo, M. K., Duodu, E., Yusif, H., & Baidoo, S. T. (2023). Effect of exchange rate on inflation in the inflation targeting framework: Is the threshold level relevant?. *Research in Globalization*, 6, 100119. <https://doi.org/10.1016/j.resglo.2023.100119>.
- Viola, A. P., Klotzle, M. C., Pinto, A. C., & Gaglianone, W. P. (2017). Predicting exchange rate volatility in Brazil. Brasilia Working Paper Series No 466,1-40.
- Yabu, N., & Kimolo, D. (2020). Exchange rate volatility and its implications on macroeconomic variables in East African countries. *Applied Economics and Finance*, 7(3), 145-171.
- Yunusa, L. A. (2020). Exchange rate volatility and Nigeria crude oil export market. *Scientific African*, 9, e00538. <https://doi.org/10.1016/j.sciaf.2020.e00538>