University of Economics in Katowice

Journal of Economics and Management

ISSN 1732-1948 Vol. 37 (3) • 2019

Benjamin Ighodalo Ehikioya

ORCID ID: 0000-0003-3824-3609

Department of Financial Studies,
Faculty of Management Sciences
National Open University of Nigeria
benehikioya@gmail.com

The impact of exchange rate volatility on the Nigerian economic growth: An empirical investigation

Accepted by Editor Ewa Ziemba | Received: September 30, 2018 | Revised: February 8, 2019; May 5, 2019 | Accepted: May 10, 2019.

Abstract

Aim/purpose – Exchange rate volatility has remained a serious issue affecting economic stability, especially in developing countries. Thus, this study aimed at examining the impact of exchange rate volatility on economic growth in Nigeria.

Design/methodology/approach – The study employed the Generalized Autoregressive Conditional Heteroscedasticity (GARCH) model and the system Generalized Method of Moments (GMM) technique to analyse the time series data from the period January 1980 to December 2017. The study used the Augmented Dickey–Fuller and Philips–Perron tests to determine the presence of a unit root and the Johansen co-integration test to establish the relationship among the variables in the study.

Findings – The results of the estimates offer evidence that exchange rate volatility persists throughout the study period, and has a negative and significant effect on the economic growth of Nigeria. This result suggests that excessive volatility due to low inflows is inimical to the growth of the Nigeria economy. The findings of the study demonstrate a negative and significant relationship between inflation and economic growth. Moreover, while credit to the private sector and crude oil prices exerts positive and significant relationship with growth, the relationship between money supply, trade openness and government expenditure and economic growth is positive but insignificant.

Research implications/limitations – Therefore, it is important for the government to pursue policies and programs that would help ensure exchange rate stability and boost local production for both consumption and export. In addition, a holistic program of economic reforms is important to complement the exchange rate policy and stimulate economic growth.

Cite as: Ehikioya, B. I. (2019). The impact of exchange rate volatility on the Nigerian economic growth: An empirical investigation. *Journal of Economics & Management, 37*(3), 45-68. http://doi.org/10.22367/jem.2019.37.03

Originality/value/contribution – The study shed some light on exchange rate volatility and confirmed its adverse effect and the importance of a stable environment on economic growth. In addition, the study introduced crude oil prices as a variable to the study of exchange rate volatility and economic growth from a developing country perspective.

Keywords: exchange rate volatility, economic growth, GARCH, GMM, developing country.
JEL Classification: C13, F43, O47.

1. Introduction

The exchange rate is an important macroeconomic fundamental that influences the economy of a country. It is the conversion rate of a currency to another, and it determines the international competitiveness of a country. In an open economy, where the demand for foreign currency is higher than the supply of foreign currency, exchange rate and its volatility on economic activities can have far-reaching implications on growth (Adewuyi & Akpokodje, 2013; Alagidede & Ibrahim, 2017; Schnabl, 2009). Nigeria operates a mono-cultural economy with over 78% of the foreign earnings to the government accruing from the sale of crude oil at the global market and fluctuations in oil prices could have implications for the economy. Conversely, the country depends on foreign countries for imported raw materials, technology and other related products to hone the economy. The pressure on the foreign exchange due to insufficient foreign earnings to meet the demand has often resulted in the volatility of the exchange rate. Over time, the Nigeria economy, like other economies, has suffered from the effect of persistent exchange rate volatility, instability in macroeconomic variables and the overall poor economic growth. Moreover, compared with the advanced countries with stable market conditions, emerging markets attached importance to this variable because of the degree of uncertainties that characterises their markets and the need to have a stable exchange rate to reduce the cost and risks associated with transactions in foreign exchange.

The interaction between exchange rate volatility and economic growth has been a subject of intense debate among the policymakers, professionals and other stakeholders of the economy. This debate is further heightened with countries' move to a floating exchange rate regime, the liberalisation of the financial markets beginning in the 1980s and the recent global economic crisis affecting economic growth. Moreover, several studies have used an array of methods, control variables and in a different environment to examine exchange rate volatility and its effect on economic growth with conflicting results (Eriș & Ulașan, 2013;

Kiyota & Urata, 2004; Wong, 2017). According to Schnabl (2009), the mixed results on the link between exchange rate volatility and economic growth may be due to country-specific factors such as the level of financial markets development, human capital development, governance and institutional structures. Musyoki, Pokhariyal, & Pundo (2012) documented that the exchange rate volatility is an important determinate of economic growth. This is because high levels of exchange rate volatility can create uncertainties that would disrupt the smooth functioning of the markets and other economic activities. In addition, uncertainties resulting from exchange rate volatility could lead to a reduced international trade; drop in investment and unfair competition that could give an advantage to foreign firms in terms of product pricing.

The economic growth models posit that stable exchange rates may result in lower inflation rates, increased trade and investment, which in turn may boost productivity and economic growth. Despite its effect on economic growth and the importance of previous studies on this issue, the magnitude of exchange rate volatility and its real effects on economic growth is still an open question, especially in developing countries like Nigeria. This is evident in the light of the recent exchange rate fluctuations in Nigeria, especially from the second half of 2015, which along with other factors led to an economic recession in 2016. Exchange rate volatility can occur in economic activities any time and this requires constant investigation, given the widespread effects on economic activities, which is of concern to the government, investors, researchers and other agents of the economy. Additionally, the lack of consistent evidence in emerging markets on the issue of exchange rate volatility and economic growth means that additional work is required to answer the pending question about the relationship between the variables. Thus, the subject of exchange rate volatility in developing countries still needs extended analysis and further research attention, especially when considered as an important determinant for pricing products at the global markets.

Consequently, the principal objective of this paper is to use the Generalized Autoregressive Conditional Heteroscedasticity (GARCH) to model exchange rate volatility and the system Generalized Method of Moments (GMM) model to examine the effect of exchange rate volatility on economic growth in Nigeria. In particular, this paper attempts to shed some light on this issue and find out whether there exists exchange rate volatility in Nigeria. If it does exist, what is the influence on economic growth? The current study postulates that exchange rate volatility has a significant effect on the Nigerian economic growth. The

results of the study suggest that exchange rate volatility persists in Nigeria. The findings indicate that exchange rate volatility is detrimental to Nigerian economic growth. The result shows that while inflation exerts a negative and significant influence on economic growth, credit to the private sector and crude oil prices demonstrates a positive and significant impact on the economic growth of Nigeria. The implication of this result is that exchange rate stability is an important factor along with other macroeconomic variables to achieve economic growth.

The investigation of exchange rate volatility and its effects on economic growth is an important issue for both the policymakers and other economic agents of the markets. This paper contributes to the literature in several ways. Firstly, by employing a GARCH model, which is one of the most efficient and standard methods to model exchange rate volatility, the current paper provides a more appropriate framework than the standard deviation technique to examine this issue. Secondly, this study shed some light on economic growth's response to exchange rate volatility for similar emerging and industrial markets as well. Thirdly, this study and the model used will assist investors and firms to estimate risk and enhance investment decisions. Fourthly, the understanding of the exchange rate volatility and its influence on different macroeconomic variables and economic growth will assist the policymakers with appropriate policies and programmes that will help stabilise the exchange rate and stimulate economic growth. Finally, researchers and other economic agents involved in the financial markets will benefit from how exchange rate volatility is determined.

The rest of the paper is structured as follows: Section 2 presents the literature review on the relationship between exchange rate volatility and economic growth. Section 3 describes the data set and the econometric methodology used. While Section 4 reports the empirical results of the paper, the final section concludes.

2. Literature review

2.1. Exchange rate volatility and economic growth

Exchange rate volatility and economic growth are two concepts that continued to attract the attention of scholars in the field of finance and economics. Previous studies have documented the importance of a stable environment for economic growth. Economic growth occurs when there is an increase in a country's productive capacity for goods and services, measured in terms of GDP

yearly. At the theoretical level, economic growth has been investigated using the neoclassical growth theory and the endogenous growth theory. The neoclassical growth theory pioneered by Solow (1956), argued that steady economic growth could be attained through progressive efforts in exogenous technical innovation. However, the endogenous growth theory popularised by Romer (1986) and Lucas (1988) argued that any country can achieve economic growth even without any exogenous technical progress but through deliberate efforts in endogenous activities such as external capital accumulation, foreign aid, human capital development or through existing product design among others. The endogenous growth theory hinges its arguments on sound economic policies that support and promote macroeconomic stability, increased investment and productivity. Moreover, the growth models posit that low inflation rates, low interest rates and trade openness can enhance productivity and economic growth through access to markets, transfer of capital goods, technologies and skills (Eriș & Ulașan, 2013; López-Villavicencio & Mignon, 2011).

According to Mundell (1961) in Optimal Currency Area (OCA) theory, exchange rate and monetary policies are Keynesian instruments that must be independent in order to deal effectively with asymmetric shocks in the economy. This is based on the concepts of trade, shocks and the degree of labour market mobility. Advancing this theory, McKinnon (1963) argued the economic benefits of fixed exchange rate regimes to include price stability for open economies that rely on foreign goods for consumption and productivity. Moreover, fixed exchange rate regimes promote stability in the environment for investment, increased trade and output growth by reducing the level of exchange rate uncertainty, which in turn would help to reduce transaction and other risk-mitigating costs (Frankel & Rose, 2002). Nevertheless, a flexible exchange rate regime is argued for its ability to allow an economy to adjust to external shocks resulting from the differences between the domestic and international prices to offset production losses (Mundell, 1961). Furceri & Zdzienicka (2011) opined that countries promoting a flexible exchange rate regime tend to experience lower production losses during periods of financial crises. However, this type of exchange rate regime is also vulnerable to excessive exchange rate volatility, which may be inimical to economic growth.

The empirical literature regarding the effects of exchange rate volatility on economic growth has been unsettled. For example, Azid, Jamil, & Kousar (2005) employed data from the manufacturing sector and the GARCH model to examine the impact of exchange rate volatility on economic performance in Pa-

kistan. The results of their study suggest a positive but insignificant impact of exchange rate fluctuations on manufacturing output performance. Musyoki et al. (2012) used the monthly frequency data, the GARCH model to capture the real exchange rate volatility and Generalized Method Moments (GMM) to examine the impact of the real exchange rate volatility on the Kenya's economic growth for the period January 1993 to December 2009. They reported persistent volatility throughout the study period and the negative influence of real exchange rate volatility on the Kenyan economic growth. Similarly, Vieira & MacDonald (2016) employed the annual data from 2000 to 2011 and the system GMM to investigate the effects of the real effective exchange rate volatility on export flows in 106 developed and emerging countries. Their empirical investigation reveals that exchange rate volatility has a negative relationship with exports. In a related study, Mukhtar & Malik (2010) used the time series data from 1960 to 2007 as well as cointegration and vector error correction model (VECM) to examine the effect of real exchange rate on the growth of three South Asian countries (India, Pakistan and Sri Lanka). The results of their estimation show that real exchange rate volatility exerts a significant negative effect on exports in both the short run and long run.

In Nigeria, Akpan & Atan (2012) furthered the study on this issue using the GMM to investigate the effects of exchange rate movements on economic growth in Nigeria. They argued that there was no evidence to suggest a strong direct link between exchange rate and output growth. Instead, monetary variables have been responsible for Nigeria economic growth. Similarly, Danmola (2013) used the ordinary least square (OLS) regression technique and the Granger causality test to analyse the impact of exchange rate variability on economic growth proxy as GDP in Nigeria for the period 1980-2010. The study found that exchange rate variability showed a significant positive relationship with economic growth. Apollos, Emmanuel & Olusegun (2015) adopted the OLS technique and data for the period 1986-2013 to investigate the relationship between the GDP and exchange rate, imports, exports and the inflation rate in Nigeria. The result of their study revealed a significant positive relationship between the GDP and the explanatory variables like the exchange rate and exports. In a related study, Isola, Oluwafunke, Victor, & Asaleye (2016) employed the autoregressive distributed lag (ARDL) model to investigate the linkage between exchange rate volatility and economic growth in Nigeria from 2003-2013 and the results indicate that there is no relationship between the variables in the long run. One concern with some of the studies that used the OLS model is that they failed to account for the panel effects of the data used and the issue with the endogeneity of the variables in the study.

2.2. The Nigerian exchange rate history from 1980

Nigeria has gone through different exchange rate regimes in a bid to stabilise the economy. The exchange rate plays an important role in the economy given its effect on the prices of goods and services, allocation of resources and investment decisions. Since the mid-1980, the country moved from the fixed regimes and adopted the flexible exchange rate regimes though with periodic intervention by the regulatory authorities. In the opinion of Okoroafor & Adeniji (2017), no exchange rate could be allowed to float completely or be determined by the market forces without the periodic intervention of the regulatory authority in order to achieve some strategic objective of macroeconomic stability and growth. Following the creation of the Nigeria entity as an independent nation in 1960, the exchange rate policy has undergone a substantial transformation as part of the effort by the government to position the economy on the path of growth. For instance, between 1960 and August 1986, Nigeria adopted the direct exchange rate control mechanism to manage foreign exchange rate along with other macroeconomic variables in order to stabilize the economy and stimulate growth. This system of direct exchange rate control was possible because of the boom in agricultural produce and a sharp rise in the prices of crude oil at the international market. However, the 1982 foreign exchange crisis that increased the demand for foreign exchange at a time when the supply dwindled due to a drop in foreign earnings necessitated the exchange controls and the development of parallel foreign exchange markets to stabilise the economy. During this period, particularly between 1981 and 1986, the Naira depreciated against the dollar from ₦0.61 to ₦2.02.

Since the adoption of the Structural Adjustment Policy (SAP) in 1986, different foreign exchange markets have been introduced. The government in 1986 introduced the Second-tier Foreign Exchange Market (SFEM) and the Unified Official Market (UOM) in 1987 to balance the economy. However, in 1990, the Naira depreciated further to ₦7.90. To stabilise the exchange rate, the government in 1994 embarked on exchange rate reform and pegged the Naira exchange rate against the Dollar at ₦21.89. The fallout of that reform compelled the government to liberalise the Foreign Exchange Market in 1995 with the introduction of the Autonomous Foreign Exchange Market (AFEM). The foreign market was further liberalised and the Inter-bank Foreign Exchange Market (IFEM) was announced in October 1999. During this same period, further deregulation saw the Naira exchange for ₦86.32 against the dollar. Furthermore, in a bid to re-

spond to the upward demand in foreign exchange and the consistent drop in the country foreign reserve, the government in 2002 deregulated the foreign exchange market and introduced the Dutch Auction System (DAS). During this period, the Naira traded against the dollar for ₦120.97 in 2002 and ₦135.5 in 2004. Meanwhile, the Wholesale Dutch Auction System (WDAS) was introduced in 2006.

Interestingly, the government's efforts to stabilise the exchange rate paid off when the Naira appreciated to ₦132.15 in 2005 and ₦118.57 in 2008. However, this period was short-lived due to the global financial crisis that saw the Naira depreciating to ₦150.01 against the dollar in 2009. The government's attempts to manage the exchange rate were aimed at finding an enduring solution to the foreign exchange crisis in the country, occasioned by the dwindling foreign exchange earnings, particularly from oil revenue. Nevertheless, the actions of the present civilian administration have again thwarted the whole essence of that effort with more challenging foreign exchange crisis. For instance, between the middle of 2015 when the present administration led by President Muhamadu Buhari came into power and the second quarter of 2017, the domestic economy witnessed an unprecedented adverse exchange rate volatility against the US dollar. During this period, the hostile business environment due to inconsistencies in government policies and programs resulted in the withdrawal of foreign currencies from the economy by foreign investors who were not certain about their future in Nigeria. This situation, coupled with the fall in foreign inflows from oil revenue, created a shortfall in foreign currencies in relation to demand. To address this imbalance, the government embarked on the devaluation of the Naira against the dollar and the exchange rate moved from ₦180 in mid-2015 to ₦254 in 2016 and ₦350 in 2017 as the official rate.

3. Data and methodology

3.1. Measuring exchange rate volatility

The determination of exchange rate volatility remains a controversial issue due to the choice of the exchange rate and the absence of a unique method in the literature. For example, while Servén (2002) argued the choice of real exchange rate to compute volatility, other studies such as Barguellil, Ben-Salha, & Zmami (2018) believe that the choice of nominal or real exchange rates does not significantly influence the results of the computed volatility. The Nigeria economic

environment is very dynamic with frequent movements of the Consumer Price Index due to fluctuations in the exchange rate. This means that a movement in the currency of Nigeria trading partner will affect the value of the Naira with implications. The prices of crude oil, which is the major source of foreign earnings for the country, fluctuate regularly with effects on the prices of products in the markets. Thus, to account for the effects of inflation in the determination of exchange rate volatility, this study employed the real exchange rate measured as follows:

$$RER_t = NER_t \left(P_t \Big/ PN_t \right) \tag{1}$$

Where *NER* is the nominal exchange rate to convert the Naira to US$1, *PN* is the inflationary price level in Nigeria, *P* is the price level of the US as a trading partner and *t* is the transaction time.

Different models such as the Generalized Autoregressive Conditional Heteroscedasticity (GARCH) model, developed by Bollerslev (1986) and the standard deviation, among others, have been used in the literature to compute exchange rate volatility (Siregar & Rajan, 2004). However, following the studies of Adewuyi & Akpokodje (2013), Alagidede & Ibrahim (2017), Musyoki et al. (2012), this study employs the GARCH model to measure the real exchange rate volatility, which is the variable of interest. The GARCH model is an extension of the Autoregressive Conditional Heteroscedasticity (ARCH) model developed by Engle (1982), which adopts the variance of a time series. The merit of the GARCH model stems from its ability to differentiate and recognise information that generates the exchange rate in a random process. Like the standard deviation approach that is deficient in its failure to recognise the interesting patterns such as time-varying and clustering properties in asset volatility, the GARCH model is a robust model that is capable of dealing with the volatility associated with financial data characterised by skewed distribution and the problem of heteroscedasticity. Moreover, apart from the skewed distribution, the standard deviation measure of exchange rate volatility is characterised with the inability to use all the relevant information to estimate the effects of volatility (Pagan & Ullah, 1988). In addition, the GARCH model allows for the differentiation and recognition of information that generates the exchange rate in a random process (Azid et al., 2005). The GARCH model to obtain the monthly exchange rate volatility time series for this study is specified as follows:

$$EVOL_t = \alpha_o + \beta_1 \gamma_{t-1} + \beta_2 \gamma_{t-2} + \varepsilon_t \tag{2}$$

$$\varepsilon_t / \theta_{t-1} \sim N(0, \sigma_t^2)$$

$$\sigma_t^2 = \alpha + \sum_{i=1}^{p} \lambda_i \varepsilon_{t-i}^2 + \sum_{j=1}^{q} \varphi_j \sigma_{t-j}^2 \quad (3)$$

Where α_o is the mean, σ^2 is a conditional variance of ε_t, and α, λ, and φ are non-negative. Equation (3) takes into consideration the conditional variance explained by past shocks or volatility, ε_{t-i}^2 (ARCH term) and the variance of the past period forecast error, σ_{t-j}^2 (GARCH term). Equation (3) is stationary where $\sum_{i=1}^{p} \lambda_i + \sum_{j=1}^{q} \varphi_i < 1$. As part of the pre-estimation checks, the study employed the Augmented Dickey–Fuller (ADF) and Philips–Perron (PP) tests to analyse the properties of the time series data and determine the level of stationarity of the variables. In other words, the ADF and PP were used to determine whether the variables are integrated of order zero 1(0) or order one 1(1). The Johansen co--integration estimation technique was used to test for the periodicity effect and establish if there is any long-run relationship among the variables in the study.

3.2. Model specification

To investigate the impact of exchange rate volatility on economic growth, there are several dependent variables such as the trade, investment, exports, employment and current account balance among others that could be used to measure the growth rate of any economy (Azid et al., 2005; Kiyota & Urata, 2004; Pagan & Ullah, 1988; Servén, 2002). Moreover, several explanatory variables have been documented in the literature to have a relationship with economic growth (Sala-i-Martin, Doppelhofer, & Miller, 2004). Consistent with the growth literature, this study employs the real GDP per capita as a proxy for economic growth and the exchange rate volatility as the explanatory variable (Katusiime, Agbola, & Shamsuddin, 2016). The control variables used in this study are inflation (INF), financial development proxy as credit to private sector (CPS), trade openness (TOPON), money supply (MS), human capital development (HCD), government expenditure (GEXP), crude oil prices (COP) and dummy variable for exchange rate regimes (DUMR). The choice of variables follows the theoretical and empirical literature on this issue. Additionally, the variable selection is based on data availability and the need to have balanced

observations for all the variables. The choice of real GDP per capita, which embeds other growth variables, will help avoid or deal with the likely problem of interdependences between variables. To estimate the effects of the exchange rate volatility of the Naira on economic growth, the study employed the following model:

$$Y = f(REVOL, INFL, CPS, TOPEN, MS, HCD, GEXP, COP, DUMR)_t \quad (4)$$

Equation (4) can further be expressed in the econometric model as:

$$\begin{aligned} Y_t &= \beta_0 + \beta_1 REVOL_t + \beta_2 INFL_t + \beta_3 CSP_t + \beta_4 TOPEN_t \\ &+ \beta_5 MS_t + \beta_6 HCD_t + \beta_7 GEXP_t + \beta_8 COP_t + \beta_9 DUMR_t + \varepsilon_t \end{aligned} \quad (5)$$

Where β_0 is the constant, β_1 to β_5 are the coefficients of the endogenous variables and ε is the stochastic disturbance term. Equation (5) can further be expressed by introducing the natural log and that gives us equation (6) below.

$$\begin{aligned} InY_t &= \beta_0 + \beta_1 InREVOL_t + \beta_2 InINFL_t + \beta_3 InCSP_t + \beta_4 InTOPEN_t \\ &+ \beta_5 InMS_t + \beta_6 InHCD_t + \beta_7 InGEXP_t + \beta_8 InCOP_t + \beta_9 InDUMR_t + \varepsilon_t \end{aligned} \quad (6)$$

Since the data are time series datasets, the lagged values of the data can be introduced as possible instruments because lagged values are less likely to be influenced by current shocks. Thus, equation (6) was redefined as

$$\begin{aligned} \Delta InY_t &= \beta_0 + \beta_1 \Delta InREVOL_t + \beta_2 \Delta InINFL_t + \beta_3 \Delta InCSP_t + \beta_4 \Delta InTOPEN_t + \beta_5 \Delta InMS_t \\ &+ \beta_6 \Delta InHCD_t + \beta_7 \Delta InGEXP_t + \beta_8 \Delta InCOP_t + \beta_9 \Delta InDUMR_t + \varepsilon_t \end{aligned} \quad (7)$$

Where In is the log and Δ is the lag of the logged variable. Table 1 presents the definition and measurement of variables.

Table 1. Description of variables

Variable	Definition
1	*2*
Y	Real GDP per capita, a proxy for economic growth and measured as the ratio of total GPD to the total population
REVOL	Real exchange rate volatility, measured using the GARCH (1, 1) model as presented in equation 2
INFL	The inflation rate, measured as the annual percentage change in the consumer price index
CPS	Domestic credit to the private sector, a proxy for financial development, and it is measured as domestic credits to the private sector over the GDP
TOPEN	Trade openness, defined as the sum of exports and imports to GDP
MS	Money supply is measured as the total money liability of commercial and merchant banks to the GDP

Table 1 cont.

1	*2*
HCD	Human capital development, measured as the ratio of annual total expenditure on education to GDP
GEXP	Government expenditure and it is measured as the ratio of government total expenditure to GDP
COP	Crude Oil Prices, measured as the annual average price of oil in US dollars per barrel
DUMR	A dummy variable for fixed and flexible exchange rate regimes taking the value of the period is fixed, 0 otherwise

The impact of exchange rate volatility on economic growth may occur through the aggregate demand channel. Excessive exchange rate volatility may reduce the international competitiveness and the aggregate demand for domestic goods due to an increase in inflation, interest rate and risk. According to the endogenous growth models, increase in consumer prices of goods and services due to volatility would reduce the purchasing power and the demand for products, which in turn would discourage economic growth (Kiyota & Urata, 2004; Wong, 2017). Moreover, exchange rate volatility may affect growth through the influence on investments and the expectations about the present and future returns from the market, which could affect growth (López-Villavicencio & Mignon, 2011). This is partly because an increase in exchange rate volatility leading to abnormal behaviour of other economic fundamentals such as the interest rates and money supply could mean a rise in the level of risks associated with the financial markets. This trend could result in the scarcity of funds in the financial markets and a rise in the cost of funds since investors may move their investment to less risky assets or may be unwilling to take up any investment in financial assets. Additionally, exchange rate volatility may impair or affect economic growth when there is the 'overshooting' behaviour of the exchange rate due to the response or behaviour of the financial markets and non-financial markets to external shocks (Frankel & Rose, 2002; Musyoki et al., 2012).

According to economic theory, the government can raise aggregate demand and boost economic growth through an increase in expenditure on infrastructure, technology and human capital development. However, increases in government expenditure may be counter-productive on economic growth because of the crowding out effects on private sector investment. Exchange rate volatility can deter government expenditure due to a reduction in inflows and in the value of the reserves, which may affect the welfare effects and consumer spending behaviour, *ceteris paribus*. The level of financial development and its ability to support the economy through savings mobilisation and risk management will determine the level of economic growth. The study introduces crude oil prices

(COP) to moderate the effect of exchange rate volatility on growth. Crude Oil prices are an important factor in the Nigeria economy due to its influence on foreign earnings and reserves. It expects the increase or decrease in crude oil prices to have a positive or negative influence on growth. This is because a decrease or increase in oil prices will reduce or increase foreign exchange earnings, discourage or improve investment in infrastructure and resource allocation. Thus, it is important to examine the dynamic relationship between this variable and economic growth in Nigeria. Finally, the study introduced a dummy variable to account for the period of fixed and flexible exchange rate regimes.

To establish the impact of the exchange rate volatility of the Naira on economic growth, this study employed the two-step system GMM technique developed by Blundell & Bond (1998). The choice for this model is to deal with the drawbacks and inaccuracy associated with the difference GMM estimator developed by Arellano & Bond (1991) and in small samples. In addition, the system GMM will help to take into consideration the time dimension of the dataset. This is in tandem with the previous empirical growth studies (Aghion, Bacchetta, Rancière, & Rogoff, 2009). Compared with the estimation using non-conditional standard deviation technique, which imposes a known restriction on the empirical analysis of exchange rate volatility on growth, the system GMM estimation technique will help avoid the likelihood of any biased results that may be due to the correlation between the endogenous variables and the error term in the study. In other words, the system GMM estimation technique will help overcome any issues about potential endogeneity and produce unbiased results even in the face of any potential lagged dependent variables among the explanatory variables. This is possible because of the ability of the system GMM to consider all variables as endogenous. To test the validity of the instruments in the model, the study used Hansen's test of over-identification of restrictions that evaluate the entire set of moment conditions.

3.3. Data source

This study employed secondary data to examine exchange rate volatility and its impact on economic growth in Nigeria. The study period is from January 1980 to December 2017 with 456 monthly time series observations. The choice of the study period was influenced by data availability for the relevant variables and the Nigeria experience of exchange rate instability against the dollar and other major currencies, especially after the suspension of the exchange rate con-

trol measure in 1986. Prior to the mid-1980s, Nigeria witnessed a shortfall in foreign revenue from crude oil and agricultural produce that could not service the expected foreign exchange demand. Following this development, from September 1986 down to 1999, the country witnessed the managed float regime with different exchange rates. Towards the end of the study period, that is, 2016, Nigeria witnessed the worse and the most volatile exchange rate regime that crashed the purchasing power of the Naira and plugged the economy into recession. The study employed data sourced from the Central Bank of Nigeria (CBN) Statistical Bulletin and Annual Reports of various issues, National Bureau of Statistics (NBS) and the World Development Indicators database of the World Bank.

4. Empirical results and discussion

4.1. Preliminary analysis

The study proceeds with the preliminary analysis of the variables in the study. Tables A1 and A2 in the Appendix depict the descriptive statistics and the correlation matrix of the variables in the model. The study carried out the estimation of the unit root of the variables to establish their behaviour over time. As presented in Table A3 in the Appendix, the results of the unit root test using Augmented Dickey–Fuller (ADF) and Philips–Perron (PP) tests show that the variables are stationary in their first difference. In addition, the results of the Johansen cointegration tests, given the order of integration of the variables in the study, are presented in Table A4 in the Appendix. The results of the Johnson co--integration tests in trace and Max–Eigen statistics show the existence of cointegration among the variables, which means there is evidence to support the existence of a long-run relationship between exchange rate volatility and other variables in the model.

4.2. Estimation of real exchange rate volatility

The study employed the ARCH test to examine the ARCH effect in the variables. Table 2 shows the results of the heteroscedasticity test for the returns series and it is statistically significant at a 5% level with the observed R-squared of 6.0118 and a p-value of 0.0031. This implies the presence of an ARCH effect in the variables since the p-value is less than the required 5%. This result sug-

gests the influence of the previous period exchange rate volatility on the current exchange rate volatility with respect to the US dollars, and thus confirms the appropriateness of a GARCH model to explain exchange rate volatility. The results of the estimation of exchange rate volatility using the GARCH (1, 1) model are presented in Table 3. The result shows that the coefficients of ARCH and GARCH term are positive and significant at 5% level. The result of the GARCH (1, 1) test suggests the persistence of shocks in the volatility of the variables, which implies that the volatility is highly persistent over the periods in consideration. It implies that the periods of high (low) exchange rate shocks tend to be followed by periods of high (low) exchange rate shocks for a prolonged period.

Table 2. ARCH Lagrange Multiplier (LM) Test

Heteroskedasticity Test: ARCH			
F-statistic	4.1042	Prob. F(1,0173)	0.0046
Obs*R-squared	6.0118	Prob. Chi-Square(1)	0.0031

Table 3. Estimation of exchange rate volatility with ARCH/GARCH Model

Variable	Coefficient	Std. Error	z-Statistic	Prob.
Mean equation				
C	0.6150	0.2047	3.0042	0.0041
Variance equation				
C	4.0312	1.3250	3.0424	0.0411
ARCH(-1)^2	0.6320	0.4653*	1.3583	0.0120
GARCH(-1)	3.2189	0.6384*	5.0422	0.0014

Note: *, **, and *** denote statistical significance at 1%, 5%, and 10% levels, respectively.

4.3. Effect of exchange rate volatility on economic growth

The study employed the system GMM model to examine the effect of exchange rate volatility on economic growth and the results are presented in Table 5. The robustness of the study outcome for policymakers, investors and other stakeholders of the economy is reinforced with the diagnostic checks of the model specification using Ramsey RESET test, normality using the Jarque–Bera test, serial correlation using the Breusch–Godfrey test and the heteroscedasticity using the White test. As reported in Table 4, the result of the model functional form shows t-stat = 1.4103; p-value = 0.5110 and it is significant at the 5% level,

which suggests that the null hypothesis that the model has no omitted variables accepted. The results show that the residuals are normally distributed (t-stat = = 2.8931; p-value = 0.3615). The LM tests results of t-stat = 4.0114; p-value = = 0.1503) and White tests results of t-stat = 3.4835; p-value = 0.0083 indicate the acceptance of the null hypotheses that there is no serial correlation and heteroscedasticity problems in the study. In Table 5, the R^2 of 0.6790 suggests that the model is fitted and 68% of the variation in economic growth is explained by the variation of the independent variables. The result of the F-value of 6.8435 with a corresponding p-value of 0.0015 indicates the overall suitability of the variables employed. The validity of the set of instruments in the model is revealed in the result of the Hansen J – statistics of 0.6802 with a high p-value of 0.3446, which indicates that the instruments are not correlated with the residuals.

Table 4. Diagnostic checks

Estimate	Technique	t-stat	Prob
Serial correlation	Breusch–Godfrey Lagrange Multiplier test of residual serial correlation	4.0114	0.1503
Functional form	Ramsey RESET test for omitted variables/functional form	1.4103	0.5110
Normality	Jarque–Bera normality test based on a test of skewness and kurtosis of residuals	2.8931	0.3615
Conditional heteroscedasticity	White's test for heteroscedasticity based on the regression of squared residuals on squared fitted values	3.4835	0.0083

Table 5. System GMM estimation of exchange rate volatility on growth

Variable	1			2		
	Coefficient	**Std. Error**	**Prob.**	**Coefficient**	**Std. Error**	**Prob.**
C	4.0091	1.9742	0.0752	1.4845	3.7421	0.8728
Δ REVOL	−0.4842**	0.4820	0.0000			
Δ INFL	−0.2273**	1.2298	0.0014	−0.1407*	1.4892	0.0021
Δ CPS	0.1293*	4.3221	0.0046	0.1461*	2.1839	0.0133
Δ TOPEN	1.0483	1.0338	0.2033	0.2942	0.2113	0.5431
Δ MS	1.4999	0.3421	0.4190	1.2340	1.3641	0.3001
Δ HCD	0.3720	3.8473	0.2010	0.3478	1.4393	0.0324
Δ GEXP	0.4208	4.0222	0.3623	1.4733	0.6836	0.1435
Δ COP	0.1709**	0.9842	0.0361	0.2239**	1.8411	0.0010
Δ DUMR	2.9928	1.2084	0.6384	3.2222	2.6372	0.5737
R-squared	0.6790			0.8220		
Adjusted R-squared	0.6102			0.6444		
F-statistic	6.8435			4.0282		
Prob(F-statistic)	0.0015			0.0000		
Durbin–Watson stat	1.9920			2.0111		
Hansen's J-statistic	0.6802			0.6408		
Prob (J-statistic)	0.3446			0.3048		

Note: *, **, and *** denote statistical significance at 1%, 5%, and 10% levels, respectively.

Table 5, Model 1 presents the results of the study with all the variables in the model. The result indicates that exchange rate volatility exerts a negative impact on economic growth in Nigeria. This result is statistically significant at 5% level and suggests that a 1% increase in the volatility of the Naira exchange rate in favour of the US dollar will lead to a 48% decrease in the economic growth of Nigeria. This finding is consistent with previous studies such as Musyoki et al. (2012) and Schnabl (2009) on the connection between exchange rate volatility and economic growth. As expected, inflation is found to have a negative influence on economic growth, which suggests that a 1% increase in inflation will significantly reduce economic growth by 23%. The result of this study demonstrates a positive and significant influence of the credit to the private sector and crude oil prices on economic growth. Specifically, the results, which are statistically significant at 5% level, indicate that a 1% increase in credit to the private sector and crude oil prices will enhance economic growth by 13% and 17%, respectively. Moreover, endogenous variables such as trade openness, money supply, government expenditure and human capital development exert positive, but insignificant influence on economic growth. In Table 5, Model 2, the study excluded real exchange rate volatility to observe the performance of other variables on economic growth. The sign of the coefficients of the variables remains in the same direction, though human capital development exhibited a significant relationship with economic growth.

4.4. Discussion of results

This study found a negative and significant relationship between exchange rate volatility and the economic growth of Nigeria. The study demonstrates that the exchange rate is one of the factors responsible for the Nigeria sluggish and unstable economic growth. The adverse effect of exchange rate volatility on economic growth might be due to the over-reliance of the Nigerian economy on a mono-product (crude oil) that is largely dependent on the global market forces. This result suggests the influence of other foreign exchange market players such as the bureau de change and other informal players. In addition, this result points to the nature of the Nigerian economy as an import-dependent economy with high consumption of foreign exchange and the resultant negative effect on economic growth. The persistent exchange rate volatility is a clear manifestation of the government's inability to build an external reserve that is adequate to supply the required foreign exchange to manage the level of volatility from time to

time. Moreover, while inflation revealed a negative and significant relationship with economic growth, credit to the private sector and crude oil prices demonstrates a positive and significant influence on the economic growth of Nigeria. All the other endogenous variables such as trade openness, money supply, government expenditure and human capital development exert a positive, but insignificant influence on economic growth.

In line with the theoretical and empirical literature, the negative effect of exchange rate volatility on economic growth may be explained through its effects of uncertainty and instability on economic variables such as inflation and investment. The implication of this is that as a mono-cultural product economy, higher exchange rate volatility due to a drop in oil revenue inflows may lead to a higher inflation rate that may affect the demand and consumption pattern, which in turn would lead to low investment. Moreover, higher exchange rate volatility may lead to low investment because of low credit to the private sector, high level of risks, higher interest rates and the demand for more collateral by the financial markets. The unwillingness of economic agents to lend to the investment sector due to volatility can hinder economic growth (Eriș & Ulașan, 2013). These relationships may have been responsible for the recent recession and poor economic growth in Nigeria. Given that the economic growth is influenced by changes in the explanatory variables, the significance placed on exchange rate volatility and other macroeconomic variables by the stakeholders of the economy is likely to continue in the mix of a dynamic and structural environment and the dwindling revenue inflows in Nigeria. The result demonstrates and confirms that the Nigerian economy seems to lack the required stability to enhance economic growth due to volatility.

The findings of this current study offer evidence to support the existing literature in the same direction. For example, Alagidede & Ibrahim (2017) employed the annual data from 1980 to 2013 and the vector autoregression model to investigate the connection between exchange rate volatility and economic growth in Ghana. The results of their study show a co-integrating relationship between the real exchange rate and real income. Moreover, they documented that the real exchange rate has a negative and significant relationship with economic growth, which means undue exchange rate volatility will reduce economic growth in Ghana. Nevertheless, the findings of the current study differ with the results of Katusiime et al. (2016). The study by Katusiime et al. (2016) used the autoregressive distributed lag model to investigate the effect of exchange rate volatility on economic growth in Uganda. The study covers a period 1960-2011

with 52 yearly observations. They employed the GARCH model to compute the monthly nominal exchange rate volatility and White's heteroscedasticity test to examine the presence of heteroscedasticity. They found that exchange rate volatility has a positive influence on economic growth in Uganda. Specifically, they reported that a 1% increase in exchange rate volatility would lead to a 0.3% and 0.5-1.3% increase in economic growth in the short run and long run, respectively.

Consequent the results of the current study, it is important for the government through the monetary authority to pursue policies and programs that would ensure the stability of the exchange rate for economic growth. This study demonstrates the need for the government and other stakeholders of the economy to create the enabling environment through the proper mix of macroeconomic variables capable of affecting each other positively. It is also important for the country to shift from the over-reliance on a single product and pursue a program of economic diversification to boost foreign earnings. The Nigerian government is encouraged to promote financial market development to reduce the cost and risks in financial assets and encourage investment that will improve productivity and economic growth. The provision of the required infrastructure, enhanced human capital development and overall improvement of the enabling environment are important to encourage the export base expansion of the economy. These measures will help reduce the level of exchange rate volatility and guarantee the country a stable economic growth.

5. Conclusions

This study aimed at examining exchange rate volatility and its effect on economic growth in Nigeria. The study employed the GARCH model and the system GMM estimation technique to analyse data for the period 1980-2017. The study offered evidence that exchange rate volatility persists throughout the study period, which suggests that periods of high (low) exchange rate shocks tend to be followed by periods of high (low) exchange rate shocks for a prolonged period. The result of the empirical analysis shows that exchange rate volatility negatively and significantly influences the economic growth of Nigeria. This result is in tandem with previous studies as reported by Alagidede & Ibrahim (2017). The implication of this result is that the Nigerian economy is susceptible to exchange rate volatility. The result also implies that exchange rate volatility is an important influencing factor, which needs to be weighed in making decisions. The study presents empirical evidence that crude oil prices, inflation, govern-

ment expenditure, trade openness and domestic credit to private sector exert influence on the economic growth of Nigeria.

This study contributes to the literature by showing the power of exchange rate volatility on economies such as Nigeria. The current study is limited to the selected variables based on data availability in Nigeria. Accordingly, further studies on the issues discussed taking into consideration other control variables based on the theoretical and empirical literature are important. Finally, given the limited number of studies that deal with the issues discussed here using the Nigerian economy, this study may provide the foundation for empirical research work into the connection between exchange rate volatility and economic growth taking into account the characteristics of a developing country.

References

Adewuyi, A. O., & Akpokodje, G. (2013). Exchange rate volatility and economic activities of Africa's sub-groups. *The International Trade Journal, 27*(4), 349-384. http://doi.org/10.1080/08853908.2013.813352

Aghion, P., Bacchetta, P., Rancière, R., & Rogoff, K. S. (2009). Exchange rate volatility and productivity growth: The role of financial development. *Journal of Monetary Economics, 56,* 494-513. http://doi.org/10.1016/j.jmoneco.2009.03.015

Akpan, E. O., & Atan, J. A., (2012). Effects of exchange rate movements on economic growth in Nigeria. *CBN Journal of Applied Statistics, 2*(2), 1-14. Retrieved from http://hdl.handle.net/10419/142047

Alagidede, P., & Ibrahim, M. (2017). On the causes and effects of exchange rate volatility on economic growth: Evidence from Ghana. *Journal of African Business, 18*(2), 169-193. http://doi.org/10.1080/15228916.2017.1247330

Apollos, E. A., Emmanuel, A., & Olusegun, D. J. (2015). Exchange rate volatility and economic growth in Nigeria (1986-2013). *Journal of Empirical Economics, 4*(2), 109-115. Retrieved from http://www.rassweb.org/admin/pages/ResearchPapers/Paper%205_1497029926.pdf

Arellano, M., & Bond, S. (1991). Some tests of specification for panel data: Monte Carlo evidence and an application to employment equations. *Review of Economic Studies, 58*, 277-297. Retrieved from http://people.stern.nyu.edu/wgreene/Econometrics/Arellano-Bond.pdf

Azid, T., Jamil, M., & Kousar, A. (2005). Impact of exchange rate volatility on growth and economic performance: A case of Pakistan. *The Pakistan Development Review, 44*(4), 749-775. http://doi.org/10.30541/v44i4IIpp.749-775

Barguellil, A., Ben-Salha, O., & Zmami, M. (2018). Exchange rate volatility and economic growth. *Journal of Economic Integration, 33*(2), 1302-1336. http://doi.org/10.11130/jei.2018.33.2.1302

Blundell, R., & Bond, S. (1998). Initial conditions and moment restrictions in dynamic panel data models. *Journal of Econometrics, 87*, 1115-1143. Retrieved from https://www.ucl.ac.uk/~uctp39a/Blundell-Bond-1998.pdf

Bollerslev, T. (1986). Generalized autoregressive conditional heteroskedasticity. *Journal of Econometrics, 31*(3), 307-327. http://doi.org/10.1016/0304-4076 (86)90063-1

Danmola, R. A. (2013). The impact of exchange rate volatility on the macroeconomic variables in Nigeria. *European Scientific Journal, 9*(7), 152-165. http://doi.org/10.19044/esj.2013.v9n7p%25p

Engle, R. F. (1982). Autoregressive conditional heteroskedasticity with estimates of the variance of United Kingdom inflation. *Econometrica, 50*(4), 987-1007. http://doi.org/10.2307/1912773

Eriș, M. N., & Ulașan, B. (2013). Trade openness and economic growth: Bayesian model averaging estimate of cross-country growth regressions. *Economic Modelling, 33*, 867-883. http://doi.org/10.1016/j.econmod.2013.05.014

Frankel, J., & Rose, K. A. (2002). A contribution to the theory of economic growth. *The Quarterly Journal of Economics, 117*, 437-466. http://doi.org/10.1162/003355302753650292

Furceri, D., & Zdzienicka, A. (2011). The real effect of financial crises in the European transition economies. *Economics of Transition, 19*, 1-25. http://doi.org/10.1111/j.1468-0351.2010.00395.x

Isola, I. A., Oluwafunke, A. I., Victor, A., & Asaleye, A. (2016). Exchange rate fluctuation and the Nigerian economic growth. *Euro Economica, 35*(2), 1-15. Retrieved from http://journals.univ-danubius.ro/index.php/euroeconomica/article/view/3312/3761

Katusiime, L., Agbola, F. W., & Shamsuddin, A. (2016). Exchange rate volatility – economic growth nexus in Uganda. *Applied Economics, 48*(26), 2428-2442. http://doi.org/10.1080/00036846.2015.1122732

Kiyota, K., & Urata, S. (2004). Exchange rate, exchange rate volatility and foreign direct investment. *The World Economy, 27*(10), 1501-1536. http://doi.org/10.1111/j.1467-9701.2004.00664.x

López-Villavicencio, A., & Mignon, V. (2011). On the impact of inflation on output growth: Does the level of inflation matter? *Journal of Macroeconomics, 33*, 455-464. http://doi.org/10.1016/j.jmacro.2011.02.003

Lucas, R. E. (1988). On the mechanics of economic development. *Journal of Monetary Economics, 22*(1), 3-42. http://doi.org/10.1016/0304-3932(88)90168-7

McKinnon, R. (1963). Optimum currency areas. *American Economic Review, 53*(4), 717-725. Retrieved from https://www.experimentalforschung.econ.uni-muenchen.de/studium/veranstaltungsarchiv/sq2/mckinnon_aer1963.pdf

Mukhtar, T., & Malik, S. J. (2010). Exchange rate volatility and export growth: Evidence from selected South Asian countries. *SPOUDAI Journal of Economics and Business, 60*(3-4), 58-68. Retrieved from http://spoudai.unipi.gr/index.php/spoudai/article/view/23

Mundell, R. (1961). A theory of optimal currency areas. *American Economic Review, 51*(4), 657-665. Retrieved from https://www.experimentalforschung.econ.uni-muenchen.de/studium/veranstaltungsarchiv/sq2/mundell_aer1961.pdf

Musyoki, D., Pokhariyal, G. P., & Pundo, M. (2012). The impact of real exchange rate volatility on economic growth: Kenyan evidence. *Business and Economic Horizons, 7*(1), 59-75. Retrieved from https://ageconsearch.umn.edu/bitstream/249373/2/v7_1_5.pdf

Okoroafor, O. K. D., & Adeniji, S. O. (2017). Currency devaluation and macroeconomic variables responses in Nigeria: A vector error correction model approach: 1986-2016. *Journal of Finance and Economics, 5*(6), 281-289. http://doi.org/10.12691/jfe-5-6-4

Pagan, A., & Ullah, A. (1988). The econometric analysis of models with risk terms. *Journal of Applied Econometrics, 3*, 87-105. http://doi.org/10.1002/jae.3950030202

Romer, P. M. (1986, October). Increasing returns and long run growth. *Journal of Political Economy, 94*(5), 1002-1038. http://doi.org/10.1086/261420

Sala-i-Martin, X., Doppelhofer, G., & Miller, R. I. (2004). Determinants of long-term growth: A Bayesian averaging of classical estimates (BACE) approach. *The American Economic Review, 94*(4), 813-835. http://doi.org/10.1257/0002828042002570

Schnabl, G. (2009). Exchange rate volatility and growth in emerging Europe and East Asia. *Open Economies Review, 20*(4), 565-587. http://doi.org/10.1007/s11079-008-9084-6

Servén, L. (2002). Real exchange rate uncertainty and private investment in developing countries (Policy Research Paper No. 2823). Washington, DC: The World Bank. Retrieved from https://openknowledge.worldbank.org/bitstream/handle/10986/14809/multi0page.pdf?sequence=1&isAllowed=y

Siregar, R., & Rajan, R. (2004). Impact of exchange rate volatility on Indonesia's trade performance in the 1990s. *Journal of the Japanese and International Economies, 18*, 218-240. http://doi.org/10.1016/S0889-1583(03)00050-9

Solow, R. M. (1956). A contribution to the theory of economic growth. *The Quarterly Journal of Economics, 70*(1), 65-94. http://doi.org/10.2307/1884513

Vieira, F. V., & MacDonald, R. (2016). Exchange rate volatility and exports: A panel data analysis. *Journal of Economic Studies, 43*(2), 203-221. http://doi.org/10.1108/JES-05-2014-0083

Wong, H. T. (2017). Exchange rate volatility and bilateral exports of Malaysia to Singapore, China, Japan, the USA and Korea. *Empirical Economics, 53*, 459-492. http://doi.org/10.1007/s00181-016-1129-x

Appendix

Table A1. Results of unit root analysis

Variable	ADF			PP		*I(d)*
	Level	*First Diff.*	*I(d)*	*Level*	*First Diff.*	
RGDP	–1.083	–3.819***	I(1)	–2.104	–4.144***	I(1)
REVOL	–3.537**	–8.011***	I(1)	–3.633***	–22.082**	I(1)
INFL	–1.285	–4.111***	*I(1)*	–2.647	–15.284***	I(1)
CPS	–2.041	–4.748**	I(1)	–0.025	–7.011***	I(1)
TOPEN	–2.173	–6.301**	I(1)	–2.153	–5.753***	I(1)
MS	0.873	–3.047	I(1)	–1.637	–9.463***	I(1)
HCD	–1.546	–3.303**	*I(1)*	–2.291	–8.029***	I(1)
GEXP	–0.172	–5.863***	I(1)	–0.180	–9.653***	I(1)
COP	–2.001	–6.301***	I(1)	–1.677	–5.793***	I(1)

Note: Akaike Information Criterion (AIC) is employed to automatically select appropriate.
lags. *, **, and *** denote statistical significance at 1%, 5%, and 10% levels, respectively.

Table A2. Johansen co-integration test result

Hypothesized No. of CE(s)	Eigen value	Trace			Maximum Eigenvalue		
		Trace Statistic	0.05 Critical Value	Prob.**	Max-Eigen Statistic	0.05 Critical Value	Prob.**
None*	0.958	114.637	85.947	0.012	98.106	64.955	0.031
At most 1	0.720	97.653	76.002	0.001	68.192	53.193	0.001
At most 2	0.539	78.842	57.645	0.053	53.347	42.013	0.030
At most 3	0.330	54.221	32.004	0.010	38.463	32.748	0.033
At most 4	0.270	36.712	35.264	0.230	22.478	25.103	0.117
At most 5	0.181	5.028	3.948	0.027	5.994	3.746	0.022

lags. *, **, and *** denote statistical significance at 1%, 5%, and 10% levels, respectively.

Table A3. Summary statistics of variables

Variable	Obs.	Mean	Max	Min	Std. Dev.	Skewness	Kurtosis
RGDP	38	1306.92	2396.76	94.73	93.16	1.18	3.79
REVOL	38	25.17	82.46	0.04	22.52	2.13	9.14
INFL	38	24.08	72.80	5.42	18.93	1.94	7.01
CPS	38	18.38	38.41	1.05	11.94	2.12	5.84
TOPEN	38	75.95	354.03	17.43	41.88	–1.09	4.26
MS	38	15.49	35.62	09.47	6.17	0.40	2.17
HCD	38	5.21	7.90	2.30	1.93	0.09	1.58
GEXP	38	21.35	52.85	15.46	12.07	1.93	7.32
COP	38	43.37	114.21	11.26	29.8	1.58	6.39
DUMR	38	0.03	1	0	0.10	0.85	3.08

Table A4. Correlation analysis

Variable	RGDP	REVOL	INFL	CPS	TOPEN	MS	HCD	GEXP	COP	DUMR
RGDP	1.000									
REVOL	–0.645	1.000								
INFL	–0.552	–0.314	1.000							
CPS	0.374	–0.495	–0.264	1.000						
TOPEN	0.301	–0.542	–0.141	0.534	1.000					
MS	0.226	–0.606	–0.113	0.219	0.335	1.000				
HCD	0.311	–0.491	0.219	0.473	0.311	0.342	1.000			
GEXP	0.219	–0.407	–0.302	0.530	0.366	0.294	0.322	1.000		
COP	0.528	–0.108	0.141	0.103	0.125	0.011	0.219	0.312	1.000	
DUMR	0.195	–0.201	0.174	0.129	0.412	0.163	0.122	0.300	0.103	1.000