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**Article**

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Full Length Article

# Exchange rate volatility and private consumption in Sub-Saharan African countries: A system-GMM dynamic panel analysis

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## Abstract

The resurgence of exchange rate volatility over the years has gained the attention of not only the scholars but also the policy makers around the world. Also, its effects on private consumption are a missing gap in the literature most especially in Sub-Saharan African (SSA) Countries. Although, several studies have discussed the consequences of exchange rate volatility to growth but there is no documented empirical evidence on the relationship between exchange rate volatility and private consumption. This paper examines the effect of exchange rate volatility on private consumption in SSA countries using system-GMM dynamic panel and GARCH (1, 1) to generate exchange rate volatility series between 1999 and 2014. The exchange rate volatility series generated through GARCH (1, 1) fulfills the conditions of ARCH effect and volatility clustering. The result of the system-GMM shows that exchange rate volatility has negative and significant effect on private consumption in SSA countries. This result is further confirmed using various diagnostic tests such as Arellano and Bond test of first- and second-order serial correlation and Hansen J-statistic test of model specification and valid overidentified restrictions i.e. validity of instruments. Based on this, the study concludes that exchange rate volatility has significant negative effect on private consumption in SSA countries.

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*Keywords:* Exchange rate volatility; Private consumption; Dynamic panel; GARCH; System-GMM

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## 1. Introduction

In the midst of the detrimental effects of unstable movement in exchange rate, the negative penalties of exchange rate volatility are of great concern. High uncertainty of exchange rate makes expectations over the future price level more uncertain. In a country where the economy depends solely on importation of raw materials like most African countries, exchange rate volatility induces risk premia for long-term arrangements, raises costs of production, reduces trade, causes unanticipated redistribution of wealth and leads to fluctuation in the real economy with adverse effects on unemployment rate, poverty rate, deficit balance of payment position and reduction in the growth of consumption. Also, uncertainty of exchange rate causes high risk in investment decision which threaten the performance of macroeconomic variables (Dedola, 2002; Mendoza, 2005; Omojimito & Akpokodje, 2010).

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Empirical literatures have abounded on the relationship between exchange rate volatility and macroeconomic variables; the popular and most cited among these studies in developing countries focused on the effects of exchange rate volatility on foreign direct investment (Lloyd & osinubi, 2009); real GDP (Azeez, Kolapo, & Ajayi, 2012); performance of manufacturing sector (David, Umeh, & Ameh, 2010); and the relationship with stock price fluctuations and the lending behavior of banks (Mbutor, 2010). Also among the industrialized countries, studies only focused on credit channel in emerging markets (Caballero & Krishnamurthy, 2005); foreign consumption (Dedola, 2002); monetary policy issues (Al Samara, 2009; Duarte & Obstfeld, 2008; Gali & Monacelli, 2002; Omojimite & Akpokodje, 2010) and oil prices (Rickne, 2009). However, issues on whether or not the fluctuations in exchange rate affects private consumption has not been documented in the midst of studies that revolve round the relationship between exchange rate volatility and macroeconomic performance in Africa. Meanwhile, economists have argued that private consumption contributes not less than 70% to the composition of GDP of a country (Mankiw, 2012). For instance, over the decades – private consumption contributes an average of 60% to GDP in African countries like Nigeria, South Africa, Ghana, Tunisia, Cameroon, Gambia, Togo and a host of others (World Development Indicator, 2014). Also, most countries in Africa rely solely on importation of goods for survival especially the raw materials that are used by the domestic industries. The importation of goods is subjected to the behaviour of foreign exchange rate market. Thus, a slight change in exchange rate would affect the price of the domestic goods and this may determine the individual consumption level since the production of these goods are directly influenced by the cost of exchange rate. Hence, the need to examine the relationship between exchange rate volatility and private consumption becomes imperative.

It is therefore obvious that there is scarcity on the research on exchange rate volatility – private consumption nexus. Hence, this study aims at providing a link between exchange rate volatility and private consumption in Africa, using annual data of 19 sub-Saharan African countries covering the period of 16 years from 1999 to 2014 using system generalized method of moments (SGMM), two-step robust estimator. This method is employed because in a well-known dynamic panel models the usual fixed effects estimator is unreliable when the time span ( $T$ ) is smaller than the cross-sectional unit ( $n$ ) (Nickell, 1981). Consequently, the instrumental variable (IV) estimator (Anderson & Hsiao, 1982) and generalized method of moments (GMM) estimator (Arellano & Bond, 1991) are widely used. However, the estimators from these models also suffer from a weak instrument problem when the dynamic panel autoregressive coefficient ( $\delta$ ) approaches unit (Blundell & Bond, 1998). When  $\delta=1$ , the moment conditions are totally inappropriate for the true parameter  $\delta$ , and the nature of the behaviour of the estimator depends on  $T$ . When  $T$  is small, the estimators are asymptotically random and when  $T$  is large, the unweighted GMM estimator may be inconsistent and the efficient two-step estimator may behave in a nonstandard way. To avoid these problems, the proposed system GMM two-step robust estimator procedure by Arellano and Bover (1995); and Blundell and Bond (1998) is employed in this paper. This approach yields reliable and consistent estimators for all  $\delta$  values; it has virtually no bias; totally avoids the usual weak instrument problem; supports asymptotically valid Gaussian inference even with highly persistent panel data and free of initial conditions on level. In addition, the limit distribution is continuous as the autoregressive coefficient passes through unity; the rate of convergence is the same for stationary and nonstationary panels; differencing transformations essentially eliminate dependence on level of initial conditions; and there are no restrictions on the number of the cross-sectional units ( $n$ ) and the time span ( $T$ ) other than the simple requirement that  $nT \rightarrow \infty$ . Thus, neither large  $T$  nor large  $n$  is required for the limit theory to hold.

These countries are selected based on data availability on private consumption and exchange rate. This paper contributes to existing literature by exploring the effect of exchange rate volatility on private consumption in sub-Saharan African countries. The study focuses on only sub-Saharan African countries because exchange rate volatility has remained their major challenges for over a decade; and this has adversely affected the performance of macroeconomic variables (Dedola, 2002). The study also applies a novel measure of exchange rate volatility- the conditional variance of exchange rate level, constructed from the GARCH (1, 1) model. Conditional variance is the true measure of volatility about a variable given a model and information set. The unconditional measure by standard deviation used in the previous studies as the measure of exchange rate volatility does not adequately measures the uncertainty of exchange rate (see Brooks (2008)). Finally, it enables policy makers to take proactive measures against any adverse effect on private consumption that might emanate from fluctuations in exchange rate as experienced in some countries among OECD countries.

The remaining of the paper is organized as follows. Section 2 presents a review of relevant empirical literature. Section 3 entails the methodology. Section 4 discusses the empirical results while Section 5 concludes.

## 2. Review of empirical literature

Although, there are scanty literature on the relationship between exchange rate volatility and private consumption but studies have evolved round most of the macroeconomic variables except private consumption in Sub-Saharan African countries. Some of these studies are reviewed here. [Aghion, Bacchetta, Rancière, and Rogoff \(2009\)](#) examined the effect of volatility on real activity given preference to financial development using monetary growth model. The study found that there was little or insignificant relationship between exchange rate volatility and real activity. It was therefore concluded that exchange rate uncertainty enhanced the negative investment effects of domestic credit market constraints. [Azeez, Kolapo, and Ajayi \(2012\)](#) evaluated the effect of exchange rate volatility on Nigerian economy. This study demonstrated that exchange rate volatility in Nigeria discouraged exportation and encouraged importation to meet the need of vast population in the country using simple regression technique. Also, the study did not use appropriate technique to measure the volatility of exchange rate.

Further, similar study was conducted on 83 trading countries using two-step dynamic panel system GMM with emphasizes on the role of financial development by [Aghion Bacchetta, Rancière, and Rogoff \(2009\)](#). They argued that the significant relationship between exchange rate volatility and productivity depends on the country's level of financial development. Thus, the study concluded that exchange rate volatility reduced the negative investment effects of domestic credit market constraints. [Al Samara \(2009\)](#) examined the determinants of real exchange rate volatility in the Syrian economy using ARCH model. The study found that three variables determined the exchange rate volatility in the country: the equilibrium level of exchange rate itself, the decline in oil production and the challenges faced by the economy to allow real exchange rate converged to its equilibrium level.

[Caballero and Krishnamurthy \(2005\)](#) examined the theoretical relationship between exchange rate and the credit channel in emerging markets. They argued that firms in emerging market were exposed to unadorned frictions and credit constraints. This was increased by sudden halt of capital flow. The study used monetary policy instruments and realized that the expansionary effect of monetary policy vanished during stick external crises by raises the value of domestic collateral but increases exchange rate depreciate; this had little effect on aggregate activity. The study concluded that there is a dynamic linkage between monetary policy and sudden stop of capital flow via exchange rate volatility. Also, study by [Duarte and Obstfeld \(2008\)](#) investigated the relationship between monetary policy and exchange rate flexibility in the open economy by revisiting the sticky-price pricing-to-market model of [Devereux and Engel \(2003\)](#) in which fixed exchange rates are optimal even in the face of country-specific nonmonetary shocks. Their results showed that Devereux–Engle model's prediction of international consumption levels were perfectly synchronized under flexible prices while the modification of the model produced non-synchronous consumption movement under the fixed exchange rate prescription.

[Dedola \(2002\)](#) addressed the consumption-real exchange rate nexus focusing on incomplete markets and non-traded goods using sensitivity analysis. The study upheld that international real business cycles models based on complete financial markets predict a perfect and unitary correlation between the real exchange rate and the ratio of home to foreign consumption during supply shocks. Meanwhile, the data collected showed that the correlation was small and negative. The study therefore concluded that this irregularity could be eliminated when models that have an incomplete financial market structure and a non-traded cum traded goods production sector was used.

[Gali and Monacelli \(2002\)](#) investigated the empirical relationship between monetary policy and exchange rate volatility in a small open economy of the Calvo sticky price model. They showed how the equilibrium dynamics reduced to a simple representation in domestic inflation and output gap. The study used this framework to analyze the macroeconomic implications of three alternative rule-based policy regimes by considering domestic inflation, CPI-based Taylor rules and exchange rate peg. The study showed that the regimes lie in the relative amount of exchange rate volatility that occurred within the regimes.

[Mendoza \(2005\)](#) analysed empirically the relationship between real exchange rate volatility and the price of non-tradable in sudden-stop-prone economies using variance analysis specifically in Mexico. As against the literature that high variability of real exchange rate is due to movements in exchange-rate-adjusted-price of tradable goods, the study showed that high variability of real exchange was due to managed exchange rate. This result was equally used to propose a model that tackles the sudden-stop that accompanied the collapse of Mexico's managed exchange rate using a Fisherian debt-deflation mechanism that operates through non-tradable prices.

[Lloyd and osinubi \(2009\)](#) investigated the empirical evidence on the effect of exchange rate volatility on foreign direct investment in Nigeria between 1970 and 2004 using error correction model and ordinary least square method.

Exchange rate volatility series was generated through standard deviation and the result of the study showed that exchange rate volatility did not distort the inflow of foreign direct investment in Nigeria. The study further showed that depreciation of the Naira increased the real inward FDI while the SAP had a negative impact on FDI; this was traceable to the deregulation that accompanied by exchange rate volatility.

Rickne (2009) examined the relationship between oil prices and real exchange rate movements in oil-exporting countries emphasizing the role of institutions for a panel of 33 oil-exporting countries. The study emphasized the extent at which political and legal institutions affected the real exchange rates of oil-exporting countries with co-move of oil price using a simple theoretical model. The results of the study indicated that strong institutions sequester real exchange rates from oil price volatility by generating a smooth pattern of fiscal spending over the price cycle. Conclusively, the study showed that countries with high bureaucratic quality and strong and impartial legal systems had real exchange rate that co-move less with the oil price.

Mbutor (2010) investigated the relationship among exchange rate volatility, stock price fluctuations and the lending behavior of banks in Nigeria by focusing on the nexus through which the international crisis passed-through to the domestic economy using vector auto regression (VAR) model. The results of the study showed that there was causality among exchange rate volatility, equity prices and bank loans on one hand. On the other hand, exchange rate volatility and equity price fluctuations were insignificantly affected the behavior of banks in Nigeria. Also, changes in bank loans were led to equity prices fluctuations.

David, umeh, and Ameh (2010) analysed the effects of exchange rate fluctuations on manufacturing sector in Nigeria between 1985 and 2010 using simple regression analysis. They found that manufacturing foreign private investment and exchange rate had positive effect on manufacturing gross domestic product. The study recommended that stimulation of export diversification in the area of agriculture; agro-investment, and agro-allied industries, oil allied industries would improve exchange rate fluctuations on manufacturing sector in Nigeria. Meanwhile, Omojimite and Akpokodje (2010) investigated a comparative analysis of the effect of exchange rate volatility on exports in the Central African Franc (CFA) and non-CFA countries of Africa using different panel data econometric techniques such as pooled, fixed effect, first difference GMM and system GMM equation while the exchange rate volatility series was generated using GARCH model. The results of the study showed that system GMM technique performed better than the other estimation techniques. Further, exchange rate volatility had negative relationship with exports of both panels of countries but the effect on the panel of the non-CFA countries was larger than that of the CFA. The study concluded that appropriate monetary and fiscal policy actions could stem the upward movement in exchange rate volatility. Rashid and Husain (2010) investigated the relationship among capital flows, inflation and exchange rate volatility using linear and nonlinear causality test and found a significant inflationary impact of capital inflows during the last 7 years. The study suggested that there is a need to manage the capital inflows in such a way that they should neither create an inflationary pressure in the economy nor fuel the exchange rate volatility.

In another study by Combes, Kinda, and Plane (2012) on the relationship among capital flows, exchange rate flexibility and the real exchange rate in developing countries using panel cointegration techniques, they found that public and private flows are associated with a real exchange rate appreciation and using de facto measure of exchange rate flexibility- the study found that a more flexible exchange rate helps to dampen appreciation of the real exchange rate stemming from capital inflows. Rabanal and Tuesta (2013) examined the relationship between nontradable goods and the real exchange rate and found that the relationship between tradable and nontradable goods is the key to understand real exchange rate volatility. Therefore, the study further showed that nontradable sector technology shocks explain about one third of real exchange rate volatility.

Abubaker (2016) examined the relationship between consumption and money uncertainty at the zero lower bound with emphasis on the 2008 financial crisis. The study found that consumption uncertainty declines; and real money uncertainty increases significantly when the economy is constrained by the zero lower bound. Furthermore, Alagidede and Ibrahim (2016) examined the causes and effects of exchange rate volatility on economic growth in Ghana and found that shocks to exchange rate are mean reverting, misalignments tend to correct very sluggishly, with painful consequences in the short-run as economic agents recalibrate their consumption and investment choices. Also, excessive volatility is found to be detrimental to economic growth in Ghana.

In summary, most of the studies reviewed centered on the relationship between exchange rate volatility and macroeconomic variables but with a total neglect of private consumption. Apart from this, the methodology employed by most of these studies were inappropriate (see Azeez, Kolapo, and Ajayi (2012) and Lloyd and osinubi, 2009). This study therefore examine the empirical relationship between exchange rate volatility and private

consumption in Sub-Saharan African (SSA) countries using panel data analysis and the exchange rate volatility series is also generated using GARCH (1, 1) approach.

### 3. Methodology

This paper employed dynamic panel model estimator as propounded by [Arellano and Bover \(1995\)](#) and fully developed in [Blundell and Bond \(1998\)](#) to examine the relationship between exchange rate volatility and private consumption in sub-Saharan African countries. In order to achieve this, a framework dynamic panel regression model to capture the relationship between exchange rate volatility (EV) and private consumption (pc) is specified as follows:

$$pc_{it} = \alpha + \lambda pc_{it-1} + \beta EV_{it} + \sum_{j=1}^k \delta_j X_{jit} + \varepsilon_{it}; j = 1, \dots, k; i = 1, \dots, n; t = 1, \dots, T \quad (1)$$

In Eq. (1) above,  $pc_{it}$  represents the regress and for country  $i$  over period  $t$ ;  $pc_{it-1}$  entails the lagged value of dependent variable for country  $i$  over period  $t$ ;  $EV_{it}$  denotes exchange rate volatility for country  $i$  over period  $t$ ;  $X_{jit}$  is the other regressors included in the model as control variables for country  $i$  over period  $t$  and  $j$  is the number of included control variables. A country specific fixed effect is assumed for the disturbance term as follows:

$$\varepsilon_{it} = e_i + u_{it} \quad (2)$$

where  $\varepsilon_{it}$  represents error term. It entails  $e_i$ , which represents country-specific fixed effects that are time invariant, meanwhile,  $u_{it}$  is assumed to be independent and normally distributed with zero (0) mean and constant variance  $\sigma_u^2$  both over time and across countries, that is,  $u_{it} \approx n(0, \sigma_u^2)$ . In order to analyse the empirical relationship between exchange rate volatility and private consumption, as earlier stated the study uses a dynamic panel approach with the system-GMM estimator. In dynamic panel, the inclusion of a lagged dependent variable as an independent variable violates the orthogonality assumption. This is due to the fact that the lagged dependent variable ( $pc_{it-1}$ ) depends on  $\varepsilon_{it-1}$ , which is a function of  $\varepsilon_{it}$ . Since  $\varepsilon_{it} = e_i + u_{it}$ , absolutely  $E(pc_{it-1}\varepsilon_{it}) \neq 0$ . As a result of this correlation, dynamic panel data estimation suffers from bias which disappears only as  $t$  tends to infinity. To get rid of the country-specific effect, Eq. (1) can be differenced as follows:

$$\Delta \ln pc_{it} = \beta \Delta EV_{it} + \lambda \Delta \ln pc_{it-1} + \sum_{j=1}^k \delta_j \Delta \ln X_{jit} + \Delta u_{it} \quad (3)$$

However, the transformed error term  $\Delta u_{it}$  is correlated with  $\Delta \ln pc_{it-1}$  since both contain  $u_{it-1}$ . In disparity to a static model, ordinary least square on the first differenced data in a dynamic model generates inconsistent parameter estimates since  $E(pc_{it-1}\varepsilon_{it}) \neq 0$ . Note that  $E(pc_{it-h}\Delta u_{it}) = 0$  for all  $h \geq 2, t=3, \dots, T$ . This opens up the possibility of using instrumental variable IV estimations using the lagged variables as instruments. Following this fact, [Anderson and Hsiao \(1982\)](#) proposed IV estimation using  $\ln pc_{it-2}$  as instrument for  $\Delta \ln pc_{it-1}$  since  $E(pc_{it-2}\Delta u_{it}) = 0$ .

[Blundell and Bond \(1998\)](#) argued that if the dependent variable is close to a random walk, the difference GMM performs poorly because the past levels convey little information about the future changes. This makes untransformed lags to be weak instruments for transformed variables. Thus, to increase the efficiency we orthogonality moment conditions that  $E(\Delta \psi_{it} e_i) = 0$  for all  $i$  and  $t$ . This approach was outline in [Arellano and Bover \(1995\)](#) by transforming the difference of the instruments to make them exogenous to the fixed effects. Hence, the validity of the assumption is that changes in the instrumental variables are uncorrelated with the fixed effect. If this assumption holds, then  $\Delta \psi_{it}$  is a valid instrument for the variables in levels since  $E(\Delta \psi_{it-1} \varepsilon_{it}) = 0$ .

Difference and system-GMM estimators are used when  $N > T$ . The [Nickell \(1981\)](#) bias disappears in large  $T$  panel indicating that the shocks to the country's fixed effect has shown by the error term will decline with time and the correlation of the lagged dependent variable with the error term will be insignificant ([Judson & Owen, 1997](#); [Roodman, 2009](#)). Dynamic GMM solves the problem of endogeneity than in the static and OLS models that do not allow the use of internally generating instruments. Also, all the variables from the regression that are not correlated with the error term (including lagged variables) can be potentially used as valid instruments ([Arellano, 2003](#); [Baltagi, 2005](#); [Han, Phillips, & Sul, 2013](#); [Horváth, Hušková, Rice, & Wang, 2015](#); [Wooldridge, 2002](#)); and it accommodates

a situation where ‘ $T$ ’ is smaller than ‘ $N$ ’ in order to control for dynamic panel bias (Baltagi, 2005; Baum, Schaffer, & Stillman, 2007; Bond, 2002; Roodman, 2009) as in this study.

Furthermore, the study employs dynamic panel model using system-GMM in this study because it has advantage over difference-GMM in variable that are ‘random walk’ or close to be random walk variables (Arellano, 2003; Baltagi, 2008; Baum, Schaffer, & Stillman, 2007; Han, Phillips, & Sul, 2013). Since the model specified in this study encompasses macroeconomic variables which are known in economic for the presence of random walk statistical generating mechanisms; the technique also produces more efficient and precise estimates compared to difference-GMM by improving precision and reducing the finite sample bias (Baltagi, 2008).

In the literature, performing the tests of over-identifying restrictions - whether the instruments, as a group appears exogenously; either Sargan or Hansen J statistics or both are used. Sargan statistic is reported for one-step non-robust estimation which minimized the value of the one-step GMM criterion function. Further, Hansen J-statistic is reported for one-step robust estimation and for all two-step estimation and minimized the value of the two-step GMM criterion function and it is robust. Based on this criterion, this study uses the Hansen J-statistic test to account for the over-identifying restrictions. Also, the time-series data employs by the study are subjected to unit-root tests using Levin, Lin & Chu  $t^*$  test and Im, Pesaran and Shin W-stat.

### 3.1. Data sources and measurements

Our study uses a cross-country panel data of 19 sub-Saharan African countries which are purposively selected based on data availability from 1999–2014. Five or four countries each are purposively selected from all the four regions that comprise the SSA countries. The countries are Cameroon, Central African Republic, Congo and Gabon for Central African region; Burundi, Ethiopia, Kenya, Rwanda and Uganda for Eastern African region; Angola, Botswana, South African, Zambia and Zimbabwe for Southern African region and Burkina Faso, Gambia, Ghana, Niger and Nigeria for Western African region. The data are mainly obtained from the World Bank Database (World Development Indicator, 2014). The following methods are used for our data measurements.

#### 3.1.1. The GARCH (1, 1) estimation process for exchange rate volatility

Exchange rate volatility is measured as the conditional variance exchange rate level constructed from quarterly data. The conditional variance is the true measure of volatility about a variable given a model and information set. To obtain conditional variance of exchange rate, the study uses GARCH (1, 1) specification as follows:

$$EX_t = \phi_0 + \sum_{i=1}^n \phi_i EX_{t-1} + u_t \quad (6)$$

$$\sigma_t^2 = \theta + \sum_{i=1}^p \vartheta_i u_{t-1}^2 + \sum_{j=1}^q \psi_j \sigma_{t-1}^2 \quad (7)$$

Eq. (6) is the mean equation, where  $EX_t$  is exchange rate,  $EX_{t-1}$  stands for the previous exchange rate and  $u_t$  represents the error term. In Eq. (7),  $\sigma_t^2$  is the one-period ahead forecast for the variance of exchange rate based on past information or volatility,  $\sigma_{t-1}^2$  is the previous volatility (GARCH term) and  $u_{t-1}^2$  denotes the previous information about volatility (ARCH term) while the equation is called conditional variance equation. The GARCH (1, 1) equation above is used to generate the exchange rate volatility series for yearly data set and this is included in the panel data model in Eq. (3) above as  $EV_{it}$ .

#### 3.1.2. The other independent variables (control variables)

The choice of control variables is informed by both theory and empirical evidence. For instance, empirical evidence also shows that increase in public consumption crowding-out private consumption (Aperre, 2014), therefore, we also include public consumption (GPC) as part of independent variable. Furthermore, increase in real GDP (RGDP) will also result in increase in private consumption (Onodje, 2009; Orji, Onyia, & Ani, 2013). The study also include inflation rate (INFL) since higher inflation rate reduces the purchasing power and hence reduces private consumption (Onodje, 2009). This is measured using annual percentage of consumer prices over the years.

## 4. Results and discussions

### 4.1. Pre-estimation results

#### 4.1.1. Descriptive statistic, normality test and correlation matrix

The mean and median of all the variables in the data set as presented in Table 1 below lie within the maximum and minimum values. More than 60% of the variables are positively skewed. Specifically, private consumption, exchange rate volatility, inflation rate, and interest rate are positively skewed while government consumption and real gross domestic product are negatively skewed. The positive values of the kurtosis for private consumption and government consumption, exchange rate volatility, inflation rate, interest rate and real gross domestic product indicate that these variables are leptokurtic in nature.

The values of the Jarque-Bera statistic show that the series are normally distributed since the p-values of all the series are not statistically significance at 5% level. This implies that the null hypothesis that says each variable is normally distributed is not rejected.

Furthermore, studies have argued that testing of the correlation among the variables of estimates would make the researchers to detect whether the variables have high multicollinearity among themselves. As a result, the parameter estimates may contradict what the theory says due to unexpected effect of multicollinearity among the independent variables (Agung, 2009; Hamsal, 2006). However, Iyoha (2004) argued that multicollinearity among variables occur when the result of the correlation coefficient is above 0.95. In line with this explanation, the study presents the results of the correlation analysis of the set of variables employed in Table 2. The table shows that the correlation coefficients among the independent variables (*EV*, *GPC*, *RGDP*, *INFL* & *INTR*) are below 0.95 indicating that there is no tendency for multicollinearity to occur among the independent variables.

#### 4.1.2. Unit root test

The study used Levin, Lin & Chu  $t^*$  test and Im, Pesaran and Shin W-stat to test for the presence of the unit roots in the panel data. It is observed that exchange rate volatility, interest rate and inflation rate are stationary at level I (0) at 5% significance level while private consumption, public consumption and real GDP are stationary at first difference at 5% significance level using both techniques as shown in Table 3 below. The autocorrelation results from correlogram show that all the series have no serial autocorrelation problem.

Table 1  
Descriptive statistics and normality test for the variables in data set.  
Source: Author, 2016.

|                     | LOG(PC)  | EV         | LOG(GPC)  | INFL      | INTR       | LOG(RGDP) |
|---------------------|----------|------------|-----------|-----------|------------|-----------|
| <b>Mean</b>         | 22.75256 | 75,300.35  | 21.25193  | 157.5381  | 25.47013   | 21.73237  |
| <b>Median</b>       | 22.73948 | 2814.535   | 21.07305  | 7.359263  | 10.97113   | 23.00774  |
| <b>Maximum</b>      | 26.09151 | 8,424,095. | 24.95955  | 23,773.13 | 477.6162   | 26.51835  |
| <b>Minimum</b>      | 19.52765 | 0.000000   | 17.16163  | -1.370974 | -25.76701  | 6.205706  |
| <b>Std. Dev.</b>    | 1.620460 | 51,5725.8  | 1.894157  | 1421.034  | 60.37230   | 4.899098  |
| <b>Skewness</b>     | 0.138374 | 14.57303   | -0.022805 | 15.35400  | 5.316652   | -2.473981 |
| <b>Kurtosis</b>     | 2.360716 | 230.3238   | 2.854051  | 253.0248  | 33.14999   | 8.263254  |
| <b>Jarque-Bera</b>  | 6.146805 | 665,324.4  | 0.296162  | 803,768.3 | 12,946.46  | 660.9994  |
| <b>Probability</b>  | 0.066263 | 0.120000   | 0.862361  | 0.090000  | 0.080000   | 0.065000  |
| <b>Sum</b>          | 6916.777 | 22,891,306 | 6460.585  | 47,891.59 | 7742.920   | 6606.641  |
| <b>Sum Sq. Dev.</b> | 795.6446 | 8.06E+13   | 1087.112  | 6.12E+08  | 1,104,379. | 7272.352  |
| <b>Observations</b> | 304      | 304        | 304       | 304       | 304        | 304       |



Table 2  
Correlation analysis matrix.  
Source: Author, 2016.

|      | PC     | EV     | GPC    | RGDP   | INFL  | INTR |
|------|--------|--------|--------|--------|-------|------|
| PC   | 1      |        |        |        |       |      |
| EXV  | −0.035 | 1      |        |        |       |      |
| GPC  | 0.842  | −0.013 | 1      |        |       |      |
| RGDP | 0.975  | −0.053 | 0.851  | 1      |       |      |
| INFL | −0.034 | −0.009 | −0.016 | −0.035 | 1     |      |
| INTR | −0.038 | 0.055  | 0.183  | −0.103 | 0.074 | 1    |

Table 3  
Unit root test results.  
Source: Author, 2016.

| Variables | Levin, Lin & Chu $t^a$ test |                     | Im, Pesaran and Shin W-stat |                     | Order of Integration | Autocorrelation |
|-----------|-----------------------------|---------------------|-----------------------------|---------------------|----------------------|-----------------|
|           | Level                       | First Diff          | Level                       | First Diff          |                      |                 |
| EV        | −13.29 <sup>a</sup>         | −                   | −11.52 <sup>a</sup>         | −                   | I(0)                 | No              |
| GPC       | 5.53                        | −10.82 <sup>a</sup> | 7.35                        | −10.05 <sup>a</sup> | I(1)                 | No              |
| INFL      | −7.44 <sup>a</sup>          | −                   | −6.66                       | −                   | I(0)                 | No              |
| PC        | 2.07                        | −14.83 <sup>a</sup> | 5.14                        | −13.98 <sup>a</sup> | I(1)                 | No              |
| RGDP      | 2.59                        | −7.87 <sup>a</sup>  | 8.14                        | −8.01 <sup>a</sup>  | I(1)                 | No              |
| INTR      | −3.51 <sup>a</sup>          | −                   | −5.36 <sup>a</sup>          | −                   | I(0)                 | No              |

Note: The results of the unit-root test are incorporated into the analysis based on the order of integration. Thus, those I (0) series are included into the analyzed model without been differenced while I (1) series are differenced.

<sup>a</sup>Probability is computed assuming asymptotic normality.

Table 4  
ARCH effect test result.  
Source: Author, 2016.

|               |          |                     |        |
|---------------|----------|---------------------|--------|
| F-statistic   | 0.003915 | Prob. F(1,296)      | 0.9502 |
| Obs*R-squared | 0.003942 | Prob. Chi-Square(1) | 0.9499 |

#### 4.1.3. ARCH effect and volatility clustering

In order to test whether exchange rate is volatile over the periods of study, the residual obtained from the exchange rate volatility model using GARCH (1, 1) must satisfy two conditions. That is, it must have ARCH effect and the volatility must be clustered otherwise the variable is not volatile. The Table 4 presented below indicated that the residual has ARCH effect since the F-statistic is not statistically significant at 5% level, implying that we accept null hypothesis that there is ARCH effect and reject alternative hypothesis that there is no ARCH effect.

Meanwhile, Fig. 1 below shows that the periods of low volatility is followed by the periods of low volatility for a prolonged period; also the periods of high volatility is followed by the periods of high volatility for a prolonged periods which revealed that the graph of exchange rate volatility is cluster and volatile.

#### 4.2. Estimation results

The coefficient of exchange rate volatility has negative sign and statistically significance at 5% level. The indirect relationship exists between exchange rate volatility and private consumption in sub-Saharan African countries (SSA) shows that volatility in exchange rate would result to decrease in private consumption. The implication of this result is that private consumers would be sceptical in their purchasing abilities and keep their money income for future expectations. Then, this action would lead to a fall in consumption level.

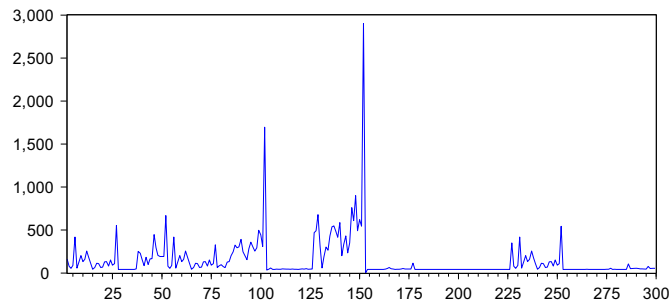


Fig. 1. Graph of exchange rate volatility.

Table 5

Empirical results of system-GMM dynamic panel – two-step robust estimate.

Source: Author, 2016.

**Dependent Variable: Private Consumption ( $\Delta \log pc$ )**

| Variables   | Coefficients | t-Statistic | P-Value |
|---|--------------|-------------|---------|
| Constant $\alpha$                                     | 4.5140       | 7.71        | 0.000   |
| Exchange Rate Volatility ( $EV$ )                     | -0.0467      | -11.42      | 0.000   |
| Lagged Dependent Variable ( $LI$ , $\Delta \log pc$ ) | 0.0592       | 2.20        | 0.028   |
| Government Consumption ( $\Delta \log gpc$ )          | 0.8014       | 73.87       | 0.000   |
| Real GDP ( $\Delta \log rgdp$ )                       | 0.0253       | 10.99       | 0.000   |
| Inflation Rate ( $infl$ )                             | -0.0970      | -2.48       | 0.013   |
| Interest Rate ( $intr$ )                              | -0.0032      | -11.46      | 0.000   |

The coefficient of lagged dependent variable is positive and statistically significance at 5% level. This is in conformity with the permanent income hypothesis theory which states that Change in present consumption depends on past consumption (Friedman, 1955). Thus, a unit percent increase in previous consumption would result in 0.06 percent increase in present consumption in SSA countries. Hence, the consumption patterns of private consumers in SSA countries follow theory. Also, the coefficient of government consumption is positive and statistically significance at 5% level indicating that in SSA countries, increase government consumption would translate to increase in private consumption. This implies that the involvement of governments in providing goods and services for the direct needs of the population has enhanced individual consumption. Thus, increase private consumption. Hence, 80% of the governments' final consumption expenditure in SSA countries goes for private consumption as evidenced from the result in Table 5. This has been confirmed by many scholars in the economic literature (Apere, 2014; Onodje, 2009; Tapsin & Hepsag, 2014) and our result also confirmed this for SSA countries. Further, the positive and significant coefficient of real GDP at 5% level shows that a sustainable increase in growth of real gross domestic product would result to increase in private consumption. This indicates that as the value of finished goods and services ready to be used by consumers, business and government increases; private consumption witness in SSA countries increases.

The coefficient of inflation rate is negative and statistically significance at 5% level implying that an increase in inflation rate would lead to increase in the opportunity cost of holding money or a decrease in the purchasing power of the currency, uncertainty over future inflation which may discourage investment and saving, impose hidden tax increases which push taxpayers into higher income tax rates unless the tax brackets are indexed to inflation, leads to shortage of goods as consumers begin hoarding out of concern that prices will increase in the future. Consequently, this would lead to decrease in private consumption as a result of decrease in investment and saving. Hence, as prices of goods and services increase in SSA countries, private consumption decreases. This shows that private consumers in SSA are forward looking consumers who react sharply to a slight increase in price due to future expectation. Lastly, the coefficient of interest rate is negative and statistically significance at 5% level. The negative significance

Table 6

Test of the validity of instruments.

Source: Author, 2016.

|   |                                     |
|---|-------------------------------------|
| F-test of Joint Significance                      | $F=1830.29$                         |
| Arellano-Bond test for AR(1) in first Differences | $z=-3.33; pr > z=0.001$             |
| Arellano-Bond test for AR(2) in first Differences | $z=-0.60; pr > z=0.546$             |
| Hansen J-test of Overidentifying Restrictions     | Chi2 (4)=1.55;<br>prob > chi2=0.813 |

Table 7

Pooled ordinary least square (POLS) results.

Source: Author, 2016.

| Variables             | Coefficients | t-Statistic | P-Value |
|-----------------------|--------------|-------------|---------|
| <i>Constant</i>       | 8.20         | 12.14       | 0.00    |
| <i>II. Δlog(pc)</i>   | 0.1282       | 4.66        | 0.00    |
| <i>Δlog(rgdp)</i>     | 0.0165       | 1.84        | 0.06    |
| <i>Δlog(gpc)</i>      | 0.8004       | 33.95       | 0.00    |
| <i>EV</i>             | -2.0800      | -4.12       | 0.00    |
| <i>infl</i>           | 0.0001       | 2.27        | 0.02    |
| <i>intr</i>           | -0.0031      | -4.40       | 0.00    |
| <b>F-statistic</b>    | 186.14       |             | 0.00    |
| <b>Adj. R-Squared</b> | 0.8187       |             |         |

Dependent Variable: *Private Consumption (Δlogpc)*.

of the coefficient of interest rate implies that increase in interest rate would lead to decrease in private consumption due to the fact that higher interest rate increase the cost of borrowing which reduces investment, output and increases unemployment but encourages more saving. Meanwhile, saving and consumption are inversely related according to Keynesian theory of consumption.

#### 4.3. Post estimation results

Table 6 above is used to test the validity of the instruments used in the system-GMM (SGMM) technique. Compared to the OLS model, SGMM does not assume normality and it allows for heteroskedasticity in the data. Dynamic panel irrespective of the kind of the models are known for the problem of heteroskedasticity of data which can be controlled (Baltagi, 2005). More so, the SGMM approach assumes linearity and that the error terms are not autocorrelated. Thus, the most imperative procedure in testing the statistical properties of this model is testing for the validity of instruments, which requires testing for the presence of first- and second- order autocorrelation in the disturbance term. In accordance with the work of Arellano and Bond (1991), the GMM estimator requires that there is first-order serial correlation but there is no second-order serial correlation in the residual. Since the null hypotheses are that there is no first-order and second-order serial correlation, it implies that one needs to reject the null hypothesis in the first-order autocorrelation test and accept null hypothesis for second-order serial correlation test to get appropriate diagnostics. Based on the results in Table 6, it shows that there is first-order serial correlation since the null hypothesis of no first-order serial correlation is rejected ( $z=-3.33; p < 0.05$ ) at 5% significance level but there is no second-order serial correlation in the result since the null hypothesis of no second-order serial correlation is accepted based on the fact that the calculated  $z$ -value is not statistically significance at 5% level (i.e.  $z=-0.60; p > 0.05$ ). These results support the validity of our model specification.

In addition, the Hansen J-statistic tests the null hypothesis of correct model specification and valid overidentified restrictions, i.e. validity of instruments (Baum Schaffer, & Stillman, 2007). Baum Schaffer, and Stillman (2007) argued further that the Hansen J-statistic tests is the most commonly used diagnostic in GMM estimation for assessment of the appropriateness of the model. Our result also shows that the Hansen J-statistic test of

Table 8  
Fixed effect results.  
Source: Author, 2016.

| Variables                              | Coefficients | t-Statistic | P-Value |
|--|--------------|-------------|---------|
| <i>Constant</i>                        | 8.9607       | 11.76       | 0.00    |
| <i>II. <math>\Delta\log(pc)</math></i> | -0.1319      | -4.60       | 0.00    |
| <i><math>\Delta\log(rgdp)</math></i>   | 0.0252       | 2.75        | 0.01    |
| <i><math>\Delta\log(gpc)</math></i>    | 0.7953       | 31.34       | 0.00    |
| <i>EV</i>                              | -0.0454      | -1.95       | 0.05    |
| <i>infl</i>                            | 0.0001       | 1.34        | 0.18    |
| <i>intr</i>                            | -0.0031      | -4.25       | 0.00    |
| <b>F-Statistic</b>                     | 197.87       |             | 0.00    |
| <b>Adj. R-Squared</b>                  | 0.8162       |             |         |

Dependent Variable: *Private Consumption ( $\Delta\log pc$ )*.

overidentifying restrictions does not reject the null hypothesis at any conventional level of significance ( $p > 0.05$ ; i.e.  $p = 0.813$ ); this is an indication that the model has valid instrumentation. The F-statistic value also shows that all the independent variables are jointly and significantly explain the model at 5% significance level.

#### 4.3.1. Robustness check

In order to check the validity of the System GMM results, the study also employs pooled OLS and fixed effect based on the documented literature (Bond, 2002). Bond (2002) suggested additional detection of the dynamic panel estimate's validity by checking if the estimated coefficient of the lagged dependent variable lies between the values obtained from Pooled Ordinary Least Square (POLS) and Fixed Effect (FE) estimators. Tables 7 and 8 (see Appendix) respectively confirm that the estimated coefficient obtained from the lagged dependent variable of the System GMM results lies between the values obtained from Pooled Ordinary Least Square (POLS) and Fixed Effect (FE) estimators (i.e.  $FE = -0.1319 < GMM = 0.0592 < OLS = 0.1282$ ).

## 5. Conclusion

The relationship between exchange rate volatility and private consumption in SSA countries has not been documented in the existing literature. The majority of findings focus on the relationship between either exchange rate or exchange rate volatility and macroeconomic variables; foreign direct investment, performance of manufacturing sector and credit channel in the banking sector. Thus, this study is aiming to provide some empirical evidence on the relationship between exchange rate volatility and private consumption in SSA countries which may help in explaining divergence in prior works using system-GMM dynamic panel two-step robust estimate model. Furthermore, the study considers fully the diagnostics and the instrumental tests as well.

Results of the GARCH (1, 1) model showed that the exchange rate volatility series has ARCH effect and volatility clustering indicating that the series is highly volatile. The results of the panel data analysis demonstrated that exchange rate volatility has significant negative relationship private consumption in SSA countries. The implication of this finding is that importation of goods is more expensive since fluctuation in exchange rate makes the local currency weaker; it also encourages foreign capital outflow which discourages foreign investors and this reduces aggregate investment, thus reduces income and consumption. Though, other control variables included into the model show surprising results. For instance, the results show that government consumption increases private consumption; the previous private consumption has significant influence on the present private consumption and increase in real GDP also significantly shows increase in private consumption. More so, the results of the diagnostic tests show that the estimated model has valid instruments, no second-order serial correlation and the model specification is valid.

Finally, the study concludes that exchange rate volatility has significant effect on private consumption in Sub-Saharan African countries. The implication of this is that majority of individuals cannot afford to consume imported goods. This may be associated to high level of poverty lingering within the SSA countries. However, if exchange rate volatility continues without being controlled; the long-run effect on private consumption may be severe. Then, it

effects would be disastrous to economic growth having established in the literature that private consumption contributes a larger proportion of the real GDP (Mankiw, 2012) and a sustainable increase in real GDP leads to economic growth. Hence, this study therefore recommends that government should embark on policy that will discourage exchange rate fluctuations; make local currency stronger; reduce export competitiveness and imports cheaper which can cause the trade deficit to widen further, eventually weakening the currency in a self-adjusting mechanism.

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