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EXCHANGE RATE FLUCTUATIONS AND MACROECONOMIC PERFORMANCE IN SUB-SAHARAN AFRICA: A DYNAMIC PANEL COINTEGRATION ANALYSIS

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ABSTRACT

In the light of the widespread effects of the recent global financial crisis on exchange rate and other macroeconomic developments, this paper investigates the implications of exchange rate fluctuations on output and other critical determining factors of exchange rates. We use Panel data set containing 40 countries from Sub-Saharan Africa (SSA) over a period of 13 years: 1995-2007. In the paper, we employ the dynamic generalized methods of moments (GMM) panel data framework using the xtabond2 Difference/ System GMM. We also examine the panel co-integration properties of the variables in order to establish long-run relationship between exchange rate and other macroeconomic variables in the SSA countries. The Panel Granger Causality test confirms the bilateral relationships between some variables in the model. Though the results of the study are tentative, in view of the many assumptions underlying the methods used, they reveal their potency to determine exchange rate (EER), a long-run relationship with variables of the model and bidirectional relationships.

Keywords: Dynamic panel data, Panel unit roots, Xtabond2, Panel granger causality, Sub-Saharan Africa.

JEL Classification: C23, C33, E43, F31.

Contribution/ Originality

The study contributes to the existing literature on the widespread effects of the recent global financial crisis on exchange rate and other macroeconomic developments in Nigeria.

1. INTRODUCTION

The exchange rate is the domestic price of foreign money. It can be simply viewed as the price of one currency in terms of another. In the wake of the recent global financial crisis in 2008/2009, there have been major fluctuations in the exchange rates of many countries, resulting in widespread exchange rate misalignments and re-alignments among countries. Since the seventies, there has been an increasing importance attached to exchange rate in many countries, which could be attributed to the following among other reasons: the floating exchange rate variability and volatility as well as the need for foreign exchange risk exposure management; the globalization process and the resultant increased rate and volume of fund flows among nations; the trade liberalization undertaken by developing countries since 1980s, resulting in opening up their economies; the internationalization of modern business; the continuing growth in world trade relative to national economies; the trends towards economic integration in some regions; and the rapid pace of change in the technology of money transfer.

As financial markets around the world have become more integrated, the volatility in exchange rate movement in one country has spilled over to other countries. This situation became pronounced with the global economic and financial crisis of 2007-2009 and whose effect is yet to attenuate. This as well as some other fallouts of the global crisis, like exchange rate fluctuations, has adversely impacted macroeconomic performance in many countries.

The exchange rate directly influences prices and /or profitability of traded and non-traded goods. It is a relative price and as such affects the allocation of resources over the short to medium term. The impact of sustained movements of the exchange rate on the competitive position of domestic industry vis-à-vis foreign industry in both domestic and foreign markets is the key transmission mechanism. In effect, uncertainties resulting from unanticipated changes in the domestic and international macroeconomic environments are also key factors. This is more striking in the developing countries which depend heavily on external trade: export to earn foreign exchange, imports to purchase consumer, intermediate and capital goods as well as external borrowing to finance the foreign exchange gap. Therefore, the dependent peripheral structure of these economies is a major factor in the determination of exchange rates.

It, thus, follows that any shock to any of the determining variables of exchange rate will have serious effects on economic activities and the financial position of the country. In effect, the global financial crisis that began with the crash in subprime lending rate in the USA in 2007 led to a slowdown in the growth of major world economies and consequently those of Sub-Saharan Africa (SSA). From a growth rate of 5.0 percent in 2003, 7.2 percent in 2004, 6.2 percent in 2005, 6.3 percent in 2006 and 6.9 percent in 2007, SSA economies grew at 5.4 percent in 2008 (IMF, 2009). The region, as further reported by IMF (2009), managed to avoid a contraction in 2009, growing by 2 percent, projected to accelerate to 4.5 per cent in 2010 and to 6 per cent in 2011.

There have been studies among which are those by Catao (2007), Berg and Miao (2010) that have examined the determinants of nominal and real exchange rates, but few have dealt with the issue of exchange rate volatility and long-run relationship with output and other macroeconomic variables in a panel of African countries. Therefore, the objective of this paper is to examine the link between exchange rate fluctuations and output, income as well as other macroeconomic variables. Our empirical methodology is the dynamic panel data regression, based on selected forty African countries

The analysis is restricted to countries that adopt the flexible exchange rate so as to observe clearly the effect of volatility in exchange rate on output and other variables. The period of analysis is set at 1995-2007. The model considers country-specific time dummies to explain aggregate shocks that may affect all the countries equally. The paper adopts the dynamic generalized methods of moments (GMM) and the STATA 10.0 computer software is used to analyze the data. The data are obtained from the African Development Bank (2008) (AfDB) Selected Statistics for Africa: Country Profile 2008.

The remaining part of the paper is arranged as follows: In section 2, the paper reviews the literature and theoretical framework of the study. Section 3 presents a Framework for Analysis including model specification, the technique of estimation, the sources of data and their measurements. The estimation results are presented in Section 4: Empirical Results including preliminary analysis, exchange rate regression results and discussion. Section 5 provides policy recommendations and conclusion.

2. OVERVIEW OF THE LITERATURE

The domain of exchange rate behaviour seems to consistently enjoy visibility and voice in all seasons and era. Research findings have dominated theoretical, methodological as well as empirical dimensions. Theoretical approaches to exchange rate analyses include the Purchasing Power Parity (PPP), the Interest Rate Parity, the Marshall-Fleming Model, the Balassa-Samuelson Exchange Rate and Productivity Model, the Dournbush Overshooting Model, the Obstfeld and Rogoff Model, and Balance of Payments Equilibrium and Exchange Rate Misalignment. The choice of theory depends to a large extent on the statement of the research problem.

Kandil *et al.* (2007) examine the theoretical model that decomposes movements in the exchange rate into anticipated and unanticipated components using rational expectations. Anticipated movement in the exchange rate is assumed to vary with agents' observations of macro-economic fundamentals, which determine changes in the exchange rate over time.

A similar approach is adopted by Kandil and Dincer (2007) who developed empirical models using an annual time series data for the period 1980-2004 to explore how currency fluctuations affect the economies of Egypt and Turkey. Based on the rational-expectation theory, they deconstruct currency fluctuations into anticipated and unanticipated shocks and estimate a system of three equations where real output, price inflation and real values components of consumption, investment imports and exports are dependent upon the growth rate of government spending, money supply, energy prices, expected changes in real exchange rate, unanticipated exchange rate appreciation and depreciation and structural breaks captured by dummy variables.

Evans and Lyons (2002) observe that macroeconomic models of exchange rates perform poorly at frequencies higher than one year. Citing the works of Meese and Rogoff (1983) and Meese (1990) they contend that the explanatory power of these models is essentially zero (Meese and Rogoff, 1983; Meese, 1990). According to Evans and Lyons (2002) as contained in Frankel and Rose (1995), the negative result has had a "pessimistic effect on the field of empirical exchange rate modeling. In order to resolve the problem, Evans and Lyons (2002) present a class of macroeconomic model that incorporates microstructure. This augmented macro model highlights new set of variables hitherto omitted in traditional macroeconomic models of exchange rate. The variable, order flow, is a proximate determinant of price in these models because it conveys information that currency markets need to aggregate. By this approach, order flow reflects new information about valuation numerators (i.e., future interest differentials) as well as new information about valuation denominators (i.e., anything that affects discount rates).

Ardic (2006) observes that many emerging economies experienced economic crises associated with large, prolonged current account deficits and real exchange rate misalignment in the 1980s. Governments were thus faced with the option of currency adjustment and they ended up devaluing their national currencies. In the case of Tukey, the author uses bivariate models of the REER and real GDP as well as multivariate VAR models that take into account other macroeconomic indicators Empirical evidence suggests that devaluation has been indeed contractionary due to demand-side and supply-side effects in Turkey. The author further investigates the mechanism through which these devaluations are transformed into contractions in output and finds out that extensive use of imported intermediate goods in production makes the cost of imported intermediate goods expensive and hence force a downward trend in production.

Bacchetta and Wincoop (2006), assert that the varying weight that traders give to different macroeconomic indicators may explain why formal models of exchange rates have found so little explanatory power of macro variables. In contrast to existing models, the relationship between macroeconomic variables and the exchange rate appears to be highly unstable. Cheung *et al.* (2000) finds that some models, with certain macroeconomic variables, do well in some periods but not in others. One explanation for this parameter instability is a scapegoat story: some variable is given an 'excessive' weight during some period. The exchange rate may change for reasons that have nothing to do with observed macroeconomic fundamentals, for example due to unobserved liquidity trades.

Consequently, Crosby and Otto (2001) corroborate similar results from the Asian area, suggest that in all but one of the countries depreciations were expansionary. This suggests that the depreciations that occurred in 1997 were unlikely to have been the only cause of subsequent falls in output.

Juvenal (2010) observes that explanation of the sources of real exchange rate fluctuations is one of the most challenging issues in international economics. Based on the standard two-country small open economy DSGE and structural vector auto regression method he analyzes the role of real and monetary shocks on exchange rate behaviour. He concludes that the contribution of demand shocks plays an important role but not of the order of magnitude sometimes found in earlier studies. His results, however, support the recent focus of the literature on real shocks to match the empirical properties of real exchange rates.'

Some other brands of research examine the effects of exchange rate fluctuations on output and prices particularly in developing countries. From their theoretical models, Kakil and Mirzaie (2003), using a sample of 33 developing countries, show that unanticipated currency fluctuations help to determine aggregate demand through exports, imports, and the demand for domestic currency, and aggregate supply through the cost of imported intermediate goods.

They also show that in many developing countries, high variability of exchange rate fluctuations around its anticipated value may generate adverse effects in the form of higher price inflation and larger output contraction.

Bahmani-Oskooee and Kandil (2007) test whether the conventional wisdom on impact of exchange rate fluctuations in oil-producing countries still applies to Iran; that is, that currency depreciation in oil-producing countries are contractionary because demand effects, limited by the prevalence of oil exports priced in dollars, are more than offset by adverse supply effects. They conclude that the emergence of the non-oil export sector has made currency depreciation expansionary rather than being contractionary. The expansionary effect is shown to be particularly evident with respect to anticipated persistent depreciation in the long-run. Notwithstanding the varying effects of exchange rate fluctuations on the demand and supply sides of the economy, it is further shown that managing a flexible exchange rate gradually over time towards achieving stability in the real effective exchange rate may strike the necessary balance. As they show, while decisions to produce and export oil are not likely to vary with fluctuations in the exchange rate, the supply side of oil-producing countries may further react to fluctuations in the exchange rate. Aggregate supply could decline because of an increase in the cost of imported inputs due to a depreciation of the domestic currency.

Boug and Fagereng (2007) construct a measure of exchange rate volatility using the GARCH model, to explore sectoral causality between export performance and exchange rate variations in Norway. This was for the quarterly time series period of 1985:1 to 2005:4. They used the Johansen Cointegration Vector Auto Regression (VAR) method to estimate a model where exports depend on exports competitiveness, foreign demand and exchange rate volatility. Their results indicated a weak causality of exchange rate variations to exports performance.

Berument *et al.* (2012) examined the effect of exchange rate shocks on macroeconomic performance in Turkey for the period 1987:1 to 2008:3. Using the Uhlig (2005) sign restriction approach, they divide exchange rate shocks into monetary policy fluctuations and portfolio preference fluctuations. Then, they estimate models where real GDP is dependent on nominal GDP, GDP deflators, exchange rate, interest rate and money supply, using the Vector Autoregressive (VAR) technique. They found no clear relationship between exchange rate shocks and the macroeconomy but concluded that macroeconomic performance depended on the sources of exchange rate shocks.

In their cross-country panel study, Arize *et al.* (2000) find robust evidence of significant and negative, short run and long run effects of exchange rate volatility on export flows in eight Latin American Countries for a quarterly period 1973-2004. Arize *et al.* (2000) used different robust Cointegration and Error correction techniques, they estimate a 4-variables model where exports is regressed against world demand conditions, relative prices and exchange rate.

3. A FRAMEWORK FOR ANALYSIS

3.1. Model Specification

The discussions in the preceding section show that there are different dimensions to examining the link between exchange rate and output in an economy and this thus suggests the existence of several models to trace the linkages. According to Grydaki and Fountas (2008), exchange rate can be determined by contemporaneous unanticipated shocks in money supply, price level, government spending, output and the trade balance account as well as past values of these shocks. This paper is an attempt to examine exchange rate fluctuations and output performance in Sub-Saharan Africa (SSA). As a starting point, we postulate that the relationship between the exchange rate and its different determinants is functionally of the form:

$$EER = f(RYG, CPI, OPN, INT, GE, FDI) \qquad (1)$$

where EER is the level of exchange rate of the national currency per US$, RYG is the real GDP, CPI indicates aggregate price level whose changes provide the information on inflation rates, OPN is degree of openness measured as the ratio of total trade to GDP, INT is the interest rate and GE, FDI is the government deficit expressed as a percentage of the GDP. This paper aims at a reliable generalization of the extent to which exchange rate fluctuations are influenced by output, degree of openness, government expenditure, foreign direct investment, consumer price index and interest rates across a certain number of African countries. The paper assumes a nonlinear relationship between the dependent variable and the explanatory variables and that the parameters are heterogenous. By nonlinearity, it means that the determinant of economic development enter the model in a nonlinear manner, while by parameter heterogeneity, we mean that the parameters of the model are explicitly allowed to vary across countries. In a standard neoclassical production function of the Cobb-Douglas variant (see Herzer *et al.* (2004)), the model is explicitly of the form:

$$EER = A.RYG_{it}^{\beta_2}, CPI_{it}^{\beta_3}, OPN_{it}^{\beta_4}, INT_{it}^{\beta_5}, GE_{it}^{\beta_6}, FDI_{it}^{\beta_6}.e_{it} \qquad (2)$$

The log-linear form of equation 2 is required for estimation. Hence, lower cases letters denote the logarithm of the variables. In this case, linear dynamic model with a variable intercept is can be used in the analysis of the panel time series data (Hsiao, 1986). Since this equation is common to all countries, then the general specification for panel data model of a single period t and for individual country *i*, can be written as:

$$leer_{it} = \beta_1 + \sum_{j=2}^{k} \beta_j X_{jit} + \sum_{p=1}^{s} \gamma_p Z_{pi} + \delta t + \phi_t \qquad (3)$$

Where X is a vector containing the logarithm of the variables of interest that influence exchange rate and the vector X may also contain lagged values and deeper lags of $leer$; $\sum_{p=1}^{s}\gamma_p Z_{pi} = \theta_i$, the unobserved heterogeneity nuisance component and unchanging over time. Since Z_{pi} are unobserved, then there is no means to find information about $\sum_{p=1}^{s}\gamma_p Z_{pi}$. Thus, it is assumed that θ_i, effect representing the joint impact of the Z_{pi} on $leer$, is unobserved and hence equation (3) becomes:

$$leer_{it} = \beta_1 + \sum_{j=2}^{k}\beta_j X_{jit} + \delta t + \theta_i + \varphi_{it} \qquad (4) \qquad \text{or}$$

$$leer_{it} = \beta_1 + \sum_{j=2}^{k}\beta_j X_{jit} + \delta t + \varepsilon_{it} \qquad (5) \qquad \text{and} \qquad \varepsilon_{it} = \theta_i + \varphi_{it}$$

(6)

ε_{it} is error term taking into account the unobserved time variant factors that influence the exchange rate fluctuations. ε_{it} contains two orthogonal shocks such that φ_{it} is time specified effect or idiosyncratic shocks and θ_i is country-specific fixed effect heterogeneity term accounting for all the unobserved factors constant in time which has impact on growth/development; i is the unit of observation; t, time period; j is observed explanatory variable; and p unobserved explanatory variable. The panel model in equation 5 can be written in its Fixed Effect form using the matrix notation as:

$$leer = X'\beta + \varepsilon_{it} \qquad (7)$$

The fundamental assumptions are that:

$$E(\theta_i) = E(\varphi_{it}) = E(\theta_i\varphi_{it}) = 0 \qquad (8)$$

The Random Effects model assumes in addition that the two error components are independent from each other such that: $\theta_{it} \approx i.i.d\ N\left(0, \sigma_\theta^2\right)$ and $\varphi_{it} \approx i.i.d\ N\left(0, \sigma_\varphi^2\right)$.

3.2. Estimation Technique

Empirical analysis of exchange rate fluctuations has been plagued by several difficulties. On the one hand, some of the explanatory variables are endogenous and measured with error. On the other hand, there is the problem of omitted variables, some of which may be unobservable. Using the OLS technique of estimation means that the estimation will be biased. The method of estimation proposed is the Generalized Method of Moment (GMM). This method in a dynamic panel gives efficient estimates of such a model as against the Ordinary Least Squares (OLS), while making it possible to control the individual and time-specific effects and to mitigate the endogeneity bias of some variables. The endogeneity is due to the problem of correlation between the explanatory variable(s) and the error term due to measurement, auto-regression with uncorrelated errors, simultaneity, omitted variables and sample selection errors.

The use of panel data methodology has several advantages. First, panels make it possible to capture the relevant relationships among variables over time. Second, a major advantage of using panel data is the ability to monitor possible unobservable trading-partner-pairs individual effects. When individual effects are omitted, OLS estimates will be biased if individual effects are correlated with the regressors. The econometric model presented in this paper is based on dynamic panel model which incorporates one lag of the dependent variable (logarithm of real GDP) as an explanatory variable.

According to Cozmanca and Manea (2009), researchers would like to use a model that allows the endogeneity of the regressions, the measurement error and omitted variables. These problems have been jointly addressed by the use of panel data methods of estimation. One of such methods is the dynamic model of the first-differenced equation estimated by the Generalized Method of Moments (GMM) approach proposed by Holtz-Eakin *et al.* (1988) and developed by Arellano and Bond (1991) and commonly known as "Difference" GMM. This method has a problem in estimating the persistent time series and more importantly when the sample size is small, the method performs poorly. Hence, attention has been drawn to an alternative panel data method known as "System" GMM. The latter is developed by Arellano and Bover (1995); and Blundel and Bond (1998). The assumptions about the data generating process of these two methods, are discussed in Roodman (2006) and Cozmanca and Manea (2009).

In addition to investigating exchange rate fluctuations using the various Arellano-Bond variants, we also examine the stationarity properties of the variables in the model in order to ensure no spurious panel data regression and for long term predictions. In effect, testing for unit roots in time series data is a common practice in time series econometrics. However, the practice is becoming popular in panel data econometrics. (See Levin *et al.* (2002) and Im *et al.* (2003)). We reiterate that many of the unit root tests that are applied in the time-series literature have been extended to panel data. In cases where the panel data are both stationary and heterogenous, issues of combining individual unit root tests applied on each time series are tackled by Im *et al.* (2003), Maddala and S.Wu (1992) and Choi (1999). It is on this basis that Kao (1999) suggested that one can avoid the problem of spurious regression by using panel data.

However, should there be spurious regression in panel data, it is different from what is obtainable in time series spurious regression literature given that its estimates provide a consistent estimate of the true value of the parameters of the model as N (number of countries) and T (length of the time series) tend to infinity. This according to Kareem (2009), "is due to the fact that the panel data estimator averages across individuals and the information of the independent cross-sectional in the panel tends towards a stronger overall signal than the pure time series case". Therefore, for panel unit roots test assuming cross-sectional independence, three tests are commonly used: the Levin *et al.* (2002) test, the Im *et al.* (2003) test and the Hadri z-statistic. These tests are carried out in the paper.

Further, the paper examines the co-integration properties of the panel data as the ability of governments or economic forces to restore equilibrium. Long-run relationship measures any relation between the levels of the variables under consideration while the short-run dynamics measure any dynamic adjustments between the first-differences of the variables. Several authors including (Gengenbach *et al.* (2006), Gengenbach (2009), and Kareem (2009) have investigated this phenomenon in panel data. Pedroni (1999; 2004) using Engle-Granger approach also investigates panel data co-integration. The latter suggests several tests for the null hypothesis which allows for the consideration of heterogeneity. The Engle-Granger co-integration test is based on an examination of a spurious regression performed using I(1) variables, but in the case where the variables are co-integrated, then the residuals will be I(0). The extension of Engle-Granger co-integration technique for panel data was introduced by Pedroni (1999; 2004) and Kao (1999). These are residual-based approach to error correction analysis.

In this study, we adopt the error correction based panel co-integration due to Westerlund (2007) and Persyn and Westerlund (2008). The underlying assumption is to test for the absence of co-integration by determining whether or not there exits error correction for individual panel members or for the panel as a whole.

3.3. Data Sources and Measurements

The sources and measurement of the variables used in this model is presented in table 1 below.

Table-1. Variable Definitions and Sources in Sub-Saharan Africa (SSA)

S/N	Variable	Definition	Source
1.	RYG	Real Gross Domestic Product (US$Million)	ADB Country Profile 2008
2.	EER	National exchange rate per US$	ADB Country Profile 2008
3.	CPI	Consumer Price Index (2000=100)	IFS CD ROM 2008
4.	OPN	Degree of Openness: (X+M)/GDP (%)	Calculated from IFS and ADB Sources
5.	INT	Interest rate (Lending rate in most countries) (%)	ADB Country Profile 2008
6.	GE	Government Expenditure (US$Million)	ADB Country Profile 2008
7.	FDI	Foreign Direct Investment (US$Million)	ADB Country Profile 2008

All variables in level are in US$ million at 2000 prices. The countries considered in the study are arranged according to geographical dictates not necessarily on any economic or political groupings. Forty (40) countries that are included in the study are shown in the footnote below[1]. The period of analysis is 1995-2007. The choice is informed by availability of data and the fact that several issues of economic importance took place during the time.

We use panel unit root test, ascertain the panel properties of the data and carry out a panel co-integration in order to establish the long run relationship between the variables. The variables that build up the model in this paper include nominal exchange rate, price level, real GDP, government expenditure, foreign direct investment, interest rate and the degree of openness of the economies.

4. EMPIRICAL RESULTS

In this section, we present the summary descriptive statistics both by region and then combined for all regions in SSA, the correlation coefficient matrix the dynamic panel data results Difference and System GMM of the Arellano-Bond xtabond2. Finally, we discuss the panel co-integration framework results.

4.1. Preliminary Analysis

This session illustrates the summary statistics for both the dependent and the independent variables in the study. It reports the overall mean, minimum and maximum values for all the variables in the model by regions as well as for all the regions combined. The mean of exchange rate is calculated at US$1 to 712.53 units of local currency for all regions combined. This figure contrasts very sharply with the different regional means. It could be seen that the mean EER for Southern region of SSA is US$1 to 431.50 which constitutes the least in the whole of SSA, while a mean of US$1 to 1128.43 is observed for the West region of SSA. The volatility in exchange rate is measured by the percent standard deviation and this shows a high disparity across the different regions in SSA. This is an indication of the divergence in macroeconomic policies and structure of the economies within the SSA. Similarly, the minimum EER is US$1 to 0.12, and this is obtained in the western region. Paradoxically, the highest level of EER of US$1 to 13536.8 is found in the same region: West. The dissimilarities between regions within the SSA is also shown in the other indicators such as real output, RYG; consumer price index, CPI; interest rate, RATE; ratio of government budget deficit to GDP, DEF, and degree of openness, OPN.

The pattern of ratio of government budget deficit to GDP, DEF, seems to be similar among the regions of Africa. For all the regions, DEF is negative. While the average for all the SSA regions combined stood at -2.17 percent per annum, the minimum and maximum over the period stood at -37.3 percent and 124.9 percent, respectively. There are also appreciable differences in the values of degree of openness, OPN, across the regions of SSA. In all the regions there is the indication that trade policies adopted over the sample period, 1995-2007, has resulted into improved trade openness. Similarly, the disparity among the regions of SSA is also shown in the interest rate, RATE, and consumer price index CPI.

We also test for the possibility of the presence of multi-collinearity among the independent variables in the model by examining the pairwise correlation matrix. The test indicates that there exists a significant positive correlation between GE and RYG on the one hand and between OPN and CPI, RATE on the other. Overall, it can be established that the magnitude of the correlation coefficients indicate that multi-collinearity is not a potential problem in the models and the data set in conjunction with the variables are appropriate for the study.

Finally, in table 4, the paper presents some measure of degree of volatility for selected variables in the model. In the study, volatility is measured by the standard deviation while relative volatility is measured by the ratio of the standard deviation of the variable to that of the GDP. High values of V confirm that the variables are subjected to high fluctuations and low RV indicates little fluctuations of the variable with respect to the real GDP. The table shows the presence of a high relative volatility of EER, GE and FDI with respect to the RGDP when the regions are combined. It is also observed that the volatility of all variables considered in the model with respect to RGDP is higher in the central region than in other regions.

Table-4. Measure of Volatility for Selected Variables in SSA

	All		East		Southern		West		Central	
Variable	**V**	**RV**	**V**	**RV**	**V**	**RV**	**V**	**RV**	**V**	**RV**
Leer	0.9981	1.6119	0.8965	1.5436	0.9373	1.6160	0.9788	1.4017	0.6381	1.7425
Lryg	0.6192	1.0000	0.5808	1.0000	0.5800	1.0000	0.6983	1.0000	0.3662	1.0000
Lcpi	0.2454	0.3963	0.0891	0.1534	0.1744	0.3007	0.1512	0.2165	0.4909	1.3405
Lrate	0.3017	0.4872	0.1623	0.2794	0.2159	0.3722	0.3491	0.4999	0.2330	0.8829
Lopn	0.3813	0.6158	0.3374	0.5809	0.3306	0.5700	0.2707	0.3877	0.5894	1.6095
Lge	0.6437	1.0396	0.4695	0.8084	0.6302	1.0866	0.7285	1.0432	0.4210	1.1496
Lfdi	1.0066	1.6256	0.7296	1.2562	1.1149	1.9222	0.9960	1.4263	1.0049	2.7441

Source: Author's calculations

Note: V is volatility measured by the standard deviation of the variables; RV is the relative volatility measured by the ratio of standard deviation of a variable to the GDP.

4.2. The Exchange Rate Fluctuations Regressions

4.2.1. Econometric Issues

In estimating equation 5 or equation 7, the paper adopts estimation method that is appropriate for panel data, deals with dynamic regression specifications, controls for unobserved time-specific and country-specific effect, and accounts for some endogeneity and measurement error in the regressors. We use the Arellano-Bond xtabond2 in two approaches. First, we do the difference generalized method of moment "Difference" GMM. This estimator is based on taking the difference of the equation and thus eliminates country specific effects while taking as instruments suitable lagged levels of all potential endogenous variables. The second is the "System" GMM due to Arellano and Bover (1995) and Blundel and Bond (1998), which augments Difference GMM by estimating simultaneously in difference and levels.

In panel data analysis, two key issues need to be addressed: the unobserved time specific effect and the unobserved country specific effect. The first is resolved by including the period's specific dummy variables as instruments into the regression for all the estimators. However, dealing with the second issue is more problematic, given the fact that the model is dynamic and contains endogenous explanatory variables. Therefore, in order to deal with the unobserved country specific effect there is the need for differencing and instrumentation. A way of doing this, according to Cozmanca and Manea (2009), is to relax the assumption of strong exogeneity of the regressors by allowing them to be correlated with the current and previous realizations of the error term. Other critical working assumptions of the method are that (1) the explanatory variables are uncorrelated with the unobserved country specific effect, and (2) the future realizations of the error term are not correlated with the current realization of the explanatory variables. The studies by Arellano and Bond (1991) and Arellano and Bover (1995) have addressed these concerns.

However, studies have shown that estimators obtained from these methods may be strongly biased if the instrumental variables are weak. This may occur when the dependent variable is highly persistent and the number of time series is very small. The method of estimation used in this study takes into account these problems. The paper employs one-step and two-step estimation approach using Difference GMM and System GMM. We introduce various combinations of options in order to take care of autocorrelation and problem of instrumentation. These include clustering around the individual units that gives robust standard error, small to provide t-statistic and F-statistic, no level equation and a lag of two or use of all available lags. To reduce the proliferation of instruments we use the collapse option which is compared with using all available instruments. In all cases, logarithmic transformations of the variables in the model are used.

4.2.2. Diagnostic Tests

The results presented in tables 5 are those of System GMM. In these tables, we show the number of instruments used in the estimations, the F-statistics to measure joint statistical significance of all the regressors, the AR(2) for the hypothesis of no autocorrelation. The Sargan test of overidentified restrictions is meant to determine the joint validity of instruments used in the models. Using both collapse and un-collapse options, the one-step and two-step system GMM performed. The AR (1) (not reported) shows the presence of autocorrelation while AR(2) rejects the null hypothesis of no autocorrelation. The Sargan test shows that the instruments are not robust but not weakened by many instruments. The introduction of option h(2) is in search of more efficient estimates. Finally, we introduce the time dummy in order to show absence of autocorrelation of errors and no correlation across individuals. These are, however, not reported in table 5. The clustering option allows for the correction of the standard error in line with Windmeijer (2003).

The regressions from non-collapsed instruments do not pass through the identification tests in the cases of one-step and two-step estimations. The un-collapsed results produce 358 instruments against 40 individual units. The estimations from the collapsed option seem to produce better results in terms of AR(2). In the one-step System GMM results, the number of instruments is 66 while the AR(2) p-value of 0.005 is an evidence of absence of autocorrelation.

4.2.3. Economic Interpretations

In this paper, we use the results of the one-step System GMM with non-collapsed instruments estimation to provide the economic interpretation of the model presented in this study (see table 5). The coefficient of lagged Leer is positive and significant at the level of 1 percent. It shows that about 98 percent of factors explaining the current Leer are due to past realizations. This justifies the dynamic specification of our model. The coefficients of the other variables are elasticities. For Lryg, its coefficient is less than one, carries a positive sign and statistically significant at the level of 1 percent.

The coefficient of Lcpi is negative and significant in the statistical sense at the level of 5 percent. This is not unexpected in SSA economies where inflation rate is expected to have a direct relationship with EER. This result is, however, expected. This result is an indication of the fact price level has an underlying implication for the determination of EER and this model captures this theoretical underpinning in a significant manner.

The coefficient of the degree of openness has a negative sign and less than one in value. This estimate indicates that the more policies are adopted to improve OPN the more the average EER in SSA depreciates and significantly. This result seemingly does not deviate from the reality of the SSA countries. In effect, most of these countries have undergone one form of structural adjustment programme or the other with exchange rate policy being a key component. Many of these economies have become so open that international economic environment determines domestic policy like the EER. Finally, the coefficient of interest rate is negative. This result indicates that movements in exchange rates are influenced, very significantly, by interest rates as found in advanced and emerging markets, where changes in interest rates are influenced, to a large extent, by market forces.

The result of the panel data properties carried out in levels and first differences shows that all the variables are integrated of I(0) in Levin, Lin and Chu (LLC), under the null hypothesis that all panels contain unit roots. Lrate, Lge and Lfdi are I(0) while Leer, Lryg and Lcpi are I(1) in Im, Peseran and Shin (IPS) panel unit roots tests under the hypothesis that individual contains unit root. This implies that those variables that are integrated of order one i.e. I(1) in the IPS unit root tests have first non-significant probability values at the conventional level of 5 percent in levels before attempt is made to carry out the test at first difference. The paper also applies the Hadri Z panel unit root test. The results show that for all the seven variables the null hypothesis of stationarity should be rejected in favour of the alternative. Thus, a significant z statistics indicates the presence of a unit root. The figures in table 6 are calculated using the following assumptions: individual intercept as the deterministic trend specification and the Kernel method; Bartlett has been used for the spectral estimation; and Newey-West automatic has been selected for the Bandwith.

Table-5. GMM Estimator of Exchange Rate Fluctuations (One-step System GMM Estimation Results)

Dependent Variable: Leer

Regressor	Collapse		Non-Collapse	
	Without h(2)	**With h(2)**	**Without h(2)**	**With h(2)**
Leer (-1)	0.7879***	0.5528***	0.9822***	0. 9606***
Lryg	(0.0269)	(0.0409)	(0.0040)	(0.0101)
Lge	-0.1039	-0.0506	0.0476***	-0.0554**
Lfdi	(0.0502)	(0.0734)	(0.0131)	(0.0223)
Lopn	0.0018	-0.0269	-0.0424***	-0.0556***
Lcpi	(0.0282)	(0.0259)	(0.0120)	(0.0165)
Lrate	0.0069***	0.0193***	-0.0121***	-0.0151 ***
C	(0.0078)	(0.0068)	(-0.0047)	(0.0048)
	0.5317***	0.6050***	-0.0266***	0.0834***
	(0.0841)-	(0.1010)	(0.0151)	(0.0304)
	0.4596***	-0.3312***	-0.0479**	0.0377
	(0.0853)-	(0.1112)	(0.0246)	(0.0377)
	0.0494***	-0.0203	-0.1154***	0.1281***
	(0.0149)	(0.0184)	(-0.0104)	(0.0103)
	1.6641***	1.8339***	0.0024	-0.1212
	(0.2441)	(0.3660)	(0.0495)	(0.0851)
No. of observations	480	480	480	480
No. of units	40	40	40	40
No. of instruments	66	66	347	358
F-Statistic	303.68	375.14	4974.64	1024.58
Arellano-Bond AR(2) in first differences p-value	0.005	0.002	0.511	0.735
SaganTest of overid.restrictions, p-value	0.000	0.000	0.000	0.000

Source: Authors' calculations using STATA 10. **Note:** Figures in brackets are Windmeijer corrected standard errors. "***", "**" mark significance at 1% and 5% respectively.

Table-6. Summary of Panel Unit Root Test Results

Var.	IPS		LLC		Hadri Z-stat	
	Level	**First Diff.**	**Level**	**First Diff.**	**Level**	**First Diff.**
			4.0101		11.1059	
Leer	-5.5610 (0.0000)	-12.6731 (0.0000)	-1.5678 (0.0000)	-3.4299 (0.0003)	13.4140 (0.0000)	6.1117 (0.0000)
Lryg	-6.6988 (0.0000)	-18.3695 (0.0000)	-0.3482 (0.3639)	-9.6363 (0.0000)	11.1819 (0.0000)	16.4423 (0.0000)
Lcpi	-14.2570 (0.0000)	-13.7003 (0.0000)	-4.5904 (0.0000)	-6.3174 (0.0000)	12.4669 (0.0000)	23.7037 (0.0000)
Lopn	3.4644 (0.0000)	-14.4275 (0.0000)	2.8235 (0.9976)	-7.7478 (0.0000)	11.5785 (0.0000)	20.3450 (0.0000)
Lrate	-106.624 (0.0000)	-52.8144 (0.0000)	-18.7900 (0.0000)	-14.2386 (0.0000)	7.3206 (0.0000)	27.1305 (0.0000)
Lge	-11.8161 (0.0000)	-23.1077 (0.0000)	-3.2321 (0.0006)	-11.4638 (0.0000)	11.0267 (0.0000)	23.0294 (0.0000)
Lfdi	-9.4815 (0.0000)	-19.6686 (0.0000)	-5.6412 (0.0000)	-13.1773 (0.0000)	10.6504 (0.0000)	17.0469 (0.0000)

Source: Authors' calculations using EViews 5.1

Note: Figures in brackets are probability values. The options used are as follow: individual trend and intercept; Lag length chosen by Schwarz automatic selection; Kernel method of Bartlett obtained by special estimation and Bandwith selection by automatic Newey-West.

This paper applies the four panel data tests introduced by Westerlund (2007) to examine the potential co-integration relationship between the variables. The paper carried out a bivariate testing between EER and the other variables in the model. Two tests, labeled G, are performed under the alternative that the panel is co-integrated as a whole. The other two tests, described as P, are under the alternative that there is at least one individual that is co-integrated. Based on the figures in table 7, the normally distributed z and p-values show a clear rejection of the null hypothesis in most cases supporting the strong evidence in favour of co-integration. Therefore, the null hypothesis of no co-integration is accepted in few cases and these results may be due to sensitivity to the choice of parameters. Persyn and Westerlund (2008).

Table-7. Panel Co-integration Testing

Variable	Statistic	Value	Z-value	P-value
Lryg	G_t	-12.711	-81.549	0.000
	G_a	-6.843	4.806	1.000
	P_t	-16.392	-3.529	0.000
	P_a	-10.036	-1.146	0.126
Lge	G_t	-12.739	-81.763	0.000
	G_a	-13.231	-1.268	0.102
	P_t	-20.585	-8.413	0.000
	P_a	-28.761	-20.972	0.000
Lfdi	G_t	-24.443	-173.933	0.000
	G_a	-10.962	0.890	0.813
	P_t	-15.679	-2.698	0.004
	P_a	-15.341	-6.763	0.000
Lopn	G_t	-7.928	-43.881	0.000
	G_a	-8.928	2.824	0.998
	P_t	-16.988	-4.223	0.000
	P_a	-16.148	-7.617	0.000
Lcpi	G_t	-22.012	-154.787	0.000
	G_a	-2.963	8.495	1.000
	P_t	-31.821	-21.500	0.000
	P_a	-13.085	-4.374	0.000
Lrate	G_t	-22.279	-164.770	0.000
	G_a	-11.388	0.485	0.686
	P_t	-9.894	-4.040	0.000
	P_a	-7.561	-1.474	0.930

Source: Authors calculations using Stata 11.

Notes: Tests are implemented with constant, trend and Westerlund options.

The panel granger causality test result shows an independent relationship between exchange rate and real GDP, Lryg, government consumption, Lge and foreign direct investment, Lfdi. This means that there is strict exogeneity between Leer and the three variables. It could be seen from table 8 that the causality between exchange rate and consumer price index is bidirectional, i.e. $Leer \leftrightarrow Lcpi$. This means that exchange rate fluctuations cause changes in price level in SSA and at the same time, price levels have caused the high volatility of exchange rates observed in

SSA. This, thus, confirms that high inflation rate has been a major underlying factor in the exchange rate depreciation in most SSA countries.

Similarly, table 8 indicates that there is bidirectional causation (feedback) between exchange rate and degree of openness, between exchange rate and consumer price index as well as between exchange rate and interest rate i.e. $Leer \leftrightarrow Lopn$, Leer↔Lcpi and $Leer \leftrightarrow Lrate$. This means that interest rates and degree of openness granger cause exchange rate in the SSA economies. The implication of this is that trade liberalization, inflation rate and interest rate policies embarked upon by African countries have preponderant effect on exchange rate fluctuations in the sub-region. It also means that exchange rate can be used to guide policies in interest rate, inflation rate as well as openness to trade.

Table-8. Panel Granger Causality Results

Null Hypothesis	F- Stat	Probability	Decision	Causality
LRYG does not Granger cause LEER	1.1827	0.0374	Accept	Independent
LEER does not Granger cause LRYG	1.6089	0.2013	Accept	
LGE does not Granger cause LEER	0.5951	0.5520	Accept	Independent
LEER does not Granger cause LGE	0.5265	0.5911	Accept	
LFDI does not Granger cause LEER	0.4030	0.6686	Accept	Independent
LEER does not Granger cause LFDI	1.5292	0.2179	Accept	
LOPN does not Granger cause LEER	11.3917	0.0002	Reject	Bidirectional
LEER does not Granger cause LOPN	14.0471	0.0000	Reject	
LCPI does not Granger cause LEER	32.8429	0.0000	Reject	Bidirectional
LEER does not Granger cause LCPI	8.1970	0.0003	Reject	
LRATE does not Granger cause LEER	4.9400	0.0076	Reject	Bidirectional
LEER does not Granger cause LRATE	9.4443	0.0010	Reject	

Source: Authors' calculations using EViews 5.1

5. CONCLUSION AND POLICY IMPLICATIONS

Many recent studies examine the determinants of exchange rate particularly in the light of process of exchange rate deregulation across the sub-region. The expectation is that a deregulated foreign exchange market will bring about a less volatile exchange rate. This paper has provided statistical evidences in support of the divergence and disparity between and within regions in SSA using descriptive statistics. In order to empirically test for the determinants of exchange rate, the paper develops a dynamic panel data model based on system GMM that allows us to control for bias that results from endogeneity and omitted variables. The results of the panel data framework estimations indicate that the model performed well as the estimated parameters are at least statistically significant at the level of 5 percent and have correct signs suggesting the adequacy of our model to capture fluctuations in exchange rates. This result is contrary to some other findings that find weak relationship between the exchange rate and its determinants as observed by Bacchetta and Wincoop (2006) and Crosby and Otto (2001).

The paper also examines the time series properties of the variables in the model. In this regards, the unit root test, the panel Cointegration using the Westerlund statistics were tested and there were evidences of long term relationships between the variables of the model. Furthermore, the Panel Granger causality test confirms the panel data estimation results. In effect, there is bidirectional relationship between exchange rate on the one hand and consumer price index, degree of openness and interest rate on the other. The results clearly indicate a strict exogeneity between exchange rate on the on hand and real GDP, government expenditure and foreign direct investment on the other.

The findings in this paper have policy implication for SSA. First, for policy-makers who are concerned about convergence, the findings can be seen as a contribution to the recent calls for stepping up the regional economic and financial integration efforts in Africa, particularly in the exchange rate mechanism, by identifying the main determinants. In particular, the paper shows that right policy on exchange rate determinants can attenuate fluctuations in exchange rate across SSA. Second, there is the need for decision makers in SSA to always weight the possible effects of variables such as FDI since it may have negative consequences in countries with dominant mono-export, like oil, which may envisage the diversification of their export base into non-oil items.

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