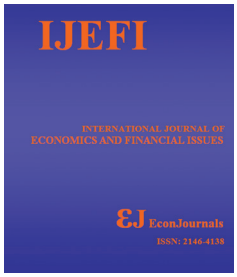

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Determinants of Exchange Rate Stability in Sudan (1991-2016)

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ABSTRACT

Exchange rate is one of the most important indicators of economic growth of a country and its stability has significant impact on international trade. This study aimed to investigate the effects of growth rate of real gross domestic product (GDP), real money supply (M), inflation rate (INF), and trade openness (OP) on exchange rate (EXR) stability in Sudan. For this purpose autoregressive distributed lag model approach was applied to estimate long run and short run relationship among exchange rate determinants, annual data covering period (1991-2016) have been analyzed. The results reveal that, there is a long run relationships between exchange rate and its determinants and statistically significant. An increase in growth rate of real GDP leads to stability in EXR. The coefficient of error correction model reveals that exchange rate (EXR) will restore back to its equilibrium with speed of adjustment of 23.2% whenever there is a shock to its equilibrium.

Keywords: Exchange Rate, Autoregressive Distributed Lag Model, Trade Openness
JEL Classifications: F3, F16

1. INTRODUCTION

It is well known that government intervention in exchange rate market leads to emergence of parallel or black market for foreign exchange, which has been considered as one of popular phenomena in developing countries. It is also acknowledged that parallel exchange rate has a negative impact on the macroeconomic performance, since parallel premium indicates a market distortion, hence reduces trade and growth (Kiguel and O'Connel, 1995). In addition, the spread between black market and official rate may enforce the speculative activities in foreign currencies and illegal trade, and result in capital flight and deviation of remittances flows from the formal channels (Kiguel and O'Connel, 1995; Elbadawi, 1994).

The importance of exchange rate stability in the attainment of macroeconomic policy objectives in both developed and developing economies cannot be over emphasized. Exchange rate is one of the determinants used in assessing the performance of an economy. A very strong exchange rate is a reflection of a strong and viable economy. On the other hand, a very weak currency is a reflection of a very vulnerable and weak economy. Governments, particularly in developing economies over the years have adopted different exchange rate management policies with a view to achieve realistic and stable exchange rate. Thus, most of these countries experienced high exchange rate fluctuation which translates into high degree of uncertainty or volatility. Exchange rate volatility is associated with unpredictable movements in the relative price in the economy. It also refers to the swings or fluctuations in the exchange rate over a period of time or deviations from a benchmark or equilibrium exchange rate. Exchange rate volatility is an important contributor to risk in the financial world. During the period of excessive movements in exchange rates, foreign trade and investments could be affected negatively (Mordi, 2006).

In another development, Asiama and Kumah (2010) examines the degree of influences upon which productivity, fiscal balance, current account balance, terms of trade, openness, oil prices, public consumptions, foreign direct investment and foreign aids affects exchange rate variability in African countries over the period of 1980-2008. The objective of their study was to investigate whether there is evidence of consistency between the theoretical and empirical framework. To test their hypothesis, the authors utilized panel co-integration approach. The study reveals that both theoretical and empirical frameworks were very much consistence, and real exchange rate was strongly influenced by openness, terms of trade and oil prices.

This paper is an attempt to address the long and short run relationship between exchange rate and its determinants in Sudan by employing a more robust technique of analysis i.e., autoregressive distributed lag (ARDL) bound testing approach was used to explore this relationship. Therefore, this paper is divided into five sections: The next section provides a review of the literature on the determinants of exchange rate. Section three presents methodology and data. While the fourth section presents the results of the analysis, the fifth section concludes the paper.

2. LITERATURE REVIEW

The theoretical underpinning for the determination of exchange rate behavior is rooted in both monetary and macroeconomic theories. The monetary theory assumes highly the integration of goods and capital markets. The theory reinforces the assertion of purchasing power parity (PPP) doctrine which was introduced by Gustav Cassel in 1970 to determine the exchange rate between the currencies of two countries (Jhingan, 2008). PPP holds that the rate of exchange between two currencies must be equal to the ratio of total price levels between two countries (Asab et al., 2015).

Given the potential impact of exchange rate on inflation prices, investment, balance of payment, and interest rate, the issue of the determination of optimal exchange rate becomes imperative for the successful implementation of development programs in the country. Chuka, (1990) argues that the objectives of exchange rate policy are to increase output and its optimal distribution. A necessary condition for the achievement of the above objectives is that the exchange rate should be stable as possible. According to him, stability permits viability of the rate in response to changes in relative prices, international terms of trade and growth factors.

The relationship between inflation targeting regime and exchange rate regime has led some analysts to conclude that one of the costs of inflation targeting adoption is the increase in exchange rate volatility. Yet, some studies show that the adoption of a free-floating exchange rate does not necessarily implies more effective of nominal and real exchange rate floating argue that inflation targeting would lead to higher exchange rate volatility find that the lack of credibility of monetary authority may lead to exchange rate volatility problem (Levy-Yeyati, and Sturzenegger, 2002).

Harberger (2004) studied the impact of economic growth on real exchange rate. He found that there is no systematic connection between economic growth and real exchange rate.

Husain et al. (2004) found in their study that little access to international capital is available for the weaker and less developed countries, so low rate of inflation and higher level of durability is associated with fixed exchange rate regime in those countries. However, they found no robust relationship between economic performance and exchange rate regime in the developing economies. They also found that advanced economies may experience durable and slightly higher level of growth rate without higher level of inflation in flexible exchange rate regime.

Nucu (2011) examined the influence of gross domestic product (GDP), inflation rate, money supply, interest rates and balance of payments on exchange rate of Romanian against the most important currencies (EUR, USD) for the period 2000-2010 and found an inverse relationship between exchange rate (EUR/RON) GDP, and money supply. On the order hand a direct relationship was found between EUR/RON, Inflation and Interest rate. The validation of the correlation between exchange rate and balance of payment could not be established because it is not significant.

Furthermore, in Nigeria, there is a dearth of literature on the determinants of exchange rate volatility. The limited evidence on the subject is reviewed below. Ajao and Igbokoyi (2013) examined the degree of influence of real exchange rate, productivity, trade openness and government expenditure, real interest rate and money supply on real exchange rate volatility in Nigeria for the period between 1981 and 2008. Using GARCH and ECM, their empirical results indicates that real exchange rate, trade openness, government expenditure, real interest rate have positive impact on exchange rate volatility in Nigeria with exception of money supply and productivity.

Chin and Chee-hong, n.d. (2013) attempt to assess the impact of trade openness on Malaysian exchange rate by applying monthly data. Their finding is consistent with the expected sign of all the variables. Also in line with the prediction of the theory; increase in trade openness will depreciate the Malaysian domestic currency and vice versa. This finding asserts the idea of threshold level; that the economy will open up at a certain level, if above that level it will depreciate the currency.

Throughout the last five decades, a number of exchange rate policies have been adopted in Sudan; including fixed, floating and dual exchange rate regimes (Ebaidalla, 2016). For example, during the period 1956-1978, the exchange rate has been pegged at a fixed rate of approximately one Sudanese pound to 2.85 US dollar. In September 1979 the monetary authority shifted from the fixed exchange rate regime to floating system, with the support of International Monetary Fund and World Bank's structural adjustment programs (Ebaidalla, 2014). Accordingly, the local currency underwent a significant devaluation to the rate of about three pounds per US. The main goal of this policy was to reduce the external imbalances through encouraging exports, and attracting remittances of Sudanese nationals working abroad.

By the second half of the 1990s, exchange rate has been stabilized owing to the flow of FDI and the commercial exploitation of oil in 1999 (Ebaidalla, 2016). That is, the exportation of oil generated a huge amount of foreign reserves to the country, which was the largest source of foreign exchange during 2000s, accounted for around 85% of the total exports (Ebaidalla, 2014). Thus, the exchange rate saw substantial stability with a limit rate of LS 2650-2600 per US dollar during 2000-2003. As a result, during such period the Central Bank of Sudan adopted the managed floating exchange regime (Ebaidalla, 2016).

3. METHODOLOGY AND DATA

This section outlines the research methodology that will be used in the analysis of the findings and the empirical results. For this purpose ARDL approach developed by Pesaran et al. (2001) was adopted. The choice of ARDL is based on many features, its relatively more efficient in the case of small and finite sample data sizes; also it takes into account the error correction model. The analysis of error correction and autoregressive lags fully covers both long-run and short-run relationships of the variable under study (Pesaran et al., 2001; Villavicencio and Bara, 2008) Following the work of Pesaran et al. (2001), as well as Augmented Dickey-Fuller (ADF) test (Dickey and Fuller, 1979) and graphical method were used to test stationary of the variables under consideration, a series is said to be stationary if its mean and variance are constant over time and the value of the covariance between the two time periods depends only on the distance or lag between the two time periods, not on the time at which the covariance is calculated Gujarati (2003). The unit root test is necessary for time series data because a regression carried out with non-stationary series gives spurious results Gujarati (2003).

ARDL method yields consistent and robust results because it allows describing the existence of an equilibrium-relationship in terms of long-run and short-run dynamics without losing long-run information (Pesaran et al., 2001). Thus, this study tests the existence of the long-run relationship (co-integration) using bound testing (ARDL) technique for co-integration.

The econometric model expressing the relationship between exchange rate and its determinants is given in equation (1):

$$EXR_t = a_0 + GDP_t + M_t + INF_t + OP_t + \varepsilon_t \quad (1)$$

EXR_t: Nominal exchange rate at time, t.
GDP_t: Growth rate of real gross domestic product at time, t.
M_t: Real money supply at time, t.
INF_t: Inflation rate at time, t.
OP_t: Trade openness at time, t.
ε_t: The error term at time, t. is serially uncorrelated disturbance with zero mean and constant variance.
α_0 = the intercept coefficient estimate, i.e. the value that would be taken by the dependent variable EXR if the independent variables (GDP, M, INF, and OP) took a value of zero.

ARDL approach proposed by Pesaran et al. (2001) was formulated in equation (2) to examine the long-run relationship among:

$$\begin{aligned}\Delta EXR_t = {} & \alpha_0 + \partial_1 NER_{t-1} + \partial_2 GDP_{t-1} + \partial_3 M_{t-1} \\ & + \partial_4 INF_{t-1} + \partial_5 OP_{t-1} + \sum_{t=0}^{n} \beta_1 \Delta EXR_{t-i} \\ & + \sum_{t=0}^{n} \beta_2 \Delta GDP_{t-i} + \sum_{t=0}^{n} \beta_3 \Delta M_{t-i} \\ & + \sum_{t=0}^{n} \beta_4 \Delta INF_{t-i} + \sum_{t=0}^{n} \beta_5 \Delta OP_{t-i} + \varepsilon_t\end{aligned} \quad (2)$$

Where:

The optimal lag length n determined using Akaike Information Criteria (AIC), Δ denotes the first difference operator. The expressions with the summation sign (∂_1-∂_5) represent the long-run relationship. The remaining expressions (β_1-β_5) correspond to the short-run dynamics of the model.

After formulating ARDL model which describe the relationship between the variables, then the long-run relationship model for exchange rate and its determinants can be estimated as in equation (3):

$$\begin{aligned}\Delta EXR_t = {} & a_0 + \partial_1 NER_{t-1} + \partial_2 GDP_{t-1} \\ & + \partial_3 M_{t-1} + \partial_4 INF_{t-1} + \partial_5 OP_{t-1}\end{aligned} \quad (3)$$

In order to estimate the short-run dynamics, the error correction model (ECM) was expressed in equation (4)

$$\begin{aligned}\Delta EXR_t = {} & \sum_{t=0}^{n} \beta_1 \Delta EXR_{t-i} + \sum_{t=0}^{n} \beta_2 \Delta GDP_{t-i} \\ & + \sum_{t=0}^{n} \beta_3 \Delta M_{t-i} + \sum_{t=0}^{n} \beta_4 \Delta INF_{t-i} \\ & + \sum_{t=0}^{n} \beta_5 \Delta OP_{t-i} + \lambda ECM_{t-1}\end{aligned} \quad (4)$$

Where:

ECT_{t-1}: The lagged error-correction term, λ: Parameter indicating the speed of adjustment back to long run equilibrium after short run shock, λ was expected to have negative sign and significant for the long run equilibrium. The larger the error correction coefficient indicates faster adjustment back to long run equilibrium after short run shock.

This study used annual time series data covering period (1991-2016). This period is selected because of; the exchange rate has witnessed many policy interventions in addition, this period ensures the availability of data on the variables under consideration. The data were obtained from official national sources, Include the Central Bank of Sudan and the Central Bureau of Statistics. The variables included in the model are exchange rate as dependent variable and GDP, money supply (M), inflation rate (INF), and trade openness (OP) as independents variables.

The real values of the GDP were obtained from Central Bank of Sudan, and then the values of real growth rate of GDP calculated, while the real values of money supply (M) are the nominal values divided by consumer price index (CPI) as well as the values of trade openness (OP) were calculated throughout sum of exports and imports as percentage of GDP.

According to theoretical and empirical evidence, the coefficient of real growth rate of real GDP is expected to be negative; Increase in real growth domestic product is also expected to boost the investment capability of the government in providing investment-enhancing facilities necessary to promote the exchange rate stability. The impact of money supply would also be positive, since monetary expansion lead to stable exchange rate. The inflation rate term is expected to be positive while the coefficient of trade openness is expected to be positive, this is because increase in credit to trade openness is expected to

enhance investment in the economy.

4. EMPIRICAL RESULTS AND DISCUSSION

This section will be devoted to present and discuss the results of empirical analysis which investigate the effect of growth rate of real GDP, real money supply, inflation rate, and trade openness on exchange rate in Sudan. The analysis proceeds via testing the properties of time series using unit roots test and co-integration tests. First, the integration of all variables will be identified, using ADF test. Even though, ARDL approach does not need a unit root test, but in the case of variables that integrated of order two I(2) the computed F-statistics provided by Pesaran et al. (2001) will be not valid, because the bounds test is designed on the assumption that the variables are I(0) or I(1). Therefore, we implemented the unit root test in the ARDL context to ensure that none of the variables are integrated of order more than I(1). The results of unit root test constant are reported in Table 1.

The results in Table 1 indicate that all variables except GDP and EXR are non-stationary at level with and without constant and trend, while INF is only stationary at level without constant and trend. Alone the same line, all variables are stationary at first difference both with constant and without constant and trend, Where GDP, M, INF, and OP are stationary at critical value 1%, while EXR stationary at critical values 10% and 5%, with constant and without constant and trend respectively.

For testing the existence of long run relationship between the dependent and explanatory variables in equation (2), The null hypothesis defined as H_0: $\partial_1 = \partial_2 = \partial_3 = \partial_4 = \partial_5 = 0$ meaning that there is no co-integration (no existence of long-run relationship) among the variables under consideration whereas the alternative hypothesis is defined as H_1: $\partial_1 \neq \partial_2 \neq \partial_3 \neq \partial_4 \neq \partial_5 \neq 0$ which signify the existence of co-integration presence or evidence of long-run relationship (Pesaran et al., 2001). The bounds test (F-statistic) was computed to differentiate the long-run relationship between the concerned variables. The computed F-statistic value was evaluated with the critical values tabulated in of Pesaran et al. (2001). The null hypothesis of no co-integration against alternative hypothesis of co-integration was tested and results represented Table 2.

Since the computed F-statistic (10.93527) greater than upper bound test value at 1% (5.06) therefore, the null hypothesis of no long-run relationship between EXR and independent variables (GDP, M, INF, and OP) has rejected. The results indicated that there are evidence of co-integrating (the existence of a long-run relationship) between the EXR and the other explanatory variables.

In the second step, the long-run ARDL model is estimated. The appropriate number of lags for each variable in the model is

Table 1: Results of ADF unit root test at level and first difference

Null hypothesis: The variable has a unit root					
At level					
	EXR	GDP	M	INF	OP
With constant					
t-statistic	−0.5170	−5.0880	−0.7955	−2.2430	−1.8610
P	0.8714	0.0004	0.8031	0.1972	0.3441
	n0	***	n0	n0	n0
With constant and trend					
t-statistic	−3.7812	−5.3248	−2.0321	−2.0893	−1.8560
P	0.0376	0.0012	0.5564	0.5265	0.6467
	**	***	n0	n0	n0
Without constant and trend					
t-statistic	0.7975	-1.5811	−0.2293	−2.2732	−0.7769
P	0.8784	0.1053	0.5935	0.0249	0.3694
	n0	n0	n0	**	n0
At first difference					
	d (EXR)	d (GDP)	d (M)	d (INF)	d (OP)
With constant					
t-statistic	−2.7445	−9.7712	−4.5138	−−7.6873	−5.3380
P	0.0814	0.0000	0.0017	0.0000	0.0002
	*	***	***	***	***
With constant and trend					
t-statistic	−2.7534	−9.6189	−4.5196	−8.1058	−5.6857
P	0.2262	0.0000	0.0076	0.0000	0.0006
	n0	***	***	***	***
Without constant and trend					
t-statistic	−2.2670	−9.8964	−4.4824	−7.4635	−5.4622
P	0.0254	0.0000	0.0001	0.0000	0.0000
	**	***	***	***	***

a: (*) Significant at the 10%, (**) significant at the 5%, (***) significant at the 1% and (no) not significant, b: Lag length based on SIC, c: Probability based on MacKinnon (1996) one-sided P values. This result is the out-put of program has developed by: Dr. Imadeddin AlMosabbeh, College of Business and Economics, Qassim University-KSA. Source: Author calculation using e-views 9

detected automatically by the program procedure using the Akaike information criterion (AIC), the result reported in Table 3.

The result in Table 3 reveals that, all of the estimated coefficients in the long-run are statistically significant at critical value 1%, The results suggest that, rise of growth rate of real GDP level will lead to decrease in exchange rate (appreciation of domestic currency) which is in line with theory as per expected. Also, increase of money supply and degree of trade openness will lead to increase in exchange rate (depreciation in Sudanese pound). Besides, high inflation rate means increase in exchange rate accompanied with an increase in goods price. Therefore, export goods become less competitive. Demand for exports will fall, and then depreciation in domestic currency. Thus, growth rate of real GDP, money supply, inflation rate, and trade openness are the major determinants of exchange rate during the study period. The positive effect of trade openness degree depends on high contribution of exports with small percentage of import. One percentage increase growth rate of real GDP leads to about 0.69% point decrease in exchange rate (appreciation domestic currency). This result, tend to the growth rate of real GDP is a statistically significant source of exchange rate stability.

Table 2: ARDL bounds test

Null hypothesis: No long-run relationships exist		
Test statistic	**Value**	**k**
F-statistic	10.93527	4
Critical value bounds		
Significance	I0 bound	I1 bound
10%	2.45	3.52
5%	2.86	4.01
1%	3.74	5.06

Source: Author calculations

Table 3: Estimated long run coefficients ARDL (3, 3, 1, 3, 3)

Variable	Coefficient	Standard error	t-statistic	P
GDP	−0.693365	0.082551	−8.399258	0.0004
M	0.000050	0.000005	9.785375	0.0002
INF	0.046260	0.010638	4.348584	0.0074
OP	0.083189	0.016907	4.920507	0.0044
C	0.085805	1.286690	0.066687	0.9494

Source: Author calculations. GDP: Gross domestic product, ARDL: Autoregressive distributed lag

Table 4: Estimated error correction representation for the selected ARDL (3, 3, 1, 3, 3)

Variable	Coefficient	Standard error	t-statistic	P
D (EXR(-1))	−0.462735	0.070080	−6.602967	0.0012
D (EXR(-2))	−0.284461	0.052947	−5.372557	0.0030
D (GDP)	−0.001696	0.004417	−0.383884	0.7168
D (GDP(-1))	0.086065	0.007795	11.040681	0.0001
D (GDP(-2))	0.033061	0.006245	5.294109	0.0032
D (M)	0.000003	0.000001	5.018596	0.0040
D (INF)	0.002849	0.000786	3.626252	0.0151
D (INF)	−0.001928	0.000935	−2.061554	0.0942
D (INF)	−0.007694	0.000870	−8.843051	0.0003
D (OP)	0.012212	0.001232	9.915385	0.0002
D (OP(-1))	−0.009395	0.001637	−5.739574	0.0022
D (OP(-2))	0.000983	0.001013	0.970413	0.3764
ECM(-1)	−0.232938	0.020055	−11.614974	0.0001

Source: Author calculation. ECM=EXR - (−0.6934*GDP+0.0001*M+0.0463*INF+0.0832*OP+0.0850). GDP: Gross domestic product, ARDL: Autoregressive distributed lag

Regarding the short run analysis of the exchange rate determinants, Table 4 shows the results of error correction model using ARDL framework.

Selected based on Akaike information criterion dependent variable EXR

The results in Table 4 above reveal that most of explanatory variables are statistically significant and consistent with the theory. Like the results of long-run model, the analysis of short-run indicates that exchange rate inversely affected by, growth rate of real GDP. On the other hand, money supply, inflation rate, and trade openness variable are found to be have positive effect exchange rate(depreciation domestic currency) in short-run. Thus, the ECM findings fit well with the results of the long-run analysis.

ECM result reveals that exchange rate (EXR) relatively strong adjustment to equilibrium with a speed of adjustment of 23.2% whenever there is a shock in long run equilibrium. The error correction term is correctly signed (negative) and statistically significant at 1%, this implies that, if there is any shock to the economy, the speed of exchange rate adjustment is very fast converge back to the equilibrium. With all these, the findings of the ECM model reveal that a robust and reliable result for the investigation so far.

Finally, the stability of ARDL long run model parameters were examined using the cumulative sum of the recursive residuals (CUSUM) and the cumulative sum of the squares of recursive residuals (CUSUMSQ) tests proposed by Brown et al. (1975), the graphical results presented in Figures 1 and 2 respectively illustrate that, residuals were within the critical bounds at 5% level of significance. This signifies that the ARDL estimates are dynamically and structurally stable, consistent and reliable.

Figure 1: Plot of CUSUM test with 95% confidence intervals

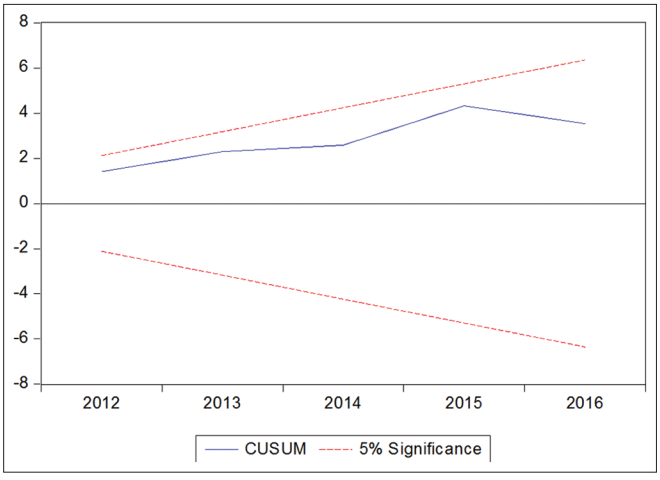
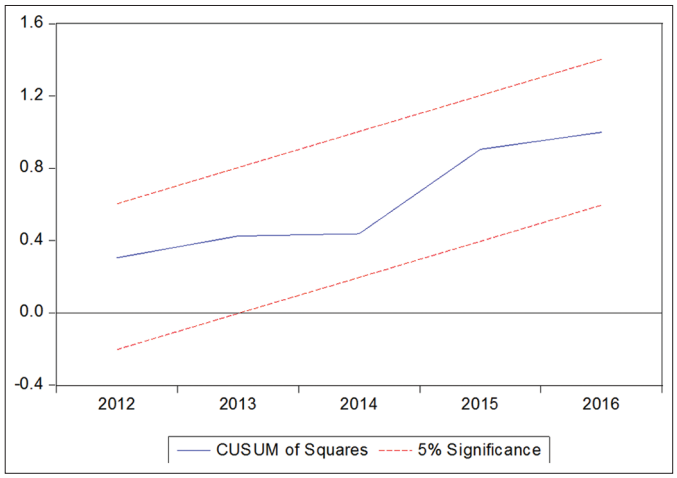


Figure 2: Plot of CUSUM of squares test with 95% confidence intervals



5. CONCLUSION AND RECOMMENDATIONS

This paper investigates determinants of exchange rate stability in Sudan; first stationary test of the variables was conducted using ADF unit roots. ADF test show that all variables are stationary at first difference level. Consequently, this supports the use of ARDL approach to co-integration as appropriate in this study to other conventional co-integration approaches such as Engle and Granger (1987), Johansen (1988) because of its applicability irrespective of whether the variables are integrated of order I(1) or I(0). ARDL model employed to estimate long run model using annual data covering period 1991-2016. The empirical analysis found that, growth rate of real GDP, money supply, inflation rate, and trade openness are statistically significant at 1%, and the impact of growth rate of real gross on exchange rate stability (appreciation of domestic currency) was highly robustness and effective, while inflation rate, money supply, and trade openness were found as important determinants of exchange rate. This suggests that all variables are becoming important and effective policy to achieve stable exchange rate.

The ARDL bounds test approach confirmed long run relationship between exchange rate and the explanatory variables. The error correction term was strongly significant with correct sign (negative), this means that the estimated speed of adjustment to the long run equilibrium in response to the disequilibrium caused by the short run shocks of the previous period was found to be 23.2% per year. Both ARDL long run and error correction models were found to be robust because they passed all diagnostic tests normality, the CUSUM and CUSUM squares test confirmed the stability of both estimated models.

Based on results discussed above, this study has some important policy implications. First, growth rate of real GDP has been identified as one of the principal determinants of exchange rate stability thus, policy that lead to stability in exchange rate should be adopted with directed a percentage of spend on key sectors (agriculture, industrial, and infrastructure) to increase the contribution of growth rate in real GDP as one of exchange rate determinants and reform collapsed projects. Second, to achieve stable exchange rate government should encourage exports strategy in order to maintain surplus or stability in the current account as well as diversification of export goods and world exports markets. Finally, money supply has significant effect on exchange rate, excess money supply in the economy causes depreciation of exchange rate; therefore there is space for the monetary authority to pursue a monetary policy targets Reducing inflation and stable exchange rate regime.

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