

# THE INTERNATIONAL JOURNAL OF HUMANITIES & SOCIAL STUDIES

## Impact of Monetary Policy Instruments on Exchange Rate Volatility in Sudan (1997-2017)

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### **Abstract:**

*This paper analyzed the impact of monetary policy instruments on real exchange rates volatility in Sudan during the period 1997-2017. The paper applies co-integration analysis to examine short run relationship between monetary policy determinants of real exchange rate. At first the stationary of the variables at first differences is obtained, then Vector Error Correction model (VECM) was estimated to explain the existent of long run relationship, after establishing the short run co-integrating relation among set of incorporated variables. The result from the paper show that, real exchange rate in Sudan have unstable during the period of study. In the short run, the variation in monetary policy instruments, namely money supply (MS) and profit margin rate (PMR) variable explain the movement of real exchange rate volatility through a self correction mechanism process with many interventions from central bank of Sudan. Moreover, the result from VECM test show that an increase of money supply have negative impact on real exchange rate volatility, such that a change in the value of money supply variable causes exchange rate volatility, while profit margin rate have positive impact on real exchange rate volatility in Sudan and there is possibility of self-adjustment of the model. The paper recommended the important of increasing the quantity of money supply as crucial policy to restore previous equilibrium level.*

**Keywords:** Monetary policy, real exchange rate volatility, VECM

### **1. Introduction**

In recent years, the issue of exchange rate policies has received great attentions in both developed and developing countries, since exchange rate stability expected to lead to strong and viable economy, on the other hand, a very volatility of exchange rate definitely will reflect in instability of all economic activities (Elfaki, K, Eltyeb, 2018). To achieve realistic and stable exchange rate, government of developing countries adopted different exchange rate management policies; some are concentrate on fiscal policies to stimulate total output; while other rely on monetary policies to stabilize exchange rate fluctuations, and some countries implement combination of the two policies instruments; notwithstanding, some economist believes that exchange rate volatility is not a disease itself, but it's a result, which reflect disequilibrium in several economic sectors. Countries are differ in the choice between exchange rate regimes, according to the degree of volatility and the level of economic instability; whether it's in exchange rate crisis or tranquil. In fact recently, monetary policies in Sudan shifted from focuses in economic growth and employment, to prices and exchange rate stability, as a response to the impact of global economy on Sudan, which driving significantly by swings among the currencies of the major economic power, such as USA; recently, these linkages becomes enormous and volatile, that lead the authority to intervene in exchange rate market, without any clear sense of sustainable equilibrium. This paper investigates the responsiveness of exchange rate to the long-term shock of monetary policies during USA economic sanction which implemented on Sudan since 1997. The sanction had many adverse impact on socio-economic and cultural settings of Sudan, our emphasis is on economic side to work out how Sudanese government react with respect to changes of macroeconomic policies to maintain the economic progress which achieved before the sanction. U.S.A sanction to Sudan not only lead to lack of foreign currencies but also encourage existence of parallel market of exchange rates (black market) and the gap between the two markets was widen reaching almost about 66% in September 2017 compared to about 20% in 2013 (IMF, Country Report No.320, 2013), it also encourage multiple exchange rates system, in this respect Sudan's exchange rate regime pivots around the following rates (1) central rate of SDG 4.42 per US dollar, that applied also to importation of fuel products (2) subsidized for wheat of SDG 2.9 per US dollar (3) Gold exchange rate used by central bank in its Gold transaction (4) commercial bank rate to all other transactions. Notwithstanding, Sudan exchange rates witnessed continuous devaluations and interventions due to, first loss of most of oil resources as a result of the secession of South Sudan<sup>1</sup>; secondly due to US economic sanction which became effectively in 1997; these scenarios enforced central bank of Sudan to take additional arrangements to stop local currency deteriorations, such as an appointment of

<sup>1</sup> - The Comprehensive Peace Agreement (CPA) of 2005, resulted in southern Sudanese referendum, which took place as scheduled in January 2011., Sudan lost most of its oil resources, as approximately 75% of oil revenue.

independent committee called "mechanism of market makers" the mechanism first set exchange rate at 47.5 SDG, instead of the prevailing rate of 29 SDG<sup>3</sup>, making about 60% depreciation of Sudanese pound, the success of action depends on whether central bank of Sudan has enough foreign currency reserve to prevent exchange rate to overshoot further, which can impose more deterioration in the economy. The contribution of this paper is, to fill the gap in literature on the impact of monetary policy shocks on exchange rate fluctuations and diversifications in Sudan; as most empirical studies focused on identifying the determinants of equilibrium exchange rate and impact of fiscal policy (Ebiadalla, 2013).

### 1.2. The Problem Statement

For understanding critically exchange rate volatility in Sudan under these extreme circumstances, it becomes of great challenges, for both the researcher and economic policy makers, to put forward proper economic plans in order to stabilize exchange rate fluctuations. In this respect, this study an attempt to answer questions, such as; in response to monetary shock, do central bank of Sudan continues depreciation of Sudanese pound succeed to maintain its original value? What are the long run effects of monetary policies on exchange rate in Sudan?

### 1.3. The Objectives of the Study

This study aims at, estimate empirically the response of real exchange rate volatility in Sudan to continuous changes of central bank monetary policy instruments, and to what extent, these policies deserved significant impact to exchange rate deteriorations, and maintaining price stability during the period of the study, more specifically, to examine the impact of monetary policy which implemented during shocks period to elevate exchange rate fluctuations and diversifications (multi-exchange rate system) and performance on economic growth in Sudan. The main questions being addressed are the effects of money supply and profit margin as a proxy of monetary policy on real exchange rate volatility in Sudan, how it can be adjusted to maintain long run equilibrium

### 1.4. The Hypothesis of the Study

Referring to various monetary economic theories and previous studies, we can derive the following hypothesis:

- An increase of money supply will have negative impact on real exchange rate volatility in Sudan.
- Profit margin has negative impact on real exchange rate volatility.

### 1.5. The Methodology

To achieve study objectives, this study intends to extend the argument of Chen,(2004) by adopting the theoretical framework of Markov model at the multiple equilibrium process, an empirical analysis of the impact of monetary policy shocks on exchange rate volatility in Sudan will be employed. Firstly, we test for the properties of time series using Unit Root test by employing Augmented Dickey-Fuller(ADF) test; since the data series in Sudan all most shows inconsistency and great variations from one year to another, we employ Vector Error correction model(VECM), which suitable for non-stationary regression model, after performing Johansen Co-integration test to validate the existence of long run equilibrium relationship between the variables, the direction of effects of monetary policy instruments on exchange rate volatility in Sudan, and finally performing some diagnostic tests of some econometrics problems.

### 1.6. Organization of the Study

After providing an introductory enlighten; the reminder of the paper consist of six sections, section 1 highlight key literature review about monetary policies and its impact on exchange rate in Sudan, section2 summarize previous studies, section3 discuss monetary and exchange rate policies in Sudan, section4 devoted to model specification and set model variables, section5 present empirical analysis and discussions, section6 include conclusions; recommendations the limitation of the study.

## 2. Literature Review

Exchange rate is the price of a domestic currency in terms of other currencies. It is usually determined by the interaction of supply and demand for money in a free market setting. The main objectives of exchange rate policy are to conserve the value of the domestic currency, sustain a favorable external reserves position and ensure external balance without compromising the need for internal balance and macroeconomic stability as a precursor to economic growth. The earliest theoretical foundation for the choice of exchange rate regimes rested on the Optimal Currency Area (Gilbert Deinde Ifarajimi,2017). According to the theory, a fixed exchange rate regime can increase trade and output growth by reducing exchange rate uncertainty and thus the cost of hedging, and also encourage investment by lowering currency premium from interest rates. However, it can also reduce trade and output by stopping, delaying or slowing the necessary relative price adjustment process. The OCA theory claimed that a fixed regime can also delay the necessary relative price adjustments and often lead to speculative attacks. Therefore, many developing and emerging economies suffer from a "fear of floating" (Calvo and Reinhart, 2002), as managed floating regimes also often end in crashes when there is a "sudden stop" of foreign investment and capital flight follows, which suit the situation in Sudan in 1997 after the shock of economic sanction and after 2011 when South Sudan decided referendum. When a currency depreciates, the exchange rate

<sup>2</sup> - its new mechanism for determining the exchange rate, called "market makers" mechanism, announced by central bank of Sudan(CBOS) in 7 oct.2018, to announce daily exchange of Sudanese pound against U.S.A dollar, the mechanism first set exchange rate at 47.5 SDG, instead of the prevailing rate of 29 SDG.

<sup>3</sup> - central bank of Sudan, official web side,<https://cbos.gov.sd/en>

movement has two potential implications for economic growth. First, it reduces that country's wages and production costs relative to those of its foreign counterparts; Secondly, the understanding of the stock price-exchange rate relationship may prove helpful to foresee potential crisis, and trying to avoid the risk arising from exchange rate uncertainty through involvement in unofficial transactions. Notwithstanding the issue of parallel exchange rate versus official exchange rate has raised a considerable policy attentions in both the developed and underdeveloped countries. because the gap between the two would lead to great impacts on macroeconomic performance, that is, pressures on inflation, lower GDP growth, unattractiveness of investment and low export performance. In theory, parallel markets for foreign exchange rate explained and analyzed via three approaches:(1) Real trade models to explain the emergence of parallel exchange to the exchange rate restrictions and heavy government interventions in trade, which have negative implications of making excess demand for foreign currency, which in turns create black market for foreign currency(Nowak,1984),this theory shows that, the supply of foreign currency in the parallel exchange market comes from five sources they are; smuggling of exports; under-voicing of export; under-voicing of imports; foreign tourists; remittances of nationals working abroad and diversion of foreign currency from official to the parallel market through corruption.(ii) portfolio-balance approach: this approach was developed by Demacedo(1987),which emphasized the role of foreign currency as an asset in portfolio composition, because loss in confidence in domestic currency lead to changing composition between foreign and domestic currency, which in turns determine the size of parallel market for exchange rate.(iii) Monetary approach: emphasized the role of money supply, since an increase in money supply lead to inflation and increase demand for foreign currency in parallel market, on other hand it can creates excess demand for goods and services and as such resulted in inflationary pressures, which inevitably lead to future depreciation of exchange rate causes parallel market rate to further appreciate(Ebiedalla,2017).concerning the debates about the impact of monetary policy on exchange rate movement, and what instruments should the central banks used? How practically is the effect of change in the monetary policy on exchange rate? How does reserve accumulation impact on foreign exchange policies? in assessing how predictable the effect of monetary policy, it's of course first necessary to determine the link from monetary policy to exchange rates, central banks present different views about the effects; research conducted in the reserve bank of New Zealand, suggests that reducing exchange rate volatility through policy instruments can be very costly in terms of higher variability in inflation, output and interest rate(West,K,2003).Academic literature has identified four main challenges, through which interventions have the potential to affect exchange rate; the monetary channel, portfolio channel, signaling channel effects and market microstructure effects(Gala,G and W Malick,2002).First, monetary policy operates if the central bank decide not to offset completely the effect of intervention on the level of domestic bank reserves. In this case, intervention will influence the exchange rate through its effect on short-term interest rate. Secondly in the portfolio channel, changes in relative supply of assets (e.g. foreign exchange) can affect the prices of assets (e.g. exchange rate) if assets are imperfect substitutes. Thirdly, in the signaling channel, interventions may contain information about the future stance of policy to influence agent's expectations, but the effect of this channel depends upon the public's perceived link of interventions to monetary policy. Unfortunately, there is a little solid evidence on whether signaling is effective in practice. Fourth, most recent studies have focused on the impact of intervention in microstructure models of foreign exchange markets. In these models, intervention influences the exchange rate because of informational asymmetries, in particular, to the extent that intervention has significant impact on order flows (Evans,M D and R K Lyons,2002).

### 3. Previous Studies

Numerous past studies, study the relationship between monetary policy and exchange rate volatility, but most studies focus on developed countries, with less emphasis in the developing ones(Olufemi M,Saibu&Adeoye,2014). In what follow a brief display of selected recent research conducted in the subject matter to bridge this gap. An and Sun(2008), analyses the interaction among monetary policy, foreign exchange intervention and exchange rate in Japan; they anchor their study on "signaling" and the leaning –against-the wind" theoretical basis, the finding from study lend support to the leaning –against-the wind and "signaling" hypothesis, but the evidence for the " signaling" is minor. Ndung u(1999), assesses whether the exchange rate in Kenya is affected by monetary policy, and whether these effects are permanent or transitory, the results of study show that, nominal exchange rate in Kenya is determined by real income growth, rate of inflation, money supply growth, the cycles in the real exchange rate volatility and the shocks. Cuhe etal,2004), argue that a monetary tightening can generate a large appreciation of the exchange rate in short-run, and therefore can be useful tool in stabilizes foreign exchange markets. Research conducted at the reserve bank of New Zealand, suggest that reducing exchange rate volatility through monetary policy instruments can be very costly in terms of higher variability in inflation, output and interest rate. Munro and Spencer (2004), conclude that, the response of exchange rate to changing policy rates is a major source of monetary policy uncertainty; this result is also found in the work at the Polish and India central banks. Szpunar,(national bank of Poland,2004), investigate how the effect of changes in the polish interest rate on the Zloty differs depending on the time horizon, he find that, in short-run the influence of monetary policy on exchange rate seems to be stronger, compared to long-run. Kapur(reserve bank of India,2004), uses VAR model estimates to characterize the predictability of exchange rate to interest rate, he notice however, that since past interest rates moves usually coincided with intervention and administrative measures, the estimates may be reflecting the joint impact.

Several empirical studies focusing on the monetary mechanism in Sudan:(Kandil, 2004), in his study stated that, the depreciation of the exchange rate of the Sudanese pound has been a major reason for various problems which the Sudan economy has been experiencing and this has made it extremely difficult to predict, the direction of the Sudanese economy with any degree of accuracy. The potentially higher cost of imported input associated with pound depreciation increases marginal cost and leads to higher prices of domestically produced goods. In the same vein, local firms increase prices in

response to foreign competitors' price increase to improve profit margins (leading to escalating inflation) especially in the absence of product substitutability. (Dada & Oyeranti, 2012; Eze & Okpala, 2014), study the process of achieving macroeconomic stability, indicates that, Sudan's monetary authorities have adopted various exchange rate arrangements over the years. It shifted from a fixed regime in the 1970s to a pegged arrangement between the 1970s through the mid-1980s and finally to the various types of the floating regimes since 1986 but none of the various policies has been able to stabilize the Pound. IMF, country report about Sudan 2015, analyze monetary policy framework, they found that, a fixed exchange rate provides the anchor for Sudan's monetary policy framework, but its effectiveness is weakened by the prevailing system of multiple exchange rates.

The findings from the previous studies is that, there are general tendency in underdeveloped economies and specifically in Sudan, to currency depreciation as monetary policy instrument for promotion output growth and stabilizes real exchange rate, the results from various studies, however are generally contrary to the theoretical expectation, which call for both further investigation and some caution in using currency depreciation as a policy instrument. Also two channels of monetary policy instruments not applicable to Sudan economy, science interest rate is prohibited in Islamic economic system, alternatively we employ profit margin as one of monetary policy instrument, portfolio channel depends in the size of capital market, which regarded as less effective, because of small size of Sudanese capital market, instate we use reserve ratio of foreign currency.

#### 4. Overview of Monetary and Exchange Rate Policy in Sudan

Exchange rate policies in Sudan, showed different system since the independence of Sudan in 1956. It applied fixed exchange rate, intermediate exchange rate arrangements and currently managements (Khalid.A, 2011). The fixed exchange rate applied during the period between 1956-1971, with two systems they are ;(1) currency board management until 1960 (2) the credible fixed exchange rate approach from 1960-1971, then incredible fixed exchange followed from 1972-1996 with different sub-systems extended from the period of fixed-like to rabid frequencies reduction in exchange rate; while managed floating exchange rate applied from 1997 till now (Alkhalifa et al, 2009). Since 1997, Sudan has been working with IMF, which advice for implementing of macroeconomic reform including managed floating exchange rate (IMF, report 2010), as said by IMF exchange rate flexibility is a key to rebuild foreign exchange reserves accounts for exchange rate fluctuations can reduce pressure on general price level and maintain favorable balance of payment, particularly after fall in international oil price, low oil revenues associated with South Sudan referendum and the implementation of U.S.A economic sanction to Sudan. During the late 1970s and beginning of 1980s, Sudanese government employed first version of the stabilization and liberalization programs, among others the program focused on exchange rate devaluation; as a result Sudanese pound has been depreciated to the rate of one US dollar equal 0.35 Sudanese pound aiming at encourage exports; attracting foreign direct investment (FDI) and reducing external imbalances, it is the first time for monetary authority to announce the dual exchange markets namely, official and parallel exchange markets (Mahjoub, 2013). Through 1980s exchange rate is again witnessed continuous devaluation, when the country suffer from sever lack of foreign reserve, as a result of 1985s famines and arises of civil war in 1983; thus the official exchange rate set at LS 2.5/US dollar and the parallel market at LS3.3/US dollar, in 1987 exchange rate devaluated further to about LS4.00/US dollar and LS5.8/US dollar for the two markets respectively, in the late 1989 black market exchange rate is rabidly increased reach about more than LS20/US dollar. The new regime of "Elngaz" government in early 1990s imposed various structural economic changes, were the economy witnessed several transformations from government control through 1970-1989 to free market policies; accordingly the exchange rate received considerable attention from the government, since it considered as a key factor effecting economic instability, as a result the black market exchange rate was prohibited and all foreign exchange transactions were confirmed to the commercial banks; in spite of that exchange rate reported as higher than in 1980s. but in the late 1990s commercial oil was exploited in 1999 and become major sources of foreign currency, as a results exchange rate shows substantial stability with limit rate at 2.650-2.600/US dollar, during the period 2008-2010 the exchange rate shows many fluctuations with increasing rate, owing to the reduction in export quantities and international oil price slump, there for resulted in split of exchange markets in to official and black market of exchange and later on in to multi-exchange rate systems.

#### 5. Econometrics Model

To achieve study objectives, this study intends to extend the argument of Chen, (2004) by adopting the theoretical framework of Markov model at the multiple equilibrium process. The estimated equation could be expressed as follows (Caoyong & Ling, 2004):

$$e_t = \alpha\beta_{st} + U_t \dots \dots \dots (1)$$

$$U_t \sim N(0, \sigma_{st}^2)$$

Where:  $e_t$  is the exchange rate volatility during either regime of crisis or tranquil, being determined by set of selected monetary policy instruments ( $\beta$ ) and observed set variables  $U_t$ . The empirical model for analyzing the effect of monetary policy shocks on generated real exchange rate volatility series in Sudan by performing Johansen Co. integration test specified as follows:

$$ECT_{t-1} = [rerv_{t-1} - \beta_1 ms_{t-1} - \beta_3 pmr_{t-1} - \beta_0] \dots \dots \dots (2)$$

Where,  $RERV_{t-1}$  is real exchange rate volatility generated from employing Purchasing Power Parity (PPP) which is the variable of interest;  $MS_{t-1}$  is broad money supply;  $pmr_{t-1}$  is the profit margin determined annually by the central bank of Sudan,  $\beta_0$  is the constant.

$RERV_{t-1}$ , will be derive by employing the absolute version of PPP<sup>4</sup> as follows;

$$RERV_t = \frac{P}{P^*} \dots \dots \dots (3)$$

Were:  $RERV_{t-1}$  measured as a function of domestic currency price of a unit of foreign currency, P is domestic rate of inflation in Sudan and  $P^*$  is the rate of inflation in Egypt which represent the foreign prices.

Referring to the co. integration test result in equation (2), we can proceed to run Vector Error Correction Model (VECM), to test for the speed of adjustment of exogenous variables on the target variables, the model can be expressed as:

$$\Delta rerv_t = \alpha_0 + \sum_{i=1}^{k-1} \alpha_1 \Delta rerv_t - 1 + \sum_{i=2}^{k-1} \alpha_2 \Delta mst - 1 + \sum_{i=3}^{k-1} \alpha_3 \Delta pmr - 1 + \alpha_4 \Delta e_{t-1} + U_t \dots \dots \dots (4)$$

Where:  $rerv_t$  stand for real exchange rate volatility(the dependant variable),  $\Delta rerv_t - 1$  lag of  $rerv_{t-1}$ ;  $\Delta mst - 1$  lag of money supply;  $\Delta pmr_t - 1$  lag of profit margin;  $e_{t-1}$  is the adjustment coefficient and  $U_t$  is the constant. According to economic theory, as Stiglitz(1999) assert that, tight monetary policy may be counter production; raising interest rate(the profit margin for the purpose of this study),will depreciate local currency rather than appreciate it, since the banking system in Sudan still very week; indeed money supply will have negative impact on exchange rate volatility, while pmrt will have positive impact on exchange rate volatility in Sudan.

**6. Empirical Results**

This section discusses the results and empirical analysis of the impact of monetary policy shocks on exchange rate volatility in Sudan. Firstly, we test for the existence of first difference of time series using Unit Root test by employing Augmented Dickey-Fuller (ADF) test; secondly, performing Johansen Co-integration test to validate the long run relationship between the variables, thirdly we proceed to estimate Vector Error Correction Model (VECM), to determine the adjustment mechanism of targeted variables to restore the previous equilibrium.

**6.1. Testing for Stationary**

Before employing empirical analysis techniques it is useful to test for the existence of stationary in the series under study. The results of the unit root test for each variable are reported in table (6-1)

Test variables	ADF		
	t-stat.	Prob.	level
$MS_t$	5.65	0.000	1 <sup>st</sup> difference
$RERV_t$	48.7	0.000	1 <sup>st</sup> difference
$PMR_t$	7.5	0.0000	2 <sup>nd</sup> difference

Table 1: Unit Root Tests  
Source: Researcher Estimation Using Eviews9

Referring to results in table (1), the coefficients of the all variables entered in the model are stationary significant at least 5% at first difference level; this mean that the null hypothesis of no co-integration between the variables is rejected, in other word there exist long run relationship between real exchange rate volatility and money supply, and the rate of profit margin.

**6.2. Co-Integration Test for the Impact of Monetary Policies on Real Exchange Rate Volatility**

Referring to analysis results presented in the appendix (1-1), we can explain two analysis results, the trace test result indicate that, there exist one co-integration equation at 5% level of significant, and Eigen value for Normalized co-integration co-efficient result indicates that, real exchange rate volatility is the dependent variable .following the e-views arrangement we can derive the following co-integration equation, which signifying long run relationship of the model.

$$ECT_{t-1} = 1.000rerv_{t-1} - 7.155ms_{t-1} + 51.149pmr_{t-1} - 482.91 \dots \dots \dots (1)$$

In the long run, lag money supply (MST) has negative impact on real exchange rate volatility ( $rerv_t$ ), while profit margin rate ( $pmr_t$ ) has positive impact on  $rerv_t$ , on average, ceteris paribus. Thus we can conclude that , the null hypothesis of no co-integration is rejected since unrestricted co-integrated rank test is significant at 5% level, this mean that there exist a co-integration relationship in the model, the appropriate number of lag of each variable in the model is deducted automatically by the program using the Akaike information criteria (AIC), the result report in appendix table(6-3) indicate that for normalized co-integration, increases in money supply will lead to decreases in real exchange rate volatility, in other word appreciate of domestic currency; this result support the study hypothesis and in line with economic theory, but in real situation central bank of Sudan tends to tight money supply by setting limit for cash withdrawal from commercial banks, this policy lead to more deterioration in real exchange rate, the same result presented in (Cucheta,2004) study. In the case of profit margin rate, result in appendix table(6-3), indicates that profit margin rate effect real exchange rate negatively, this mean that raising annual profit margin lead to more depreciation of domestic currency, this result opposed research hypothesis and economic theory ,but it is an expected result since Islamic economic system in Sudan prohibits employing interest rate.

**6.3. Vector Error Correction Model (VECM) Analysis for the Impact of Monetary Policies on Real Exchange Rate Volatility**

Since all variables are co-integration at first difference  $I(1)$  ADF test, we can proceed to estimate VEC model, to explain long run relation between the real exchange rate volatility; money supply and rate of profit margin in order to

4 - PPP is the theory of exchange rate determination, developed in sixteen century in Spain and England. Its assert that, the exchange rate between two currencies over any period of time, is determined by the change in the two countries price levels.

explain these variable can adjust to restore the previous real exchange rate equilibrium. Referring to analysis results in appendix (6-4), the following VECM equation can be derived as follows:

$$\Delta rerv_t = -0.52ECT_t - 0.25rerv_t - 2.43ms_t + 0.01pmr_t - 27.28 \dots\dots\dots(2)$$

From the results of equation(1), the adjustment co-efficient is equal to -0.52, this result indicate that, previous year deviation from long run equilibrium can be adjusted or corrected at speed of 52% annually, this high rate of adjustment is expected because of the great amount of natural resources in Sudan. Concerning money supply variable, one percentage decreases in money supply is associated with 243% increases in real exchange rate volatility on average ceteris paribus in the short run, for profit margin rate one percentage increases will be associated with 1% increases in real exchange rate volatility. Notwithstanding, central bank of Sudan monetary policies in general and more specifically exchange rate policies witnessed continuous changes and high instability, which associated with devaluation of Sudanese Pound during the last five years, which in turn has negative consequences on real exchange rate. In addition Central Bank of Sudan exchange rate policies fail to attract inflow of foreign exchange and to utilize all quantity of Gold which produced as a result of smuggling. Therefore monetary policy makers embarked on continuous devaluations of Sudanese pound against the main foreign currencies, which resulted in multi-exchange rates system. In its effort to increase foreign currencies reserve, the central bank of Sudan financial policies failed to attract the remittances of considerable numbers of Sudanese working abroad; on the other hand it did not succeed to manage Gold exports, because about two third of total production of Gold lost through smuggle, other exports declined because of declining in the main production sectors mainly(cash crops, Sugar and Oil), moreover, the access of foreign exchange reserve is hindered by some restricted administrative measures; which widen the gap between official and parallel exchange rates. With respect to profit margin rate the matter of designing equity-based instruments by central bank pose significant difficulties because of complexities in computing appropriate profit margin. Concerning money supply management, recently central bank of Sudan raised the required reserve ratio about three times from 11% to about 18%, which not proved to be effective way of controlling money supply, instead this policy lead to lack of liquidity, which reflected in adverse effect on all financial activities. Also as indicated by the development of purchasing power parity, the Sudanese currency has been over valued, more specifically recently has intensified, though did not correspond to gains in productivity.

#### 6.4. Diagnostic Test

After the estimation of long run Error Correction Model, we proceed to run residual test to insure that non spurious econometrics model, referring to Appendix(6-3) result shows there is no serial correlation since the prob.=.506 is greater than .005, while Appendix(6-4) result shows that joint Jacque Bera probability test equal to 0.000, which mean that residual are normally distributed, fortunately proceeding to last test in Appendix(6-5) the joint test indicate there is no residual heteroskedasticity, since the critical value of prob.=0.296, as a result the model not spacious and can be valid for policy makers to relay on this model for further decision to maintain stable real exchange rate in Sudan.

## 7. Conclusion and Recommendations

### 7.1. Conclusion

Review literature of monetary policy instruments and exchange rate policies in Sudan, and the results and discussions we present the main concluding points as follow:

- Analysis results based on two scenarios, indicates that shock of South Sudan referendum is the most effective factors were scarcity of foreign exchange reserve has been occurred, due to loss of about seventy percent of oil revenues after a separation in 2011; which imposed a significant negative impacts on real exchange rates volatility; therefore monetary policy makers embarked on continuous devaluations of Sudanese pound against the main foreign currencies, which resulted in multi-exchange rates system.
- Government of U.S imposed long run package of economic sanctions in 1997, which mainly designed to restrict many financial transactions, resulted in several negative shocks, more specific on real exchange rates market.
- The pressures in exchange rate market put many constraints on monetary policies which lead to high exchange rate fluctuations; decreases of foreign reserve and rabid increases in parallel exchange rate market.
- One can observe that unstable financial policies push up parallel exchange rate to work as a lead for exchange market, which resulted in continuous up word movement.
- With respect to the main sources of foreign currencies, the central bank of Sudan financial policies failed to attract the remittances of considerable numbers of Sudanese working abroad; on the other hand it did not succeed to manage Gold exports as a result two third of total production of Gold lost through smuggle, other exports declined because of declining in the main production sectors mainly(cash crops, Sugar and Oil)
- Long run analysis indicates, there exist one co-integration equation, were supply of money has negative impact on real exchange rate volatility.
- The profit margin rate deserves negative impact on real exchange rate volatility in Sudan.
- The previous deviation from long run disequilibrium can be achieved at speed of 52% increases in money supply or decreases in profit margin rate.
- The matter of designing an effective equity-based instrument poses significant difficulties, because of complexities in computing appropriate profit margin rate.

### 7.1. Recommendations

Referring to the above discussions and concluding points the study summarizes the following main recommendations:

- These finding reinforce the need for comprehensive packages of monetary policies instrument by strengthen its framework and improve effectiveness.
- Unification of multi-exchange rate should be given priority.
- To restore the previous real exchange rate equilibrium, money supply should increases with respect to deep analysis of actual requirements to determine the quantity to be injected in to real productive sectors.
- There is serious need to revise profit margin rate as an alternative method of traditional interest rate practices.

### 7.3. Limitations of the Study

There are some conceptual and methodological obstacles prevent coherent empirical analysis, because of data limitations and its inconsistency related to the length and quality of time series data; market imperfections; multiple exchange rate practices and unstable monetary policies, in addition to other variables which complicated the output of this study. Also the existence of sever foreign exchange rate restrictions prevent meaning full estimation of the impact of all monetary policy instruments on real exchange rate volatility in Sudan.

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**Appendix**

VAR Lag Order Selection Criteria						
Endogenous variables: RERTV MST PRMT						
Exogenous variables: C						
Date: 02/03/19 Time: 21:54						
Sample: 1997 2017						
Included observations: 19						
HQ	SC	AIC	FPE	LR	LogL	Lag
24.87663	25.00052	24.85140	12460302	NA	-233.0883	0
24.37920*	24.87474*	24.27825*	7158352.*	22.80778*	-218.6434	1
24.66219	25.52938	24.48553	9635281.	8.881032	-211.6125	2
* indicates lag order selected by the criterion						
LR: sequential modified LR test statistic (each test at 5% level)						
FPE: Final prediction error						
AIC: Akaike information criterion						
SC: Schwarz information criterion						
HQ: Hannan-Quinn information criterion						

Table 2

Date: 02/03/19 Time: 22:00				
Sample (adjusted): 1999 2017				
Included observations: 19 after adjustments				
Trend assumption: Linear deterministic trend				
Series: RERTV MST PRMT				
Lags interval (in first differences): 1 to 1				
Unrestricted Cointegration Rank Test (Trace)				
	0.05	Trace		Hypothesized
Prob.**	Critical Value	Statistic	Eigenvalue	No. of CE(s)
0.0053	29.79707	37.50409	0.701054	None *
0.0688	15.49471	14.56176	0.450840	At most 1
0.0748	3.841466	3.173831	0.153837	At most 2
Trace test indicates 1 cointegrating eqn(s) at the 0.05 level				
* denotes rejection of the hypothesis at the 0.05 level				
**MacKinnon-Haug-Michelis (1999) p-values				
Unrestricted Cointegration Rank Test (Maximum Eigenvalue)				
	0.05	Max-Eigen		Hypothesized
Prob.**	Critical Value	Statistic	Eigenvalue	No. of CE(s)
0.0275	21.13162	22.94233	0.701054	None *
0.1358	14.26460	11.38793	0.450840	At most 1
0.0748	3.841466	3.173831	0.153837	At most 2
Max-eigenvalue test indicates 1 cointegrating eqn(s) at the 0.05 level				
* denotes rejection of the hypothesis at the 0.05 level				
**MacKinnon-Haug-Michelis (1999) p-values				
Unrestricted Cointegrating Coefficients (normalized by b*S11*b=I):				
		PRMT	MST	RERTV
		-0.227716	0.120306	0.002851
		0.179878	-0.011243	0.008173
		-0.247582	-0.105308	0.003890
Unrestricted Adjustment Coefficients (alpha):				
	-9.817659	-89.98361	-36.26661	D(RERTV)
	2.094442	-3.547091	-6.833874	D(MST)
	0.586999	-0.357666	1.071269	D(PRMT)
	-218.8934	Log likelihood	1 Cointegrating Equation(s):	
Normalized cointegrating coefficients (standard error in parentheses)				



		PRMT	MST	RERVT
		-79.87648	42.20025	1.000000
		(23.3341)	(9.75871)	
Adjustment coefficients (standard error in parentheses)				
			-0.103391	D(RERVT)
			(0.10543)	
			-0.019482	D(MST)
			(0.00666)	
			0.003054	D(PRMT)
			(0.00132)	
	-213.1994	Log likelihood	2 Cointegrating Equation(s):	
Normalized cointegrating coefficients (standard error in parentheses)				
		PRMT	MST	RERVT
		18.79300	0.000000	1.000000
		(13.3193)		
		-2.338125	1.000000	0.000000
		(0.62052)		
Adjustment coefficients (standard error in parentheses)				
		-3.351456	-0.838807	D(RERVT)
		(3.39469)	(0.24318)	
		-0.782280	-0.048472	D(MST)
		(0.25785)	(0.01847)	
		0.132902	0.000131	D(PRMT)
		(0.05485)	(0.00393)	

Table 3

Vector Error Correction Estimates			
Date: 02/03/19 Time: 22:41			
Sample (adjusted): 2000 2017			
Included observations: 18 after adjustments			
Standard errors in ( ) & t-statistics in [ ]			
		CointEq1	Cointegrating Eq:
		1.000000	RERVT(-1)
		-7.155499	MST(-1)
		(9.05518)	
		[-0.79021]	
		51.14965	PRMT(-1)
		(22.1706)	
		[ 2.30709]	
		-482.9199	C
D(PRMT)	D(MST)	D(RERVT)	Error Correction:
			CointEq1
-0.006180	-0.021999	-0.524007	
(0.00280)	(0.02239)	(0.30094)	
[-2.21048]	[-0.98272]	[-1.74123]	
0.004521	-0.035218	-0.253309	D(RERVT(-1))
(0.00301)	(0.02410)	(0.32399)	
[ 1.50201]	[-1.46132]	[-0.78184]	
-6.81E-05	-0.000621	-0.009155	D(RERVT(-2))
(0.00012)	(0.00092)	(0.01239)	
[-0.59159]	[-0.67418]	[-0.73892]	
-0.035576	-0.169696	-2.905053	D(MST(-1))
(0.03875)	(0.31028)	(4.17124)	
[-0.91802]	[-0.54691]	[-0.69645]	
0.045118	-0.518514	-2.433659	D(MST(-2))
(0.03346)	(0.26788)	(3.60126)	
[ 1.34852]	[-1.93561]	[-0.67578]	
0.209436	-0.426086	0.015390	D(PRMT(-1))
(0.19556)	(1.56577)	(21.0494)	

[ 1.07097]	[-0.27213]	[ 0.00073]	
0.457844	0.700039	-11.86999	D(PRMT(-2))
(0.17122)	(1.37092)	(18.4298)	
[ 2.67399]	[ 0.51064]	[-0.64406]	
0.134847	-0.053355	-27.28482	C
(0.41335)	(3.30956)	(44.4919)	
[ 0.32623]	[-0.01612]	[-0.61325]	
0.723039	0.445476	0.408486	R-squared
0.529167	0.057309	-0.005574	Adj. R-squared
22.49614	1442.162	260636.6	Sum sq. resids
1.499871	12.00900	161.4424	S.E. equation
3.729456	1.147641	0.986537	F-statistic
-27.54764	-64.99263	-111.7655	Log likelihood
3.949738	8.110293	13.30728	Akaike AIC
4.345459	8.506013	13.70300	Schwarz SC
-0.183333	0.800000	-9.886229	Mean dependent
2.185850	12.36865	160.9943	S.D. dependent
	4287364.		Determinant resid covariance (dof adj.)
	735144.6		Determinant resid covariance
	-198.1931		Log likelihood
	25.02145		Akaike information criterion
	26.35701		Schwarz criterion

Table 4

VEC Residual Serial Correlation LM Tests		
Null Hypothesis: no serial correlation at lag order h		
Date: 02/03/19 Time: 22:52		
Sample: 1997 2017		
Included observations: 18		
Prob	LM-Stat	Lags
0.5069	8.273086	1
0.6636	6.745828	2
Probs from chi-square with 9 df.		

Table 5

VEC Residual Normality Tests			
Orthogonalization: Cholesky (Lutkepohl)			
Null Hypothesis: residuals are multivariate normal			
Date: 02/03/19 Time: 22:54			
Sample: 1997 2017			
Included observations: 19			
Prob.	df	Jarque-Bera	Component
0.0003	2	16.25479	1
0.5222	2	1.299399	2
0.3206	2	2.274993	3
0.0030	6	19.82918	Joint

Table 6

VEC Residual Heteroskedasticity Tests: No Cross Terms (only levels and squares)					
Date: 02/03/19 Time: 22:57					
Sample: 1997 2017					
Included observations: 19					
Joint test:					
			Prob.	df	Chi-sq
			0.4721	48	48.01728

Table 7