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The Determinants of Money Supply in Sudan: Empirical Assessment Based on an Application of the (ARDL) Model (1980-2016)

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Abstract

The objective of the study is to examine the empirical evidence of the existence of a long-run and short-run relationship between money supply and it is determinants (GDP growth, exchange rate, domestic investment, inflation rate, exports, cost of finance, foreign direct investment and government spending) in Sudan. The method has been employed to annual time series data covering the period (1980-2016), which are collected from the Central Bank of Sudan and Central Bureau of Statistics. This method is Auto-Regressive Distributed Lag (ARDL) approach associated error correction method (ECM) using Eviews package Version 10. The results indicate that real GDP and real government spending have positive and statistically significant effects on real money supply in the long run and short run, while real exports have negative and statistically significant effects on real money supply just in the long run. As well asexchange rate, real domestic investment, inflation, and foreign direct investment have positive and statistically insignificant effects on real money supply in the long run and short run. While the cost of finance has negative and statistically insignificant effects on real money supply in the long run and short run. Since real GDP, government spending and exports are found to be key determinants of money supply in Sudan. The results showed that the adjustment coefficient (EC-1) with a negative sign and statistically significant, these findings indicate that the presence of an error correction mechanism works in this form. The coefficients of EC-1 are equal to (-0.99) and imply that deviation from the long-term real money supply is corrected by only 99% percent in the model. The study recommended thatthe government should employ a suitable monetary policy so as to encourage financial integration with all sectors of the economy that will enhance positive outcome to the country.

Keywords

Moneysupply, Domestic Investment, Autoregressive Distributed Lag (ARDL)

1. Introduction

The money supply is a very sensitive variable, the size of which determines the pace of any economic activities. Apart from being a powerful instrument of monetary policy, its expansion or contraction dictates the growth in investment and output of any economy. It is, therefore, the usual motto of the Monetarist school of thought that money matters. They argued that changes in the quantity of money in the circulation are the sources of othereconomic changes. In other words, the changes in the size of the money supply have a number of implications on the macroeconomic variables especially inflation.

Like many other countries in Sub-Saharan Africa, Sudan has experienced many years of political tension and civil war since it became independent in 1956 until a comprehensive peace agreement (CPA) was signed on January 9, 2005 with

the Sudan People's Liberation Movement / Army (SPLM/A), ending the conflict in Southern Sudan. Sudan's population is estimated at about 38 million in 2014. Though well-endowed with natural resources in relation to its population, Sudan's economic performance has been substantially below its potential. According to the World Bank: World Development Indicators [1], Sudan is classified as one of the poorest Sub-Sahara African countries.

During the period of our study, the money supply in the Republic of Sudan has substantially increased; it has increased at an annual average rate of about 2.48 insup section period (1980-1984) to the 12.10 in sup section period (1985-1989), also it is has a continuance increased during the 1990s. Still, this average is too high in theleast sup section period (2005-2009) and (2010-2016) from an average 20573.10 and 54025.10 respectively. Summing up, the question concerning the possible sources that could help in providing and achieving sustainable economic growth in Sudan: what are the factors that affect the money supply in Sudan?

The objective of this research is to examine the determinants of the real money supply rate in Sudan by using time series data covering the period (1980-2016).

The hypotheses to be tested can be stated as follow:

1. There are a long- run and short-run relationship between real money supply and some macroeconomic indicators in Sudan.
2. It is hypothesized that real GDP, domestic investment, government spending, inflation, real exchange rate, and exports affect real money supplypositively in the long run and short run.
3. It is hypothesized thatthe cost of finance and imports affects real money supplynegatively in the long run and short run.

The importance of this study is that it will help to identify the factors that affecting real moneysupply in Sudan. Policymaker can use the results of this study on implementing monetary policy to manage the real money supply in Sudan.

2. Empirical Studies About the Determinants of Exchange Rate

Various studies have been conducted in order to materialize their impact. Some of the significant studies are referred below i.e., analyzed which macro (GDP, exchange rate, consumer price index, Bank Indonesia Certificates/Sharia and money supply) and micro (loan/financing to deposit ratio, capital adequacy ratio, operational efficiency ratio) variables the most affecting to credit/financing growth and credit/financing risk [2]. This research utilized the Vector Error Correction Model (VECM). The result of this research showed Bank Indonesia Certificates and money supply as macro variables have the most influence and CAR as an internal factor has the biggest contribution to credit growth. For financing growth, macro variables that have the biggest influence are exchange rate and Bank Indonesia Certificates Sharia, as for micro variable CAR has the biggest contribution. Credit risk affected by Bank Indonesia Certificates, and for a micro variable, LDR has the biggest influence. For financing risk, Bank Indonesia Certificates Sharia has the biggest influence, and OER has the biggest contribution.

The study revealed that price level, income, and exchange rate positively affects money supply in Nigeria while interest rate and foreign direct investment has negative impact on money supply in Nigeria which basically answered the research questions and also the pairwise result revealed that there is no causal relationship between price level and money supply in Nigeria in both directions, but there is a one way causal relationship between gross domestic product and money supplyin Nigeria but the relationship runs from gross domestic product to money supply which brings to conclusion that GDP causes Money supply in Nigeria and finally there is a bidirectional relationship between interest rate and money supply in Nigeria this brings to conclusion that interest rate causes money supply and money supply to causes interest rate in Nigeria. The estimated long-run test proved that the variables under study are related in the long run. This result, therefore, showed that money supply is really determined based on the movement of macroeconomic variables of the nation and the variables also impact on money supply as clearly evident [3]. examined the determinants of money supply growth and its implications on inflation in Nigeria. He employed a quasi-experimental research design approach for data analysis. The results of the regression showed that credit expansion to the private sector determines money supply growth by the highest magnitude in Nigeria [4]. The results also showed a positive relationship between money supply growth and inflation in Nigeria which of course has theoretical bases.

Investigated the long-run relationship between money supply, real GDP and price level in Sudan covering a period from 1960-2015. They're used the regression and granger causality test. He found no causal relationship between GDP and money supply but GDP, money supply and consumer price index are co-integrated in the long run [5].

Carried out a study on money supply and inflation in Nigeria. Using a times series data from 1970- 2008. And used the variables money supply, exchange rate, oil revenue, inflation rate, interest rate and employed the techniques for their analysis which are OLS, VAR, Granger causality, impulse response function. Based on the result, it revealed money supply, the exchange rate was stationary at level, while oil revenue was stationary at first difference. And the causality result indicates a unidirectional causality between money supply and inflation rate as well as between interest rate and inflation rate [6].

Investigated empirically the theory of endogenous money based on a panel dataset of 177 countries. Consistency of the GMM estimator depends on the validity of the instruments [7]. Two specification tests are used. Firstly, Sargan/Hansen test of over-identifying restrictions which tests for overall

validity of the instruments and the null hypothesis is that all instruments as a group are exogenous. The second test examines the null hypothesis that error term of the differenced equation is not serially correlated particularly in the second-order (AR2). Ones should not reject the null hypothesis of both tests. Hefound that real GDP per capita and bank lending are indeed significant determinants of money supply, hence supporting the earlier arguments of money supply endogeneity asproposed by Post-Keynesian economists. Inflation is however not, and this is not uncommon since it is in line with the fundamental theory of inflation according to monetarist perspective. also past studies utilized Granger Causality and Vector Error Correction (VECM) methodology to examine money endogeneity in a developing country [8, 9]. Aimed at testing monetary transmission mechanism and passive money (or money supply endogeneity) hypothesis, they used seven types of variables: money base, money supply, credit capacity, industrial production index (the proxy for the GDP), interest rates, inflation, and real exchange rate. They used quarterly data for the sample periods of ten years, ranging from 1997 to 2006. One of the major outcomes of the study is that the endogeneity of money supply hypothesis of the Post Keynesian economics is supported in part by Accommodationists view but differ from those of Structuralist and Liquidity Preference theories.

Investigated the changing relative importance of the determinants of the US money supply, both narrowly and broadly defined, over the past two decades. The paper has been particularly interested in assessing the changing roles of these determinants during the recent financial crisis. The findings, which seem to corroborate the earlier results in the literature, single out the currency ratio is generally the most important determinant of the US money supply over the sample period [10, 11].

3. The Method

3.1. The Theoretical Model

To provide a preliminary empirical assessment on the monetary endogeneity, the following money supply model is used:

$$M2G_t=F\ (RGDP_t, ING_t, Inf_t, XPG_t, EXRt, GGt, IMt, CF_t)\ (1)$$

Where, $RGDP_t$, ING_t, Inf_t, XPG_t, $M2G_t$, EXRt, GGt, IMt, and CF_t, are the real gross domestic product, domestic investment, inflation rate, exports, money supply, exchange rate, government spending, imports and cost of finance. According to classical theory, the relationship between money supply and inflation is positive; implying that increasing money supply would lead to higher prices given the money demand as a function of the velocity and real GDP. It is clear that expansion of money supply, through an open-market operation, will increase the inflation rate by the same amount if there is no effect of monetary growth on growth of output [12]. Normally, an increase in the supply of money, if not simultaneously compensated by an increase in output results in a rise in prices (inflation will take place). Conversely, a decrease in the supply of money, if not accompanied by a decrease in output, results in decrease behaviors of prices (deflation). The interrelationships between money, output, and prices have remained an area of controversy despite a lot of research works that have been done in this direction [13].

According to economic theory, the relationship between exports and money supply is positive. Suppose that a Sudanese exporter earns Dollars for his exports and he surrenders the same to BoS and gets an equivalent amount of Sudanese currency. In other words, whenever BoS or any other bank acquires foreign exchange or foreign assets, it will have to distribute the equivalent amount of Sudanese currency within the country.

Normally, the central government finances its current expenditure through current revenue. In case, tax revenues are inadequate the government restores to borrowings. Borrowings of government from the general public will have the effect of reducing the money supply with the people - for money is transferred from the people to the government. But when the government borrows from the central bank i.e. Bank Sudan by providing Government Musharakah Certificates (GMCs), government securities or I owe you (IOU) to the bank of Sudan - the government receives the loan from Bank of Sudan. In this case, the money supply is not immediately affected, but the government receives funds from the central bank. It is against the government securities that bank of Sudan prints and issues currency notes and coins. This means that every increase in government securities will have the direct effect of increasing the issue of currency notes and coins in Sudan and thus, increasing the money supply in the country

3.2. Autoregressive Distributed Lag (ARDL) Approach Estimation Procedures

The ARDL modeling approach was originally introduced by Pesaran & Shin [14] and later extended by Pesaran, Shin, and Smith [15] is employed for the following certain econometric advantages in comparison to other co-integration procedures, it is mentioned by Ozturk and Acaravci [16]. It is Involvestwo steps for estimating the long-run relationship [17]. Bahmani-Oskoee and Bohi [21] suggest that the results of this first step are usually sensitive to the order of lags. The optimal lag is selected by using Akik Information Criteria (AIC) Then the study imposes different lags order on the first difference of each variable and computes the F- statistic for the joint significance of lagged levels of variables. The computed F- statistic for each order of the lags is compared with F-critical value in testing the existence of a long-run relationship. Thus, the unrestricted error correction model (UECM) frameworks for Equations (1) are;

$$\Delta \mathrm{LnM2G_t} = \alpha_4 + \sum_{i=1}^{p} \beta_{1i} \Delta \mathrm{LnM2G_{t-1}} + \sum_{i=0}^{p} \beta_{2i} \Delta \mathrm{LnRGDP_{t-1}} + \sum_{i=0}^{p} \beta_{3i} \mathrm{i} \Delta \mathrm{LnXPG_{t-1}} + \sum_{i=0}^{p} \beta_{4i} \Delta \mathrm{Ln} ING_{t-1} + \sum_{i=0}^{p} \beta_{5i} \Delta \mathrm{LnEXR_{t-1}} + \sum_{i=0}^{p} \beta_{6i} \Delta \mathrm{LnGG_{t-1}} + \sum_{i=0}^{p} \beta_{8i} \Delta \mathrm{Ln\ Inf_{t-1}} + \sum_{i=0}^{p} \beta_{9i} \Delta \mathrm{Ln\ IM_{t-1}} + \sum_{i=0}^{p} \beta_{10i} \Delta \mathrm{Ln\ CF_{t-1}} + \delta 1 \mathrm{LnRGDP_{t-1}} + \delta 2 \mathrm{Ln\ XPG_{t-1}} + \delta 3 \mathrm{Ln\ ING_{t-1}} + \delta 4 \mathrm{Ln}\ Inf_{t-1} + \delta 5 \mathrm{LnM2G_{t-1}} + \delta 6 \mathrm{LnGG_{t-1}} + \delta 7 \mathrm{LnIM_{t-1}} + \delta 8 \mathrm{LnEXR_{t-1}} + \delta 9 \mathrm{LnCF_{t-1}} + \varphi it4 \quad (2)$$

Where all the variables are as previously defined in equations (1), Δ is the first difference operator, p is the optimal lag length, the residuals are φit assumed to be normally distributed and white noise. For these equations, the F-test can be used to examine whether a long-run equilibrium relationship exists between the variables, by testing the significance of the lagged level variables. The null hypothesis of no co-integration in each equation above is that:

Ho: δ1= δ2= δ3= δ4= δ5= δ6= δ7= δ8= δ9=0 while, the alternative hypothesis (existence of cointegration) is that; H_1: δ1≠ δ2≠ δ3≠ δ4≠ δ5≠ δ6≠ δ7≠ δ8≠ δ9≠0

The rejection of the Ho in a particular equation implies that the independent variables are the long run forcing variables for the dependent variable. On other words, if the dependent variables deviate from the long-run equilibrium path as results of shock, the independent's variables interact together and correct this disequilibrium and bring the dependent variable to it is the long-run path.

The F-test has a non-standard distribution which depends on (i) whether variables included in the model are I (0) or I (1), (ii) the number of regressors, and (iii) whether the model contains an intercept and/or a trend. Given a relatively small sample size in this study the critical values used are as reported by Pesaran & Shin [14]. The test involves asymptotic critical value bounds, depending on whether the variables are I (0) or I (1) or a mixture of both. Two sets of critical values are generated where one set refers to the, I (1) series; and the other for the, I (0) series.

Critical values for the I (1) series are referred to as the upper bound critical values, while the critical values for I (0) series are referred to as the lower bound critical values. If the F test statistic exceeds their respective upper critical values, we can conclude that there is evidence of a long-run relationship between the variables regardless of the order of integration of the variables. If the test statistic is below the lower critical value, we cannot reject the null hypothesis of no co-integration. If it lies between the bounds, a conclusive inference cannot be made without knowing the order of integration of the underlying regressors. In the case where the F statistic falls between the lower bound and the upper bound critical value, it is recommended to consider the t-test corresponding EC_{T-1}, if it is significant, this suggests the existence of co-integration among the variables [18]. Thus, if there is evidence for the existence of cointegration (long-run relationship) between variables, the next step involves selecting the appropriate lag orders of the dependent variable and regressors involved to obtain what is known as the conditional (restricted) ARDL model [19]. This is normally accomplished by applying OLS methods to estimate the general ARDL model of the form:

$$\Delta \mathrm{LnM2G_t} = \alpha_4 + \sum_{i=1}^{q} \gamma_{1i} \mathrm{Ln\ M2G_{t-1}} + \sum_{i=o}^{p1} \gamma_{2i} \mathrm{Ln\ RGDP_{t-1}} + \sum_{i=0}^{p2} \gamma_{3i}\ \mathrm{Ln\ ING_{t-1}} + \sum_{i=0}^{p3} \gamma_{4i}\ \mathrm{LnXPG_{t-1}} + \sum_{i=0}^{p4} \gamma_{5i}\ \mathrm{Ln} Inf_{t-1} + \sum_{i=o}^{p5} \gamma_{6i}\ \mathrm{LnEXR_{t-1}} + \sum_{i=o}^{p6} \gamma_{7i} \mathrm{Ln\ GG_{t-1}} + \sum_{i=o}^{p7} \gamma_{8i}\ \mathrm{LnIM_{t-1}} + \sum_{i=o}^{p8} \gamma_{9i} \mathrm{Ln\ CF_{t-1}} + \mathrm{U_t} \quad (3)$$

Where all variables in equations (2 and 3) are as previously definite in equation (1) above.

Error Correction Model (ECM)

After obtaining estimates of the long-run parameters, the estimated equation is also used to obtain an estimate of the error correction term (EC_{t-1}), which is obtained from above Equations (3) as:

$$\mathrm{ECT_t} = \mathrm{LnM2G_t} - \alpha_t - \sum_{i=1}^{q} \gamma_{1i} \mathrm{Ln\ M2G_{t-1}} - \sum_{i=1}^{p1} \gamma_{2i} \mathrm{Ln\ RGDP_{t-1}} - \sum_{i=0}^{p2} \gamma_{3i}\ \mathrm{Ln\ ING_{t-1}} - \sum_{i=0}^{p3} \gamma_{4i}\ \mathrm{LnXPG_{t-1}} - \sum_{i=0}^{p4} \gamma_{5i}\ \mathrm{Ln} Inf_{t-1} - \sum_{i=o}^{p5} \gamma_{6i}\ \mathrm{LnEXR_{t-1}} - \sum_{i=0}^{p6} \gamma_{7i} \mathrm{Ln\ GG_{t-1}} - \sum_{i=o}^{p7} \gamma_{8i}\ \mathrm{LnIM_{t-1}} - \sum_{i=0}^{p8} \gamma_{9i} \mathrm{Ln\ CF_{t-1}} \quad (4)$$

where all variables in equations (4) is a previously definite in equation (1) above. After the long-run parameters and the error correction terms are estimated, the final step involves estimating the short-run dynamic parameters by applying OLS to the error correction representation of the conditional ARDL model in Equation (4). The ECM models are given by:

$$\Delta \mathrm{LnM2G_t} = \alpha_t + \sum_{i=1}^{q} \gamma_{1i} \Delta \mathrm{Ln\ M2G_{t-1}} + \sum_{i=0}^{p1} \gamma_{2i} \Delta \mathrm{Ln\ RGDP_{t-1}} + \sum_{i=0}^{p2} \gamma_{3i} \Delta \mathrm{Ln\ ING_{t-1}} + \sum_{i=0}^{p3} \gamma_{4i} \Delta \mathrm{LnXPG_{t-1}} + \sum_{i=0}^{p4} \gamma_{5i} \Delta \mathrm{LnInF_{t-1}} + \sum_{i=o}^{p5} \gamma_{6i} \Delta \mathrm{Ln\ EXR_{t-1}} + \sum_{i=o}^{p6} \gamma_{7i} \Delta \mathrm{LnGG_{t-1}} + \sum_{i=0}^{p7} \gamma_{8i} \Delta \mathrm{Ln\ CF_{t-1}} + \sum_{i=o}^{p8} \gamma_{9i} \Delta \mathrm{LnIM_{t-1}} + \varphi_1 \mathrm{ECT_t} \quad (5)$$

where EC_T is the error correction terms in (5) obtained from Equations (4). The parameters γ_{th} in the above Equations are the short-run dynamic coefficients which measure the model's convergence to equilibrium, while the coefficient of the error correction terms are the adjustment parameters, which gives the proportion of the deviations (errors) of the dependent variables from their long-run equilibrium values that have been adjusted (corrected). The coefficients must be negative and statistically significant. The negative sign of the coefficients mean that the dependent variables adjust back to their equilibrium values (or the dynamic model converges to equilibrium) following a disturbance, the magnitude of the coefficients measure the speed of adjustment.

3.3. Data

The data set included all the variables under study for Sudan and generally covered the period (1980-2016). The data obtained primarily from the annual reports from the Central Bank of Sudan (CBOS) database, Central Bureau of Statistic and World Bankreport. Thus, the data used is essential for secondary nature.

4. Empirical Analysis and Results

4.1. Unit Root Test

In this study, non-stationarity was tested with the Augmented Dickey-Fuller test. So, initially, we have to investigate the order of integration. This is to ensure that the variables are not 1 (2) stationary to avoid spurious results. In the presence of 1 (2) variables the computed F-statistics provided by Ozturk and Acaravci [16], are not valid. Because the bound test is based on the assumption that the variables are 1 (0) or 1 (1), therefore, the implementation of unit root tests in the ARDL procedure might still be necessary in order to ensure that none of the variables is 1 (2) or beyond. The results of the ADF test are reported in Table 1. The results suggest that all the variables are integrated of order one i.e. stationary after first difference. This result gives support to the use of the ARDL bounds approach to determine the long-run relationships among the variables.

Table 1. *ADF Unit Root Tests for Stationarity of Variables.*

Variable	Calculated ADF statistic					Order of integration (d)
	Levels		Ist differenced			
	With Intercept	With Intercept and trend	With Intercept	With Intercept and trend	Without intercept and the trend	
LnRGDP	-0.680176	-2.058810	-5.379695**	-5.417128**	-5.417422**	I (1)
LnXPG	-1.886255	-2.887360	-7.180707**	-7.072949**	-7.290872**	I (1)
LnInG	-3.522168*	-4.026731*	-6.364763**	-6.326205**	-6.461124**	I (0)
LnInf	-1.977088	-2.097878	-8.237375**	-8.117117**	-8.361493**	I (1)
LnCF	-1.528112	-1.703748	-5.587790**	-5.727330**	-5.666216**	I (1)
Ln GG	-1.593625	-1.976441	-5.008720**	-4.931988**	-5.083879**	I (1)
LnFDIG	-8.836993**	-8.642659**	-5.062302**	-2.265592	-6.706555**	I (0)
LnREX	-5.872502**	-6.348835**	-6.922744**	-6.817308**	-7.030082**	I (0)
LnM2G	-1.195243	-1.481329	-5.071152**	-4.996690**	-5.086086**	I (1)

Source: Author's calculations. **, and * mean significant at 1% and 5%, respectively

4.2. Co-integration Analysis

In the first step of the ARDL analysis, we test for the presence of long-run relationships in the model. Given the fact that we have annual time series data and a limited number of observations (37), the lag length will be restricted to two. Table 2 bellow reports results of the bound test for the existence of a long-run relationship

Table 2. *Co-integration Tests.*

Model	F-statistics	Critical value bounds of the F-statistics			
		1% Level		5% Level	
		1 (0)	1 (1)	1 (0)	1 (1)
M2G	6.649740	2.91	4.19	2.34	3.50

Source: Author's calculations. Critical Values are from Pesaran, Shin, and Smith [15], Table CI

The case I and II: Unrestricted intercept and without intercept.

As shown in table 2 the calculated F-statistics in the model is higher than the upper bound critical value at the 1% significant level. This implies that the null hypothesis of no co-integration cannot be accepted and that there is indeed a co-integration relationship among the variables in the model.

4.3. Estimation of Long-run Coefficients of (ln (M2G) Model

From table 3 it is clear that the F statistic is higher than its critical value suggesting a good overall significance of the estimated model at 1% percent. Also, the value of R^2 square indicates that 60% of the variation independent variable has been explained by variations in explanatory variables.

Table 3. *Estimation of long-run Coefficients Using the ARDL Model for (ln (RM2G).*

Variable	Coefficient	Std. Error	t-Statistic	Prob.	R^2	R^{-2}
LOG (RGDP (-1))	0.113151	0.054505	2.075995	0.0479	0.95	0.93
LOG (XPG (-1))	-0.048298	0.038747	-1.246502	0.2237		
LOG (ING (-2))	0.017676	0.062712	0.281866	0.7803		
LOG (INF (-1))	0.027097	0.057242	0.473378	0.6399		
LOG (REX (-1))	-0.012815	0.012630	-1.014627	0.3196		
LOG (FDIG (-1))	0.026106	0.023764	1.098535	0.2820		
LOG (GG (-1))	0.199734	0.095943	2.081787	0.0473		
LOG (M2G (-1))	0.573963	0.139441	4.116164	0.0003		
LOG (CF (-1))	-0.034228	0.058844	-0.581683	0.5658		

The results in table 3 showed that in the short-run real GDP hasa positive and significant effect on real money supply in Sudan. This coefficient indicates that other things are being equal, a 1% rise in real GDP leads to an increase in exports over time by 0.11%. This result is consistent with Ahmed & Suleiman [5] and Adeleke & Sola [6]. The results in table 3 show that export has negative and significant effects onthe money supply. This coefficient indicates that other things being equal, a 1% rise in exports leads to a decrease in real money supply over time by 0.62 percent. Although the result of the negative relationship between exports and real money supply reported in this study is inconsistent with general evidence in the empirical literature, it is not surprising in the case of Sudan. A possible explanation for that over our study period is that money supply increased to finance the deficit in Sudan. And this is because the deficit in Sudan is used to pay off foreign debt obligation and not spent on goods and services and also it was used to finance the civil war in the south and the armed conflicts in Darfur. It could also be due to corrupt practices by the elite who take money outside the country to foreign accounts.

Domestic investment has positive and statistically significant effects on the money supply. Other things being equal, a 1% rise in domestic investment leads to an increase in money supply over time by 0.018 percent. This result consistent with economic theory, According to monetary theory an increase in money supply leads to a decline in interest rate thus investment increases [20]. The inflation rate has positive and statistically insignificant effects on the money supply. Other things being equal, a 1% rise in Inflation rate has led to an increase in money supply over time by 0.027 percent. This result is consistent with World Bank: World Development Indicators [1], their found that positive relationship between inflation and money supply in Nigeria.

Also, it is obvious from table 3 the coefficient of the exchange rate is negative and insignificant in the model. Accordingly, an increase in the exchange rate by 1% leads to a decrease in real money supply by (0.013) percentage points. In particular, the result indicates that as the exchange rate increases (this is called devaluation of domestic currency), the money supply will decrease in the long run. In this respect. Foreign direct investmenthas a positive and statistically significant effect on the money supply in the long run. Accordingly, an increase in government spending by 1% leads to an increase in real money supply by (0.026) percentage points. Government spending has a positive and statistically significant effect on the money supply in the long run. Accordingly, an increase in government spending by 1% leads to an increase in real money supply by (0.20) percentage points. This means that every increase in government securities will have the direct effect of increasing the issue of currency notes and coins in Sudan and thus, increasing the money supply in the country. The results in table 3 show that the cost of finance has negative and significant effects on the money supply. This coefficient indicates that other things being equal, a 1% rise in the cost of finance leads to a decrease in real money supply over time by 0.034 percent.

4.4. Diagnostic Tests of the Estimated Long-run

For this purpose, we have examined the Auto Regressive Destitution Lag (ARDL) model, namely normality, functional form, Autocorrelation and Heteroscedasticity Tests.

i. Normality and Functional Form Test:

The Jarque-Bera test for normality compares the third and fourth moments of the residuals to those of the normal distribution and analyzes under the null hypothesis of normal distribution.

The result of the residual analysis tests for the equation is summarized in table 4. It can also be observed that the residuals are normally distributed in the model.

Table 4. *Normality and Functional Form Tests.*

Model	Normality				Functional form		
	(Jarque-Bera)		Kurtosis	Skewness	AIC	Ramsey Reset	
	F-statistic	Prob				F-statistic	Prob
Ln (M2G)	0.741595	0.690184	3.605760	-0.188130	0.942828	1.795973	0.1923

Source: Authors' calculation.

ii. Autocorrelation and Heteroscedasticity Tests

The famous test which used to detect the autocorrelation problem is that Darbin-Watson (D-W) test, and also we used the Breusch – Godfrey test to detecting the autocorrelation problem.

The results of these tests are summarized in the table 5 below. Also, we used the White test to know where the models are suffering from heteroscedasticity problem or not.

Table 5. *Autocorrelation and Heteroscedasticity Tests.*

Model	Autocorrelation			Heteroscedasticity	
	D-W	Breusch-Godfrey		White	
		F-statistic	Prob	F-statistic	Prob
Ln (RM2G)	1.750501	0.646303	0.5329	0.592009	0.7912

Source: Authors' calculation.

Table 5 above shows that White heteroscedasticity test statistic with cross terms it is significant, suggesting that there is no heteroscedasticity in the models. Table 5 above shows that the Durbin Watson test is almost equal or near to

2 Breusch-Godfrey test statistics for serial correlation are significant for the model.

iii. Stability Testing of the Parameters:

The plots of the CUSUM and CUSUMSQ in Figures 1 - 2 below are obtained from a recursive estimation of the model. These plots indicate stability in the coefficients of the models.

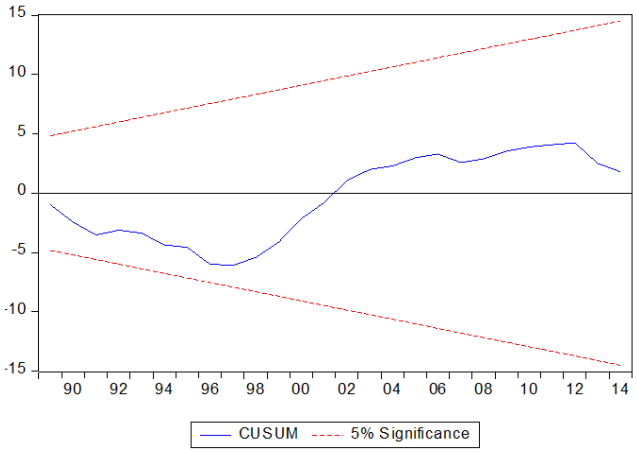

Figure 1. *The cumulative sum of recursive of residuals.*

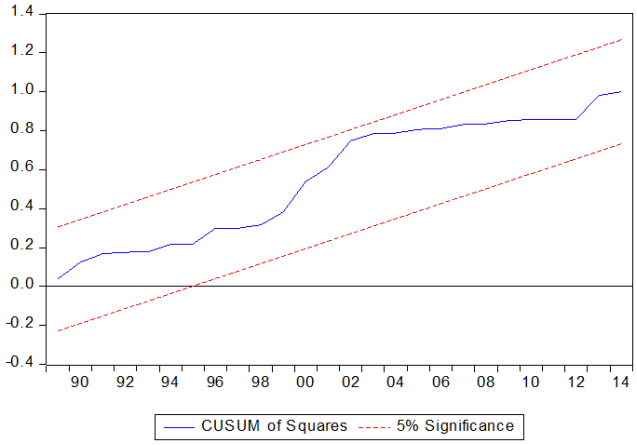

Figure 2. *The cumulative sum of recursive of residuals.*

4.5. Estimation of the Short-run Dynamic Coefficients

The value of R^2 indicates that 67% variation in the dependent variable has been explained by variations in explanatory variables. F value is higher than its critical value suggesting a good overall significance of the estimated model.

Table 6. *Estimation of the Short-run Dynamic Coefficients of the Error Correction Representations of the ARDL Model D (Log (RM2G).*

Variable	Coefficient	Std. Error	t-Statistic	Prob.	R^2	R^{-2}	F-statistic	Prob (F-statistic)
C	0.051486	0.038802	1.326897	0.1982	0.67	0.58	4.366328	0.001895
D (LOG (RGDP (-3)))	0.455533	0.149212	3.052926	0.0058				
D (LOG (XPG (-1)))	-0.093162	0.045550	-2.045276	0.0530				
D (LOG (ING (-2)))	0.070322	0.044967	1.563846	0.1321				
D (LOG (INF (-1)))	0.066542	0.053332	1.247693	0.2253				
D (LOG (REX (-1)))	0.074615	0.071777	1.039538	0.3098				
D (LOG (FDIG (-1)))	0.007188	0.017320	0.414993	0.6822				
D (LOG (GG (-1)))	0.231234	0.113715	2.033446	0.0542				
D (LOG (M2G (-2)))	0.690384	0.259696	2.658436	0.0144				
D (LOG (CF (-1)))	-0.198703	0.122389	-1.623527	0.1187				
EC (-1)	-0.991236	0.350654	-2.826819	0.0098				

The results in table 6 showed that in the short-run real GDP has a positive and significant effect on real money supply in Sudan. This coefficient indicates that other things are being equal, a 1% rise in real GDP leads to an increase in real money supply over time by 0.46%. This result is consistent with Bakare, [4] and Adeleke and Sola [6]. The results in table 6 show that export has negative and significant effects on the money supply. This coefficient indicates that other things being equal, a 1% rise in exports leads to a decrease in real money supply over time by 0.09 percent.

Although the result of the negative relationship between exports and real money supply reported in this study is inconsistent with general evidence in the empirical literature, it is not surprising in the case of Sudan. It could also be due to corrupt practices by the elite who take money outside the country to foreign accounts. Domestic investment has positive and statistically significant effects on the money supply. Other things being equal, a 1% rise in domestic investment leads to an increase in money supply over time by 0.07 percent. This result consistent with economic theory, According to monetary theory an increase in money supply leads to a decline in interest rate thus investment increases [20].

The inflation rate has positive and statistically insignificant effects on the money supply. Other things being equal, a 1% rise in Inflation rate has led to an increase in money supply over time by 0.07 percent. This result is consistent with Ahmed & Suleiman [5], Adeleke & Sola [6] and Abakpa, Purokayo, Asaph [3]. their found that positive relationship between inflation and money supply.

Also, it is obvious from the table 6 the coefficient of the exchange rate is negative and insignificant in the money supply model. Accordingly, an increase in the exchange rate by 1% leads to a decrease in real money supply by (0.074) percentage points. In particular, the result indicates that as the

exchange rate increases (this is called devaluation of domestic currency), the money supply will decrease in the short-run. Foreign direct investmenthas a positive and statistically significant effect on the money supply in the long run. Accordingly, an increase in government spending by 1% leads to an increase in real money supply by (0.01) percentage points. This result is consistent with Abakpa, Purokayo, Asaph [3] their found that positive relationship between inflation and money supply in Nigeria. Government spending has a positive and statistically significant effect on the money supply in the long run. Accordingly, an increase in government spending by 1% leads to an increase in real money supply by (0.23) percentage points. All the time, the government receives funds from the central bank. It is against the government securities that bank of Sudan prints and issues currency notes and coins. This means that every increase in government securities will have the direct effect of increasing the issue of currency notes and coins in Sudan and thus, increasing the money supply in the country. The results in table 6 show that the cost of finance has negative and significant effects on the money supply. This coefficient indicates that other things being equal, a 1% rise in the cost of finance leads to a decrease in real money supply over time by 0.20 percent.

The results showed that the adjustment coefficient (EC_{-1}) with a negative sign is statistically significant; these findings indicate that the presence of an error correction mechanism works in this form. The coefficients of EC_{-1} are equal to (-0.99%) and imply that deviation from the long-term money supply is corrected by only 99% percent in the model.

4.6. Diagnostic Tests of the Estimated Short-run ARDL Models

In this subsection, we discuss the diagnostic test of the estimated short-run (ARDL) models, namely Normality, Functional Form, Autocorrelation and Heteroscedasticity tests.

i. Normality and Functional:

The Jarque-Bera test for normality compares the third and fourth moments of the residuals to those of the normal distribution and analyzes under the null hypothesis of normal distribution.

Table 7. *Normality and Functional form Tests.*

Model	Normality (Jarque-Bera)		Kurtosis	Skewness	Functional form AIC	RamseyReset	
	F-statistic	Prob				F-statistic	Prob
Ln (RM2G)	1.3032	0.5212	3.935420	-0.134899	-1.388530	3.132158	0.0906

Source: Author's calculation.

The result of the residual analysis tests is summarized in table 7. It can also be observed that the residuals are normally distributed in exports equation.

ii. Autocorrelation and Heteroscedasticity Tests

The famous test which used to detect the autocorrelation problem is Darbon-Watson (D-W) and Breusch – Godfreystatistic.

Table 8. *Autocorrelation and Heteroscedasticity Tests.*

Model	Autocorrelation			Heteroscedasticity	
	D-W	Breusch-Godfrey		White	
		F-statistic	Prob	F-statistic	Prob
Ln (RM2G)	2.050902	0.779925	0.4713	1.865821	0.1045

Source: Author's calculation.

Table 8 above shows that the Durbin Watson test is almost equal or near to 2, and the probability value to Breusch – Godfrey test (LM Test) using two-period lags is greater than 5% level these results indicate that there is no autocorrelation problem in all equations. The result also indicates that the probability value of the White test is greater than 5% level which means that there is no heteroscedasticity problem in the equations. Therefore, the fitness of the model is acceptable empirically.

iii. The Testing of Stability for parameters in Short-run Relationships:

The plots of the CUSUM and CUSUMSQ in Figures 3-4 below are obtained from a recursive estimation of the model. These plots indicate stability in the coefficients of all models.

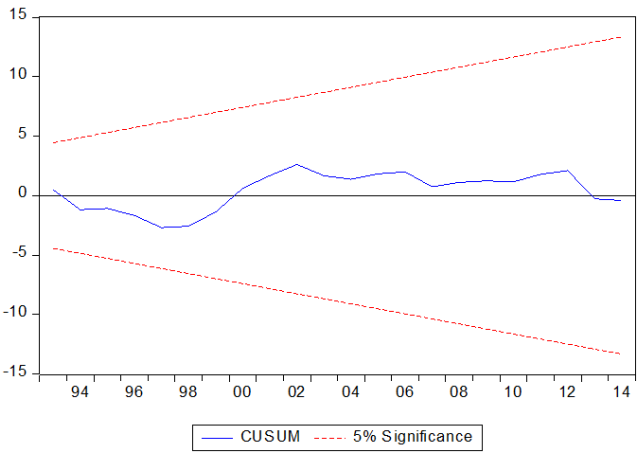

Figure 3. *The cumulative sum of recursive of residuals.*

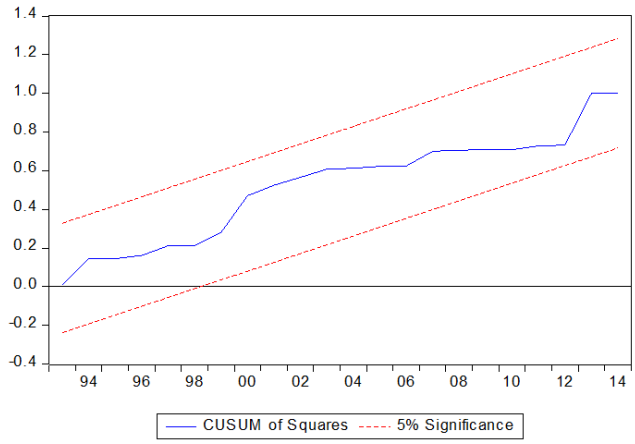

Figure 4. *The cumulative sum of recursive of residuals.*

5. Conclusion

This study estimats determinants of money supply 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. This test 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 [17] 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 and shor run model using annual data covering period 1980-2016. The empirical analysis found that, growth Real GDP and real government spending have positive and statistically significant effects on real money supply in the long run and short run. While exchange rate, real domestic investment, inflation, and foreign direct investment have positive and statistically insignificant effects on real money supply in the long run and short run. Also the results showed that real exports have negative and statistically significant effects on real money supply just in the long run, while cost of finance has negative and statistically insignificant effects on real money supply in the long run and short run. Growth Real GDP, real government spending, exports and lag of money supply were found as important determinants of money supply. This suggests that all variables are becoming important and effective policy to achieve stable money supply. 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 99% 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.

6. Recommendations

Based on results discussed above, this study has some recommendations. First, the government should employ a stable monetary policy so as to encourage financial integration with all sectors of the economy that will enhance positive outcome to the country. Second, Sudan government should channel her increase money supply in productive sectors and not on government expenditures. Because with massive production the country will export and increase the strength of her domestic currency, create employment opportunities, reduce imported inflation and above all promote economic growth and development.

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