

Research Article

Real Effective Exchange Rate in Sudan Measurement and Trend Analysis (1975-2017)

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Abstract: The study aims to measure, estimate of the real effective exchange rate (REER) in Sudan during (1975-2017) and analysis of trend of its relation with the explanatory variables. The independents variables includes; Degree of openness (DOP), relative productivity differentials (Prod/GDP), capital inflows in terms of loans and grants (KF/GDP), government expenditure (GE/GDP), terms of trade(TOT), inflation rate (INF) and the dummy variable refers to the civil war up to separate South Sudan (DUM 1985-2011). Annual data were collected from annual reports of Central Bank of Sudan (CBOS) and was used to apply the Ordinary Least of Square Method. The empirical results shows that set of explanatory variables except (KF/GDP) has significant influence on REER but with different directions. The study recommends that, the government should follow a policy of encouraging exports and attract foreign direct investment to increase capital inflows. Also the CBOS should adopt contractionary monetary policy to control inflation.

Keywords: Sudan; REER; Real Effective Exchange Rate; Measurement; Trend Analysis.

1. Introduction

The exchange rate is now recognized to be a decisive link between the internal economy of a country and the international economy. Given the very limited flexibility of internal prices, the nominal exchange rate is the key determination of the real exchange rate RER in the short and medium term. RERs are in turn of key importance in determining macroeconomic stability and the incentive to engage in trade. The exchange rate policy influence examination on the RER of an economy is sensitive to the type of objective policy and RER index selected. For example, if the objective is to measure the impact of capital inflows on the economy as well as the international competitiveness of the home country, then the trade weighted consumer price index (CPI) based index is more appropriate. This is mainly due to the fact that capital inflows are assumed to be distributed between the tradable and the non-tradable sector of the receiving economy and will affect the relative prices of tradable and non-tradable, and thereby impact on the real effective exchange rate (REER) of the home country. Also, if a study depending on export competitiveness, import competitiveness or total international competitiveness, the uses of export weighted, import weighted or total trade weighted will be valid.

This study will estimate the (REER) using a number of indexes for Sudan. REER is defined as the measure of nominal effective exchange rate (NEER) adjusted for (CPI) differentials between the home country (Sudan) and its trading partners.

2. The Problem Of The Research

The estimation of REER requires uses of all official, nominal, real exchange rates and in addition to consumer price index of both home country (Sudan) and trade partners. Therefore the problem of the research is to how to empirically estimate the model of REER in Sudan?

3. Objectives Of The Study:

The main objective of the study is to estimate the simple regression model of REER in Sudan during 1975-2017 in addition to the following sub-objectives:

- To analysis the trend of REER with its determinants.
- To review and assess the exchange rate policies in Sudan.

Quick Response Code



Journal homepage:

<http://www.easpublisher.com/easiebm/>

Article History

Received: 10.03.2019

Accepted: 25.03.2019

Published: 12.04.2019

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DOI: 10.36349/easiebm.2019.v02i04.006

4. The Research Hypotheses:

In particular, the study aims to answer and examine the following hypotheses:

- Do the foreign exchange policies enhance the foreign exchange rate?
- There is a significant relationship between REER and set of explanatory power includes; Degree of openness, relative productivity differentials, capital inflows, government expenditure, terms of trade, inflation rate and the civil war factor.

5. The Research Methodology:

The descriptive - analytical approach and econometric techniques will use to estimate the regression model of REER in Sudan during (1975-2017). Data will collect from the annual reports of the Central Bank of Sudan. The Unit Root Test will used to examine whether the variables are stationary or not. Ordinary Least Square method will apply.

6. Literature Review

There is relatively little theoretical or empirical research looking at measurement and trend analysis of REER.

Edwards (1989) developed a theoretical model of real exchange rate behaviour and devised an empirical equation of how to estimate the real exchange rate dynamics. According to him, the long-run equilibrium real exchange rate is affected by real variables only that can be classified as internal and external fundamentals. In the short-run however, the real exchange rate (RER) may be affected by both real and nominal factors. The important fundamentals that determine the real exchange rate are the terms of trade, level and composition of government consumption, controls on capital inflows, trade exchange, technological progress and capital accumulation. In his study he empirically tested the model by using pooled data for a group of twelve developing countries and analyzed the relative importance of real and nominal variables in the process of real exchange rate determination in the short-run and long-run. The study found that in the short-run, RER movements are affected by both real and nominal factors. In the long-run however, only real factors affect the sustainable equilibrium real exchange rate. His conclusion was that the countries whose RERs were closer to equilibrium out-performed those with misaligned RERs.

Baffes and Elbadawi (1997) are examined empirically how to estimate a single-equation of the equilibrium RER for Cote d'Ivoire and Burkina Faso. Baffes pointed out that the standard theory of equilibrium RER indicating that the level of exchange rate is a function of observable macroeconomic variables and that the actual RER approaches the

equilibrium rate over time. A recent strand of the empirical literature exploits these observations to develop a single-equation approach to estimate the equilibrium real exchange rate. The study outlined an econometric methodology for estimating both the equilibrium real exchange rate and the degree of exchange-rate misalignment.

Opoku (2004) estimated the (REER) by using a number of indices for Ghana. He defined REER as the measure of nominal exchange rates adjusted for price differentials between the home country (Ghana) and its trading partners. The study found that the choice of price indexes matters. Ghana seems highly competitive more recently based on the GDP-deflator index but much less so when the CPI index is used in the computation of the RER.

Abdel-Nabi *et al.*, (2005) investigated empirically the exchange rate determinants for Sudan during the period 1982-2004 using Ordinary Least Squares method. The study ignored time series unit root tests as well as conventional cointegration tests. The main findings of the study are as follows (i) there is a positive relation between exchange rate as dependent variable and GDP; (ii) deterioration of terms of trade has contributed to depreciation of the real exchange rate.; (iii) there is a negative relation between exchange rate and trade openness; (iv) there is a strong inverse relation between change in exchange rate and the level of inflation rate.

Ebaidalla (2017): discussed the determinants of parallel market for foreign exchange rate in Sudan and explained its impact on macroeconomic performance.

Although, a growing body of research has discussed the methodologies of estimation of nominal and RER regionally or globally, however, this study focuses on estimation the REER in Sudan particularly.

7. Trend of Exchange Rate in Sudan 1975-2017: An Overview

Right through the last decades, a number of exchange rate policies have been adopted in Sudan including; fixed, floating and dual exchange rate regimes. For instance 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 Sept 1979 the monetary authority shifted from the fixed exchange rate regime to floating system, with the support of International Monetary Fund (IMF) and World Bank's structural adjustment programs (Ebaidalla, 2016). In view of that, the local currency underwent a significant devaluation to the rate of about 3 Sudanese pounds per US. The key objective of this policy was to reduce the external imbalances through encouraging exports, and attracting remittances of Sudanese nationals working out of the country.

For the duration of 1980s, exchange rate in Sudan has experienced a sequence of devaluations. It is worth mentioning that over 1980s the country has witnessed many factors that affecting economic performance, such as, drought and famines in 1984-1985 and the eruption of the second civil war in 1983 (Ebaidalla, 2014). The country, therefore, suffered from a severe lack of foreign reserves and relied largely on foreign aid in financing development projects. Accordingly, the exchange rate has devalued sharply for the period of 1980s, reaching an official rate of one dollar to 8 pounds in 1989, while the black market exchange rate set at more than LS20/US\$ in the same year (Central Bank of Sudan, 2009).

At the beginning of 1990s, Sudan economy witnessed several transformations, especially the transition from the state control policies that characterized the period of 1970s and 1980s to free market policies (Ebaidalla, 2014). In such period, the exchange rate has received great attentions from policy makers, as it was believed to be a core factor affecting the economic instability. Thus, the government launched the economic recovery program in early 1990, which prohibited the black market exchange rate and considered it as an illegal practice and strict punishments have been adopted to obstruct illegitimate exchange transactions. Therefore, all foreign exchange transactions were confined to the licensed commercial banks. However, despite these policies, the exchange rate reported higher rate in the early 1990s compared to the 1980s. Subsequently, in 1992 the government unified the exchange rate market.

Nevertheless, due to the drastic depreciation of local currency and sustainable increase in inflation rate, the floating system was abandoned by the end of 1993 and replaced by the dual exchange system. After that, the exchange rate experienced continuous devaluations, as the official rate reached LS300/\$ and LS430/\$ in 1994 and 1995, respectively (Central Bank of Sudan, 2009).

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. 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.

The period 1997-1998 has been characterized by relative stability of the exchange rate, due to the implementation of policies of economic liberalization; those policies are represented in abolition of determination of exchange rate by the CBOS. Commercial banks determine exchange rate based on the forces of demand and supply and the CBOS calculates a weighted average exchange rate for commercial banks. But in 1999, CBOS introduced a

mechanism to intervene in the foreign exchange market by buying (selling) foreign currencies from (to) the banks and exchange companies across foreign exchange dealing room to meet customer's requests related to import. The major developments that occurred during the period 2000-2001 in relation to the foreign exchange market are abolition of restrictions on the foreign exchange dealings and liberalization of exchange market. Exchange rate during the period 1998-2001 was characterized by the resumption of Sudan's relationship with the (IMF), and it's a partial relationship, without financial grants from the Fund. Under the program, which was agreed upon, CBOS adopted creeping exchange-rate. The most important feature of this system, the level of exchange rate became determined by the State in order to reduce the value of domestic currency weekly or daily depending on what would need to be. In addition to being a means of adjusting the exchange rate and includes nominal value greater than the true value, and it ranges in certain limits. The nominal value is adjusted according to the procedures established by the authorities (Abd-Elnabi, 2005). Thus, the exchange rate saw substantial stability with a limit rate of SDG 2.57-2.61 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).

During the period 2002-2004, CBOS followed managed floating exchange rate system by targeting the money supply to achieve a positive growth rate of gross domestic product (GDP) and stability of the general level of prices according to the economic program which has been agreed upon with IMF. The exchange rate became part of tools used in the management of liquidity.

Foreign exchange policies in 2002 aimed to maintain exchange rate stable and expand the liberalization policy of foreign exchange dealings. In addition to adjustment, the margin of indicative exchange rate, which advertised by the Central Bank of Sudan in the range of 1% to 2%, depending on the requirements of foreign exchange market.

In 2003, CBOS has focused on strengthening foreign exchange resources in the banking system through provision of sale of foreign exchange via the window of the Central Bank, beside take necessary arrangements for the management of foreign exchange reserve, inventory and registration of foreign capital invested.

Although the period 2000-2004 has been characterized by relative stability in the level of exchange rate, but in practice there were several patterns of the exchange rate, which can be summarized as follows:

- Exchange rate of Central Bank (Official rate): this rate is used to settlement of transactions relating to the CBOS.
 - Exchange rate of commercial banks: these rates are determined by commercial banks, according to the guidance of the CBOS.
 - Indicative exchange rate: this rate is calculated by CBOS, according to the reality of transactions which carried out in the foreign exchange market through banks, exchange companies and between exporters and importers.
 - Exchange rates of exchange companies: these rates are determined based on indicators of exchange market, exchange rates in each of the commercial banks and CBOS.
 - Exchange rates of parallel market: these rates are the best choice for sellers of foreign exchange, and it is considered an important channel for demand side, because, the buyers could obtain their needs of foreign exchange without restrictions or formal procedures (Abd-Elnabi, Ibid).
- Maintaining stability of foreign exchange market.
 - Activating the inter-bank market.
 - Gradual implementation for the action plan to switch from using the US dollars, as the main currency for the external dealings, to the Euro or any other stable currencies.
 - Encouraging the Commercial Banks to exert efforts in mobilizing foreign exchange resources instead of relying considerably on CBOS.
 - It's not permissible to present and accept locally issued financial papers as guarantees for any external finance or as mortgage in favour of non-residents (CBOS, Annual reports 2008).

During the period 2005-2006, based on the study which prepared by CBOS and IMF, Sudanese diner exchange rate against the U.S. dollar has appreciated from 250.6 to 240 by the end of September 2005. Also notes that the managed floating exchange rate system was used as a system of exchange rate, but according to market mechanisms .In the year 2006, CBOS has continued to implement of managed floating exchange rate system. In addition to activating the foreign exchange market according to economic conditions (CBOS, Statistic Directorate).

During the period 2007-2008, CBOS has managed to pursue the followings:

- Continuation of maintaining the stability and flexibility of exchange rate.
- Continuation of managing the foreign reserve in accordance with priorities of soundness of the reserves usages, adequacy of liquidity for meeting the needs of the economy and lucrative return on reserves investments.
- Working robustly to pegging the exchange rate of the Sudanese pound to a basket of major foreign currencies.

In the Area of foreign exchange market, CBOS has pursued policies aimed towards achieving the following:-

During the period 2008-2010, the exchange rate saw many fluctuations due to the drop in oil prices as a result of the global financial crisis of 2008-2009. The decline in the inflow of foreign currency that followed led to another split in exchange markets into official and black. Moreover, in the aftermath of the secession of South Sudan in 2011, Sudan has suffered from many economic challenges owing to the sudden loss of oil revenues. As a result, the exchange rate depreciated rapidly, leading to increase in the black market premium. In response to such situation, the authorities adopted a number of exchange rate devaluation measures in recent years, which result in high parallel exchange rate premium (Ebaidalla, 2017).

The foreign exchange policies for the year 2010, focused basically on regulating and developing the foreign exchange market for the purpose of achieving the following:

- A stable and flexible exchange rate.
- Building reserve of foreign exchange currencies.
- Management the reserve in a manner that assists stability of the foreign exchange market.

In the year 2013 the CBOS exerted substantial efforts to maintain the stability of the exchange rate and the external credibility of the Sudanese banking system. Towards this end, the CBOS policies aimed at building sizeable foreign reserves to meet the respective external commitments. In this context, the CBOS continued to adopt the managed-float exchange rate regime by means of regular interventions –when necessary-in the foreign exchange markets in order to reflect the real value of the exchange rate. Accordingly, the domestic

exchange rate was devaluated from SDG 4.4 vis-à-vis US dollar to 5.7 SDG in September 2013, as part of the economic reform undertaken by the government (CBOS, 2013).

The CBOS resorted to devalue the national currency to reflect the real value of the Sudanese pound (Gueniah) to achieve a unified and stable price determined by supply and demand forces in the foreign exchange market. By the end of the year 2014, the national currency was devalued by 6%.

CBOS has taken a number of measures aiming to achieve relative stability in the exchange rate and bridge the gap between the official exchange rate and the parallel exchange rate in the 2015, the measures adopted include: regulating foreign exchange resources, reorganizing foreign exchange accounts of local and foreign entities to attract foreign organizations resources to the official market, in addition to obliging foreigners to pay the value of hotel services and other tourism activities in foreign currency.

In the context of encouraging exports, CBOS continued simplifying and easing procedures of exports, and allowing the “Nil –Value” importation for the inputs of agricultural and industrial sectors in order to encourage investment and minimize the demand for foreign exchange (Central Bank of Sudan, 2015).

In the years 2016-2017, The CBOS policies for the year 2016 were aligned with the government budget guidelines for the year 2016 and the Five-Year Economic Program (2015-2019) in its second year, aiming at stabilization of the economy, increasing production and productivity by curbing inflation and reducing balance of payments disequilibrium. Beside that the policies also aimed at stabilizing the exchange rate through organizing the foreign exchange market, as well as the creation of suitable environment to stabilize the financial system by launching the financial inclusion and financial deepening throughout the Sudan which will help in attracting deposits and improving the efficiency of allocating resources to finance the productive sector.

The policies and measures have been taken led to relative stability in the exchange rate in 2016. The gap between the official and the parallel market rates narrowed to an average of 5% in December 2016. The Central Bank of Sudan has taken a number of measures to reduce the gap between supply and demand of foreign exchange (Central Bank of Sudan, 2015).

Generally, exchange rate in Sudan during 1975-2017 has experienced a series of devaluation since 1979, which in turn lead to widen the gap between official and parallel exchange rate. Appendix (I) shows that the official exchange rate reported a positive trend

with a slight increase during the period 1975-1991, but did not exceed SDG 0.135/US\$.

After the free market policies of 1992 and up to the mid of 1997s, the exchange rate depreciated dramatically to about SDG1.7/US\$ in 1997. However, during the period of the managed floating exchange rate regime and oil exploitation (1998-2007), exchange rate was stable at the rate of 2.5SDG/US\$ on average and then decreased subsequently to about SDG2.21/US\$ in 2008. After the separation of South Sudan in 2011 official exchange rate has seen a considerable devaluation owing to the lost of oil revenues and instability of economic situations about SDG21.6/US\$ in 2017.

8. Theoretical Framework And Methodology

4.1 Measuring Real Exchange Rate (RER)

In this framework the relative domestic price of nontraded to traded goods within the country is the RER. It is the relative price that achieves internal balance in the domestic supply and demand of nontraded and traded goods and captures the internal relative price incentives in an economy for producing or consuming tradable¹ or nontradable goods (Beatrice, 2001). This measure has particular appeal in the low-income country (LICs) context and has been widely used in empirical RER studies like those of Edwards (1989), Elbadawi (1994).

In principle, the domestic price indices of tradable and nontradables should be used to construct the internal RER, but these series are typically not available in LICs. In practice, the internal RER is measured using the foreign Wholesale Price Index (WPI) and the domestic Consumer Price Index (CPI). The foreign WPI multiplied by the nominal exchange rate proxies the home country's tradable goods price, while the domestic CPI is a proxy for non-tradable prices in the home economy.

1 Tradable goods are those that have export or import potential. The possibility of their being traded abroad sets up a continuous comparison between their price and that of their overseas competitors, verifying that no barriers exist to the substitution of one product for another. Some goods are non-tradable, either because of their nature or due to high transportation costs per product unit, high tariffs or other restrictions. Examples of internationally non-tradable goods may be found in the sectors of housing, electricity generation, transport, educational services, and personal services. World Bank estimates (World Development Report, 1991) of the proportion of non-tradable goods in the GDP of certain countries in 1990 included: retail and wholesale trade; transport and communications; insurance services, property and commercial brokerage; personal, social and community services; public administration; security and defense.

A key drawback in using the (CPI) as a proxy for nontradables prices is that the greater the weight of traded goods in the CPI implies a greater divergence in the proxy to non-traded goods prices. An important drawback in using foreign (WPI) is that it is unlikely to

track fluctuations in a (LIC's) exports price, especially commodity prices. It may, however, do better tracking of import prices and nontraditional exports.

Li and Ying (2007), illustrated that, one alternative is to calculate a domestic tradable price index by taking a weighted average of the foreign price of importable (PMd) and exportable (PXd) multiplied by the nominal exchange rate as in equation below.

$$RER = Edc \cdot [PMd]^\alpha \cdot [PXd]^{(1-\alpha)} PNd$$

Where:

- RER is Real Exchange Rate
- Edc is units of domestic currency per unit of foreign currency.
- PMd and PXd are price indices of importables and exportables respectively.
- PNd is domestic nontradables price index.
- α is the share of importables in total tradable .

The concept of RER that has been most heavily used in analyses of external adjustment by developing countries is the domestic relative price of traded to nontraded goods

$$RER = e = \frac{EP^*T}{PN} \tag{1}$$

Where:

- P^*T : Foreign price of traded goods
- PN : Domestic price of nontraded goods

Although the foreign price of traded goods, P^*T , is exogenous for a small country, the domestic price of nontraded goods, PN , is endogenous except over short periods of wage/price rigidity. The RER is therefore endogenous even under a predetermined nominal exchange rate.

The literature defines the long-run equilibrium RER as the rate that prevails when the economy is in internal and external balance (IB, EB) for sustainable values of policy and exogenous variables (Baffes and Elbadawi, 1997).

Internal balance holds when the markets for labor and nontraded goods clear. This occurs when

$$yN (e) = CN + gN = (1-\theta)ec + gN, \quad yN < 0. \tag{2}$$

where yN is the supply of nontraded goods under full employment, c is total private spending (measured in traded goods), ec is real exchange rate multiplied by total private spending, θ is the share of this spending devoted to traded goods, and gN is government spending on nontraded goods. Equation (2) is shown as the IB, arise in private spending creates an

excess demand for nontraded goods at the original RER. Restoration of equilibrium requires a real appreciation that switches supply towards nontraded goods and demand towards traded goods. Rise in government spending on nontraded goods shifts the IB schedule downwards.

To define external balance, we begin with the current account surplus, which is given by

$$f' = b + z + r f = yT(e) - gT - (\theta + \tau)c + z + r f \tag{3}$$

Where f is total net foreign assets, b is the trade balance, z is net foreign aid received by the government, and r is the real yield on foreign assets, measured in traded goods. The trade balance is the difference between domestic production of traded goods, yT and the sum of government (gT) and private spending on these goods. The equation is standard except for the term τ which measures the transactions

costs associated with private spending. Theoretical models such as Montiel (1986) used these costs to motivate the holding of domestic money, which would otherwise be dominated in rate of return by foreign assets. They are assumed to be incurred in the form of traded goods (at the rate r per unit of spending) and therefore appear as an outflow in the trade balance.

We can solve for the combinations of private spending and the real exchange rate that are consistent with this notion of external balance by holding f at its

steady-state level and setting the right-hand side of equation (3) to zero. This traces out a second relationship between the RER and private spending.

The equilibrium RER, e^* , is given by Setting the right-hand-side of equation (3) to zero and combining this with equation (2), we obtain

$$e^* = e^*(gN, gT, r^*f^* + z, \tau^*), \quad e1 < 0, e2 > 0, e3 < 0, e4 > 0. \quad (4)$$

Where:

"*" superscripts denote steady-state values of endogenous variables. The signs of the partial derivatives in (4) are easily verified either graphically or algebraically using equations (2) and (3).

The final expression for the equilibrium real exchange rate in the *Montiel Model* takes the form:

$$e^* = e^*(gN, gT, Z, rW, \pi T), \quad e1 < 0, e2 > 0, e3 < 0, e5 > 0. \quad (5)$$

Where: rW is the world real interest rate and πT is the rate of inflation in the domestic price of traded goods. Note that the nominal exchange rate does not appear among the fundamentals in equation (5). This means that the underlying behavioural relationships are all homogenous of degree zero in nominal variables. A nominal devaluation therefore has at most a transitory effect on the real exchange rate.

Equation (5) emphasizes that the real exchange rate consistent with internal and external balance is a function of a set of exogenous and policy variables. In practical applications, this relationship between e^* and its macroeconomic "fundamentals" differentiates the modern approach to equilibrium real exchange rates from the earlier Purchasing Power Parity (PPP) approach.

The analysis underlying equation (5) can readily be modified to accommodate features that are important in particular applications. Important extensions could involve rationing of foreign credit, changes in the domestic relative price of traded goods, and short-run rigidities in domestic wages and prices. **Shifting to** rationing of foreign credit, equation (6) is derived under the assumption that the country faces an upward-sloping supply curve of external loans. The current account and trade balance are therefore endogenously determined at each moment by the saving and portfolio decisions of households. An extreme version of this view, more relevant for countries without access to commercial international borrowing on the margin, is that the country faces a binding credit ceiling (or equivalently, a floor on its international net creditor position). In this case, the trade surplus becomes exogenous, both in the short run and in the long run, provided that the credit ceiling remains binding. Equation (4) then takes the simpler form:

$$e^* = e^*(gN, gT, b, \tau^*) \quad e1 < 0, e2 > 0, e3 < 0, e4 > 0. \quad (6)$$

In equation (6), we treat the trade surplus $b = r f + z$

Where: b is trade balance, r is the real yield on foreign assets, f is total net foreign assets and z is transactions costs associated with private spending.

To estimate the terms of trade and trade policy, we start with the domestic relative price of exports and imports is given by

$$\frac{Px}{PM} = \frac{\theta}{\eta}, \quad \theta = \frac{P^*x}{P^*M}, \quad \eta = \frac{1+tM}{1-tx} \quad (7)$$

Where: Px is export prices, PM is import prices, θ is the external terms of trade and η is a parameter summarizing the stance of domestic trade policy. If either θ or η change over time, the analysis must be disaggregated to accommodate different real exchange rates for imports and exports. The equilibrium RER for imports and exports can then be written as

functions of the set of fundamentals identified above, along with θ and η . Since the RER for tradable is itself a function of these two, it will depend on the same set of fundamentals, with elasticities depending on the relative weight (α) of imported goods in the tradables price index. Equation (6) then becomes

$$e^* = e^*(gN, gT, b, \theta, \eta, \tau^*), \quad e1, e3, e5, <0; e2, e6 > 0; e \theta \quad (8)$$

An improvement in the *terms of trade* increases national income measured in imported goods; this exerts a pure spending effect that raises the demand for all goods and appreciates the real exchange rate. This effect can be overcome by substitution effects on the demand and supply sides, leading to an overall real depreciation, but the spending effect has proved dominant in most empirical applications. A tightening of trade policy, appreciates the real exchange rate in the long run. (Baffes and Ebadawi, 1997)

4.2 Shifting from (RER) to Real Effective Exchange Rate (REER):

Acknowledging the existence of different definitions of REER in the literature, we define REER as the product of the nominal effective exchange rate NEER and the effective relative price indices in this instance the weighted CPI of trading partners and the CPI for the home country. This is defined in domestic currency terms as:

$$REER = (NEER) (P^* / P)$$

Where:

REER: Real Effective Exchange Rate.

NEER: Nominal Effective Exchange Rate.

P*: The total weighted Consumer price index of the trading partners representing the price of non-tradable goods.

P: The Consumer Price Index (CPI) of the domestic country a proxy for price of non-tradable.

The **NEER** denotes the nominal effective exchange rate for the home country with respect to partners. This is defined as an index reflecting movements in the nominal exchange rate between a home country and trading partners, adjusted for by the respective

weight of the trading partner. Like the **REER**, the **NEER** is also a measure of the multilateral nominal exchange rates. The nominal effective exchange rate is defined in domestic currency terms as:

$$NEER = W * E$$

Where:

W: The appropriate total trade weight for trading partners.

E: The period average nominal exchange rate between the home country and trading partners.

The trading partner weights are defined to allow for time variation in the weights and so that weights sum to unity. For total trade we have:

$$W = (X + M) \text{ for trade partner} / \Sigma(X + M) \text{ for a home country total trade}$$

Where:

W: Trading partner weights

(X + M): Trade partner with a home country

Σ(X + M): A home country total trade with all trading partners. All trading partners, total imports of the domestic country from all trading partners and total trade between the domestic country and all the trading partners respectively.

Similarly, X_t , M_t and $X_t + M_t$ represent exports to trading partner i by the domestic country, imports from trading partner i by the domestic country and total trade between trading partner i and domestic country respectively. The subscript t represents the time period in all definitions (Opoku, 2004).

Real Effective Exchange Rate Index (REERI):

REERI is measured as the nominal effective exchange rate (NEER) multiplied by the ratio of foreign

consumer prices index of trading partners representing the non-tradables goods to the CPI of the domestic country a proxy for price of non-tradables goods.

To estimate the degree of real exchange rate mis-alignment based on the theoretical model of REER determinations developed by *Edwards* (1989), *Elbadawi* (1994), *Baffes* and *Elbadawi* (1997) and *Beatrice* (2001), the reduced form of REERI equation is presented as follows:

$$\text{REERI} = f(\text{trop}, \text{tot}, \text{govc}, \text{rigdp}, \text{remg}, \text{capinf}, \text{tfpd}/t)$$

(+/-) (+/-) (+/-) (-) (+) (-) (+)

The variables included in the analysis are: real effective exchange rate index (**REERI**), trade openness (**trop**), terms of trade (**tot**), real investment to GDP ratio (**rigdp**), government consumption as percent of GDP (**govc**), workers' remittances as percent of GDP (**remg**), long-term capital to gross domestic product (**capinf**) and total factor productivity differentials (**tfpd**) or time trend (**t**) representing **Harrod-Balassa Samuelson effect**.

Theoretical models and empirical studies such as *Elbadwai* (1994), *Edwards* (1989) and *Baffes* and *Elbadawi* (1997) have proposed and ascertained the following signs for each fundamental variable in determining the behavior of REER:

An increase in trade openness (**trop**) depreciates REER because trade liberalization and trade opening makes future consumption of importable very cheap; this in turn induce consumers to substitute from non-tradable to tradable goods.

The impact of terms of trade (**tot**) on REER is theoretically ambiguous and can take either sign depending on the substitution and income effect. More specifically, the worsening of trade terms has a positive substitution effect on **REER** due to increase in import prices. On the other hand, the terms of trade worsening will also have a negative effect on REER, which in turn may lead to downward pressures on the prices of all goods. If the substitution effect dominates income effect, then the impact of terms of trade deterioration will be negative, otherwise it will be positive.

Similarly, the impact of government consumption (**govc**) on REER depends not only on government inter-temporal budget constraints but also on the composition of government consumption. If government consumption contains a larger share of non tradable goods then the increase in government consumption will worsen the current account thus leading to depreciation of REER.

The sign of (**rigdp**) would be negative as the rise in **rigdp** means higher spending on tradable (imported machinery and raw materials). However, as described by *Elbadwai* (1994), when investment is included in the theoretical model, the inter-temporal analysis includes supply-side effects that depend on the relative ordering of factor intensities across sectors. Therefore, the sign on the exchange rate in response to increased investment is ambiguous.

The sign of workers' remittance to GDP ratio (**remg**) on real exchange rate is positive which reflects that the rise in workers' remittance to GDP ratio, **remg**, lead to appreciation of real exchange rate (RER).

As far as the impact of net capital inflows (**capinf**) on REER is concerned, it depends on the magnitude of capital flows. The capital inflows over and above the current account deficit will appreciate REER while the capital inflows matching or lower than the current account will depreciate REER. (*Baffes* and *Elbadawi*,1997) also justified the negative sign of capital inflows on the basis of its associated increases in domestic absorption particularly in non-tradable. When net capital inflows exceed debt-services obligations, then the real exchange rate may appreciate as in the case of large foreign direct investment flows.

The inclusion of the Total Factors Productivity Differentials (**tfpd**) or time trend (**t**) in REER equation represents well-known Balassa-Samuelson Effect, which contends that productivity improvements will be, generally, concentrated in the tradable sector and thus lead to an appreciation. (Hyder, 2006).

9. Empirical Analysis And Conclusions:

In this study the estimated equation of REERI is defined as:

$$\text{REERI} = \beta_0 + \beta_1 \text{DOP} + \beta_2 (\text{Prod} / \text{GDP}) + \beta_3 (\text{KF} / \text{GDP}) + \beta_4 (\text{GE} / \text{GDP}) + \beta_5 (\text{INF}) + \beta_6 (\text{TOT}) + \beta_7 \text{DUM} 1985-2011 + \varepsilon$$

where:

REERI is the real effective exchange rate index .The following formula is used to calculate REERI² in Sudan during the period (1975-2017):

REERI = (REER in current year / REER in base year)*100 , **DOP** is (**Degree of Openness**) a measure of trade liberalization and a proxied by the ratio of exports plus imports to Sudan's **GDP**, (**Prod/GDP**) is the relative productivity differentials³ , measured as ratio of per capita income to real **GDP** , (**KF/GDP**) is the net capital inflows including loans and grants measured as percentage of **GDP** , (**GE/GDP**) is the government expenditure measured as percentage of **GDP** , (**INF**) is the inflation rate ,(TOT) is the terms of trade measured as ratio of value of total exports to value

² Appendix A : Calculation of REERI for Sudan (1975-2017).

³ There are a number of measures that proxy relative productivity:(1) relative productivity within a country .(2) relative productivity between more than one country .But due to data limitations of all trade partners with Sudan we will use the difference in ratio per capita income to GDP through the time in Sudan.

of total imports in Sudan , **DUM** 1985-2011 is the dummy variable refers to the civil war up to separate South Sudan in 2011 and ϵ is the error term. In our model the **REERI** is the dependent variable and other factors are explanatory power.

5.1 Stationarity Test Results: The Unit Root Method:

The Unit Root Test has been applied to examine whether the variables are stationary or not. The test carried out through Dicky-Fuller (DF) and the Augmented Dicky-Fuller (ADF) methods as suggested by Engel and Granger. The (ADF) analysis carried at both level and difference. The null hypothesis in ADF test is that there is presence of unit root.

To apply these unit root tests, consider the following equation.

$$Y_t = a + \rho Y_{t-1} + U_t$$

The time series Y is considered stationary if ρ lies between -1 and 1. On the other hand, if ρ equals to or greater than one then the series is non-stationary, hence explosive. This means that a stationary time series must have ρ value of less than one. The null hypothesis of unit root test is that the series has a unit root. Symbolically,

$$H_0: \rho = 1$$

Alternatively, the unit root test measure involves the following process.

$$D(Y_t) = a + \delta Y_{t-1} + U_t$$

Where:

$$\delta = \rho - 1$$

D = the difference operator.

In this instance, the null hypothesis is that the δ has zero value. Symbolically,

$$H_0: \delta = 0$$

If ρ carries the value of 1, δ will be zero and if ρ is greater than 1, then δ will have a value greater than zero. In the latter case, the series is explosive. It is clear that a series to be stationary, ρ value should not exceed one. It follows that the coefficient of δ must be negative with the corresponding negative DF t-statistic (Bahadur, 2001).

Before estimating the model, augmented Dickey-Fuller (ADF) tests are calculated to give a first indication of the order of integration of each of the time series.

Results of (ADF) test are reported in table (1) indicating that all the variables included in the model were not stationary at level. That can be seen through comparing the critical value with the ADF value, when the critical value is greater that ADF value meaning that the variable is not stationary. However, when the critical value of the variables is less than the ADF value the variable is stationary. Another criterion for the stationary test is that the p-value of the variables under investigation should be less than 5%. The result showed that all the variables includes (REERI),(DOP),(Prod/GDP), (KF/GDP),(GE/GDP), (INF) and (TOT) are not stationary at level, but these entire variables except (REERI) are stationary at 1st difference I (1) of 5% MacKinnon critical value and that meaning that the critical value of the variables is less that ADF value. This implies that the ADF test suggested that all variables are integrated at first difference or order I (1).

Table 1. The Unit Root Test - Augmented Dickey Fuller Method

Variables	t-Statistic Level Data	t-Statistic 1st diff.	t-Statistic 2 nd diff	5% cri. Value Level Data	5% cri. Value 1st diff.	5% cri. Value 2 nd diff	P-value at Level	P-value at 1st	P-value at 2 nd diff	Status
REERI	6.862266	3.245890	-5.485794	-2.933158	-2.941145	-2.936942	1.0000	1.0000	0.0000	I(2)
DOP	-3.500743	-8.368898	-	-2.936942	-2.935001	-	0.0131	0.0000	-	I(1)
Prod/GDP	-3.126790	-8.010786	-	-2.935001	-2.935001	-	0.0323	0.0000	-	I(1)
KF/GDP	-3.632852	-8.890978	-	-2.933158	-2.935001	-	0.0091	0.0000	-	I(1)
GE/GDP	-3.85671	-6.723994	-	-2.933158	-2.936942	-	0.0050	0.0000	-	I(1)
INF	-1.637556	-6.722278	-	-2.933158	-2.935001	-	0.4549	0.0000	-	I(1)
TOT	-2.877333	-7.854733	-	-2.933158	-2.935001	-	0.0566	0.0000	-	I(1)

Source: Own Calculation

5.2 Model Estimation Results:

The main purpose of estimating the model is to explain the direction of the relations between the REER and its fundamentals. Also to show and analyze the trend of the variables. Table (2) represents the results of the regression model.

Table 2 Results of the Regression Model

Dependent Variable: D(REERI (-1),2)				
Method: Least Squares				
Date: 03/16/19 Time: 19:18				
Sample (adjusted): 1978 2017				
Included observations: 40 after adjustments				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	23.32586	1.171293	19.91463	0.0000
D(DOP (-1))	2.379029	0.616411	3.859487	0.0005
D(Prod/GDP(-1))	1.96E+08	7500243.	26.12915	0.0000
D(KF/GDP(-1))	-0.077970	0.202337	-0.385345	0.7025
D(GE/GDP (-1))	-6.103119	1.289134	-4.734278	0.0000
D(INF (-1))	-2.513311	0.370396	-6.785477	0.0000
D(TOT (-1))	-2.539203	0.220625	-11.50914	0.0000
DUMMY1985-2011	-4.617476	1.148906	-4.019021	0.0003
R-squared	0.985822	Mean dependent var	8.587634	
Adjusted R-squared	0.982721	S.D. dependent var	12.23013	
S.E. of regression	1.607655	Akaike criterion	info 3.964287	
Sum squared resid	82.70578	Schwarz criterion	4.302063	
Log likelihood	-71.28574	F-statistic	317.8639	
Durbin-Watson stat	1.077004	Prob(F-statistic)	0.000000	

Source: Own Calculation

5.2.1 Dissection of the Regression Results:

The results show that the fundamentals on REER are generally higher in their values except (KF/GDP). The explanatory variables have different direction with a different degree of influence in their relations to the REER.

All the coefficients have appropriate signs and consistent with economic theory. The set of explanatory variables have probability less than (0.05) except KF/GDP (0.70).

Adjusted R- Squared is high; this means that the explanatory variables explain about 82% of total changes in REERI.

The total test of regression is significant because, F- statistic have value of (317.8) with probability (0.0000).

The coefficient of openness (**DOP**) appearing with a positive sign indicates that trade liberalization and increased openness of the Sudanese economy to the world would lead to appreciation of the currency, because trade liberalization and trade opening makes

future consumption of importable not very cheap; this in turn induce consumers to substitute from tradable to non-tradable goods .

The estimated elasticity of **REERI** to changes in relative productivity differentials (**Prod/GDP**) is elastic; because the elasticity coefficient is more than one (1.96E+08). Analysis of this result is based on **Balassa-Samuelson Effect** .Within a country, an increase in productivity in the traded goods sector will lead to an increase in wages in both the tradable and non-tradable sectors. Consequently, there is an increase in nontradables prices and an appreciation of the REER.

The estimated parameter of capital flow ratio (**KF/GDP**) appeared with a negative sign, this suggests that a one percent reduction in the ratio of capital flow would probably lead to depreciation of the REER by (0.1) percent, because, the decrease of: foreign reserve, foreign direct investment, aid and grants lead to reducing the quantities supplied of foreign currencies. This implies that more should be paid to obtain one unit of foreign currency. The result is a depreciating REER for the country with the lower capital inflows.

Government expenditure ratio (**GE/GDP**) appeared a negative sign, with very strong significant influence (**P-value of 0.0000**); hence, an increase of government expenditure may lead to depreciation of the REER. If government consumption contains a larger share of non-tradable goods then the increase in government consumption will worsen the current account.

Inflation (**INF**) and terms of trade (**TOT**) continues to exert a significant and strong influence on REER changes in the short –run. These results suggests that a country with higher inflation exhibit a lower value of domestic currency .On the other hand, the worsening of terms of trade have a negative effect on REER, which in turn may lead to downward pressures on the prices of all goods. If the substitution effect dominates income effect, then the impact of terms of trade deterioration will be negative.

The dummy variable (**DUMMY1985-2011**) were inserted to highlight the impact of the civil war in Sudan on REER up to separation south Sudan in 2010. The variable has a negative sign and statistical significance (probability of dummy is 0.0003). The interpretation of the inverse relationship between the war and changes in REER refer to the expansion of government spending on the military efforts, increased imports of weapons, more current account deficit and thus lead to depreciation of the REER.

Consequently from the last dissection, there is a statistically significant and negative relationship between the REER (the dependent variable) and all of: trade openness, capital inflows, government spending, inflation rate, terms of trade and the dummy variable.

There is a statistically significant and positive relationship between the REER and productivity differential and trade openness.

6. Conclusion And Policy Implications

6.1 Conclusion:

The chronic deficit of Sudan's trade balance during the last ten years led to more trade openness because of increase of importations, consequently, resulting in negative effect on the REER.

Expansion of government spending is matter because the external sources of financing of public budget deficits are currently not available from assistance sources such as donor countries , so Sudan have need to develop the internal sources of revenue .

Although capital inflow has low influence but it consider the major transmission channel; especially the decline in exports earnings, aid, loans, grants, foreign direct investment negatively affected the REER.

Productivity differentials between the home country and trade partners left negative effect on the REER, therefore, Sudan need to improve both production and trade sectors thus lead to an appreciation of exchange rate.

Sudan suffered from higher inflation rate in 2017 about 25% exhibit a lower value of domestic currency .As its purchasing power decreases in relation to the other currencies, typically means appreciating foreign currency in relation.

The inverse relationship between terms of trade and changes in REER means that the deterioration of terms of trade has contributed to depreciation of the exchange rate.

The civil war (1985-2005) up to secession of south Sudan in 2011 has contributed to deterioration of the value of domestic currency against foreign currencies because of the increased spending on the war effort, increased import of military equipment resulting in balance of payment deficit as well as the deterioration of the foreign reserve, consequently, depreciation of the REER.

6.2 Policy Implications:

Based on the findings, the following recommendations need to be adopted and gives Sudan policy maker's suggestions to enhance the REER:

Central Bank of Sudan (CBOS) should focus on foreign exchange policy working to build strong reserves to maintain the exchange rate stability through organize and rationalize the demand for foreign currencies.

Implementation of trade liberalization policies which lead to enhance exports performance.

The monetary authority should reduce the inflationary pressures through adopt contractionary monetary policy to improve REER.

The fiscal policy with regard to government expenditures should direct toward production sector to enhance raise of GDP growth rate.

To attract more capital inflows such foreign aids, government strongly need to reform and construct good relations with the international society or the donor's countries.

Appendix I: Calculation Method of the REERI in Sudan 1975-2017

Year	Sudan Total Trade (Million US. \$)	Weight = W	Official Exchange Rate SDG per U.S \$ =E	W*E = NEER	CPI*.Aver age	Sudan CPI	REER	REER I
1975	1158.934	0.004909	0.000348432	1.71045E-06	23.9	0.01	0.004088	14.37302
1976	1164.193	0.004931	0.000348432	1.71812E-06	26.3	0.01	0.004519	15.88726
1977	1351.595	0.005725	0.000348432	1.99477E-06	28.6	0.01	0.005705	20.05851
1978	1160.64	0.004916	0.0004	1.9664E-06	30	0.01	0.005899	20.74116
1979	1128.465	0.00478	0.0005	0.00000239	32.1	0.02	0.003836	13.48692
1980	1021.695	0.004327	0.0009	3.8943E-06	35.3	0.02	0.006873	24.16651
1981	1637.36	0.006935	0.000632	4.38292E-06	38.6	0.03	0.005639	19.82757
1982	1585.21	0.006714	0.000925	6.21045E-06	41.3	0.03	0.00855	30.06019
1983	1548.27	0.006558	0.00132	8.65656E-06	43.3	0.04	0.009371	32.94679
1984	1121.22	0.004749	0.00156	7.40844E-06	45.3	0.06	0.005593	19.66589
1985	947.13	0.004012	0.00244	9.78928E-06	47.1	0.08	0.005763	20.26383
1986	864.35	0.003661	0.00294	1.07633E-05	48.2	0.11	0.004716	16.58211
1987	975.056	0.00413	0.00357	1.47441E-05	50	0.013	0.056708	199.3815
1988	1284.23	0.005439	0.00455	2.47475E-05	51.4	0.021	0.060572	212.9683
1989	1001.02	0.00424	0.00667	2.82808E-05	55	0.35	0.004444	15.62522
1990	922.56	0.003908	0.00455	1.77814E-05	59.2	0.57	0.001847	6.493109
1991	954.8	0.004044	0.01428	5.77483E-05	63.7	1.28	0.002874	10.10435
1992	1057.86	0.004481	0.135	0.000604935	67	2.79	0.014527	51.07627
1993	1185.87	0.005023	0.233	0.001170359	70.8	5.63	0.014718	51.74684
1994	1389.91	0.005887	0.301	0.001771987	76.4	12.12	0.01117	39.27273
1995	1555.3	0.006588	0.42443	0.002796145	81.8	20.4	0.011212	39.42055
1996	1522.7	0.006449	0.85481	0.00551267	85.6	47.5	0.009934	34.92867
1997	1772	0.007505	1.462	0.01097231	85.4	69.66	0.013452	47.29469
1998	1875	0.007942	1.724	0.01369208	93.2	81.57	0.015644	55.00377
1999	1829	0.007747	2.27	0.01758569	96.5	94.62	0.017935	63.0585
2000	2613	0.011067	2.57	0.02844219	100	100	0.028442	100
2001	3155	0.013363	2.57	0.03434291	103.3	105.85	0.033516	117.8383
2002	3560.1	0.015079	2.61	0.03935619	108.3	114.63	0.037183	130.7324
2003	4427.4	0.018752	2.61	0.04894272	113.9	123.46	0.045153	158.7543
2004	6396.1	0.027091	2.59	0.07016569	118.6	133.83	0.062181	218.623
2005	9656.3	0.040899	2.5	0.1022475	124.3	145.21	0.0875	307.72

5							24	81
2006	11713.9	0.049614	2.3	0.1141122	133.2	147.3	0.103189	362.8051
2007	15545.5	0.065843	2.01	0.13234443	136.7	148	0.12224	429.7861
2008	19899.9	0.084286	2.21	0.18627206	137.7	148.2	0.173075	608.5178
2009	16361.7	0.0693	2.37	0.164241	141	122	0.18982	667.3916
2010	20243.7	0.085743	2.50	0.2143575	134.7	129	0.223829	786.9668
2011	17726.3	0.07508	2.88	0.2162304	147.8	140.1	0.228115	802.0343
2012	11705.7	0.04958	4.40	0.218152	209.4	190.9	0.239293	841.3367
2013	13716	0.058094	5.70	0.3311358	301.4	247.3	0.403576	1418.944
2014	12743.9	0.053977	6.04	0.32602108	428.3	418	0.334055	1174.512
2015	11727.2	0.049671	7.50	0.3725325	518.9	510	0.379034	1332.654
2016	10584.7	0.044832	15.15	0.6792048	640.5	637	0.682937	2401.156
2017	12307.7	0.05213	21.6	1.126008	831.9	801.4	1.168862	4109.634
	$\Sigma = 236098.5$	$\Sigma = 1$						
Source of Sudan trade partners: Annual reports (CBOS), Statistics Directorate (CBOS), Foreign Trade Statistical Digest (CBOS), Direction of trade statistics, Year Book (IMF) and Economic & Financial Statistics Review.								
Source of Sudan CPI : World Development Indicator database (WDI)-IMF , REER = NEER (CPI*/CPI), REERI = (REER in current year/ REER in base year ,The year 2000=100)*100								

Appendix II: Data Matrix

1	2	3	4	5	6	7	8	9
Year	REERI	DOP	GE/GDP	INF	KF/GDP	PROD	TOT	DUM 1985-2011
1975	14.37302	12.84619	17.87812	46.8	0.291771	5.86E-06	55.00000	0
1976	15.88726	23.91559	14.54601	37.3	0.183876	5.73E-06	87.00000	0
1977	20.05851	19.55424	13.51054	36.3	0.227869	5.60E-06	93.00000	0
1978	20.74116	18.14704	12.68855	44.9	0.260087	5.41E-06	75.00000	0
1979	13.48692	14.45389	13.69440	36.6	0.190431	5.20E-06	48.00000	0
1980	24.16651	13.45243	9.783451	28.1	0.288821	5.00E-06	70.10000	0
1981	19.82757	13.41388	12.68575	24.4	0.534703	4.82E-06	82.00000	0
1982	30.06019	19.70000	12.50889	24.1	0.572701	4.66E-06	89.00000	0
1983	32.94679	15.10000	10.00792	26.29	0.791470	4.51E-06	70.00000	0
1984	19.66589	14.20000	10.48368	29.8	0.627221	4.37E-06	90.00000	0
1985	20.26383	13.50000	8.263595	31.4	0.577879	4.22E-06	60.00000	1
1986	16.58211	13.10000	7.196761	42.2	0.682673	4.10E-06	40.00000	1
1987	199.3815	8.100000	5.847664	32.5	0.726231	3.99E-06	10.00000	1
1988	212.9683	13.90000	9.275100	26.2	5.954442	3.91E-06	50.00000	1
1989	15.62522	13.90000	5.792317	43.0	1.367047	3.85E-06	40.00000	1
1990	6.493109	11.80000	19.13260	65.9	2.523043	3.80E-06	60.00000	1
1991	10.10435	13.30000	32.80076	66.7	4.597536	3.74E-06	30.00000	1
1992	51.07627	108.0000	11.44794	107.5	4.875045	3.66E-06	40.00000	1
1993	51.74684	79.00000	7.687718	115.9	2.639613	3.58E-06	30.00000	1
1994	39.27273	103.0000	9.078821	104.9	0.399045	3.50E-06	50.00000	1
1995	39.42055	44.00000	6.478771	116.1	0.942402	3.40E-06	50.00000	1
1996	34.92867	34.00000	9.416938	81.3	0.251875	3.31E-06	40.00000	1
1997	47.29469	21.00000	6.873380	117.2	0.159230	3.23E-06	40.00000	1
1998	55.00377	23.00000	7.611297	65.4	0.115553	3.16E-06	30.00000	1
1999	63.0585	22.60000	8.144924	29.7	0.413779	3.09E-06	60.00000	1
2000	100	27.10000	9.439609	19.6	0.133429	3.02E-06	120.0000	1
2001	117.8383	17.00000	9.982182	11.0	0.163444	2.95E-06	70.00000	1
2002	130.7324	26.00000	11.22897	6.6	0.299153	2.90E-06	80.00000	1
2003	158.7543	30.00000	12.13836	6.9	0.477664	2.84E-06	100.0000	1
2004	218.623	24.87681	14.12682	7.8	0.982946	2.80E-06	105.0000	1
2005	307.7281	29.39197	14.96305	8.5	0.878927	2.75E-06	105.7000	1
2006	362.8051	34.50639	17.02921	8.4	1.723217	2.70E-06	103.6000	1
2007	429.7861	31.25313	19.26410	7.5	1.714192	2.65E-06	102.0000	1
2008	608.5178	34.51794	18.82154	12.0	1.113545	2.59E-06	103.0000	1
2009	667.3916	30.33906	13.97099	14.0	1.109604	3.44E-06	97.00000	1
2010	786.9668	31.50338942	15.04049	13.0	2.140874	2.97E-06	129.0	1
2011	802.0343	28.02710933	15.68663	18.0	2.000096	2.91E-06	118.8	0
2012	841.3367	23.14336824	13.40004	35.1	1.456136	2.77E-06	40.4	0
2013	1418.944	25.70762286	13.40538	37.1	1.609632	2.71E-06	53.6	0
2014	1174.512	17.18157707	12.42255	25.7	1.014535	2.64E-06	53.7	0
2015	1332.654	15.08806949	10.54592	12.6	0.567128	2.58E-06	37.0	0
2016	2401.156	24.02125401	10.30352	30.5	0.489516	2.52E-06	41.3	0
2017	4109.634	32.26533064	11.08918	25.2	0.84519	2.46E-06	49.2	0

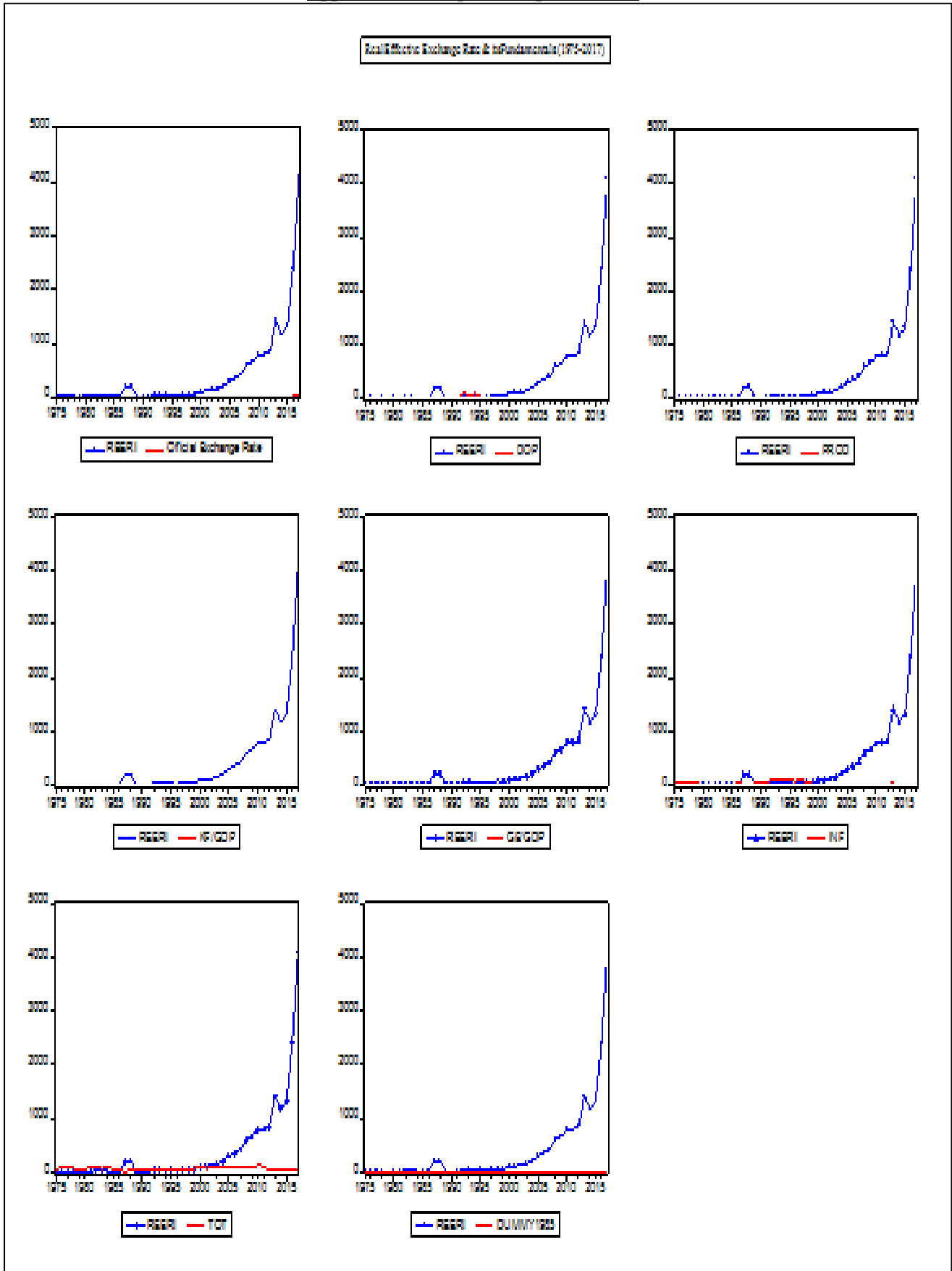
Sources :1- Calculated from data in appendix V, 2, 3, 4, 5, 6 and 7: Based on Data from Central Bank of Sudan Annual Report, Different Issues, World development indicators database (WDI) –IMF, 8- Statistics directorate, Central Bank of Sudan (CBOS)

Appendix III: Correlation Matrix

	REERI	DOP	GE	INF	KF	PROD	TOT
REERI	1.000000	-0.578901	-0.552103	-0.614587	-0.322836	0.550816	-0.486182
DOP	-0.578901	1.000000	-0.120813	0.554290	0.274798	-0.279710	-0.117940
GE	-0.552103	-0.120813	1.000000	-0.219378	0.341095	0.018422	0.273771
INF	-0.614587	0.554290	-0.219378	1.000000	0.215588	0.067847	-0.674301
KF	-0.322836	0.274798	0.341095	0.215588	1.000000	-0.150695	-0.264919
PROD	0.550816	-0.279710	0.018422	0.067847	-0.150695	1.000000	-0.157897
TOT	-0.486182	-0.117940	0.273771	-0.674301	-0.264919	-0.157897	1.000000

Source: Own Calculation

Appendix VI: Graphical Representation



Source: Based on data matrix

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