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IMPACT OF EXCHANGE RATE VOLATILITY ON MACROECONOMIC PERFORMANCE IN SUDAN

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Abstract

This paper investigates the impact of exchange rate volatility on macroeconomic performance in Sudan, focusing on three key indicators namely, economic growth, foreign direct investment and trade balance, during the period (1979-2009). The study measures the volatility of real effective exchange rate (REER) using the Generalized Autoregressive Conditional Heteroscedasticity (GARCH) model. The results of the 2SLS method reveal that REER volatility has a detrimental impact on economic growth and flow of foreign direct investment into Sudan. This finding implies that volatility of REER has played important role in the fluctuations of economic growth and FDI inflows during the last decades. The results also point out that volatility of the exchange rate has a positive impact on current account balance, indicating that exchange rate flexibility enhances the balance of payment adjustment in response to the international shocks. Moreover, the results of the robustness checks of variance decomposition and impulse response function analysis confirm the findings of 2SLS estimators.

JEL Classification: C3, F3, F4

Keywords: Exchange rate volatility, macroeconomic performance, Sudan

ملخص

تهدف هذه الورقة الى دراسة تأثير تقلبات سعر الصرف على أداء الاقتصاد الكلي فى السودان، مع التركيز على ثلاثة مؤشرات رئيسية وهي النمو الاقتصادي والاستثمار الأجنبي المباشر والميزان التجارى، وذلك خلال الفترة (1979-2009). تقيس الدراسة تقلب سعر الصرف الفعلي الحقيقي بإستخدام نموذج الإنحدار الذاتي المشروط بعدم التجانس (ARCH). وقد كشفت نتائج طريقة المربعات الصغرى ذات المرحلتين (2SLS) أن تقلب سعر الصرف الفعلي الحقيقي له تأثير سلبى على النمو الاقتصادي وتدفق الاستثمارات الأجنبية المباشرة إلى السودان. وهذه النتيجة تعني أن تقلب سعر الصرف الفعلي الحقيقي قد لعبـدوراً مهماً في تقلبات النمو الاقتصادي وتدفقات الاستثمار الأجنبي خلال العقود الماضية. وتشير النتائج أيضا إلى أن تقلب سعر الصرف كان له تأثير إيجابي على الميزان التجاري، مما يعنى أن تقلبات سعر الصرف تعزز من مقدرة ميزان المدفوعات للاستجابة للصدمات الدولية. وبالاضافة الى ذلك، فإن نتائج إختبارات متانة التحليل بإستخدام دوال الاستجابة للصدمات ونموذج مكونات التباين تؤكد نتائج نماذج 2SLS.وأخيراً ، أختتمت الورقة ببعض التوصيات المتعلقة بإدارة سياسة سعر الصرف في السودان، وبالاضافة الى مقترحات لمزيد من البحث فى هذا الموضوع.

1. Introduction

The impact of exchange rate volatility on macroeconomic variables has become a subject of increasing debate in recent decades, in both developing and advanced countries. Advocates of fixed exchange rate argue that exchange rate stability enhances exports, provides an attractive environment for the flows of international capital like foreign direct investment (FDI), and eventually stimulates economic growth. In their view, volatile and unpredictable exchange rates may lead to many harmful macroeconomic consequences such as, volatility of prices and output, deterioration of total exports, as well as worsening the external competitiveness (Gylfason 2000; Rose 2000; Frankel and Rose 2002; and De Grauwe and Schnabl 2004). On the other hand, proponents of floating exchange rate regimes believe that exchange rate flexibility helps the balance of payment adjustments in response to external shocks and positively influences the trade volume and economic growth (Friedman 1953; Fischer 2001; Edwards and Levy-Yeyati 2003).

Like other developing countries that face the challenge of improving the balance of payments and stimulating economic growth, Sudan has adopted a number of different exchange rate regimes over the last five decades. These systems included the fixed, floating and dual exchange rate regimes. For example, following independence in 1956, and up to early 1979, Sudan adopted a fixed exchange rate. Thereafter, in September 1979, the government shifted from a fixed to a flexible exchange rate system, with the support of the IMF and the World Bank's structural adjustment programs. Since then, the exchange rate has witnessed continuous devaluations and interventions. However, these changes in exchange rate have been accompanied by considerable fluctuations in the macroeconomic indicators such as economic growth, foreign trade and foreign direct investment. In the spirit of such context, this paper aims to examine the impact of exchange rate volatility on macroeconomic performance in Sudan.

The contribution of this paper is to fill a gap in literature on the impact of exchange rate volatility, as most of empirical studies on exchange rate in Sudan have focused on identifying the determinants of equilibrium exchange rate and the extent of its misalignment (e.g. Abdallh 2009). In addition, many factors have been blamed as major variables responsible for the disappointing economic performance of Sudan; nevertheless, the effect of exchange rate volatility has not been adequately studied. Moreover, Sudan's economy is now experiencing a sharp decrease in foreign exchange reserves due to the loss of most of the oil resources as a result of the secession of South Sudan[1]. Therefore, understanding the impact of exchange rate volatility would help in guiding appropriate exchange policies that foster exports' competitiveness, and attract foreign financial sources such as, FDI and migrants' remittances.

The remainder of this paper is organized as follows: section 2 reviews exchange rate policies in Sudan. Section 3 outlines the theoretical and empirical literature on the relationship between exchange rate fluctuations and macroeconomic indicators. Section 4 discusses data and research methodology and section 5 presents the empirical results. Section six ends with a conclusion, policy recommendations and suggestions for further research.

2. Exchange Rate Policy in Sudan: An Overview

The exchange rate market in Sudan has undergone numerous policy interventions. Throughout the period 1956-1979, the exchange rate has been pegged at a fixed rate of approximately one Sudanese pound to US$2.85. In 1979, the government shifted to a floating exchange rate system with the aim of boosting the economy since the country had witnessed

[1] Based on the Comprehensive Peace Agreement (CPA) of 2005, southern Sudanese were given the right of self determination through referendum, which took place as scheduled in January 2011. The result of the referendum revealed that about 98% of southern people voted in favor of independence. As a result, Sudan lost most of its oil resources, as approximately 75% of oil production was in South Sudan.

many economic problems including, fiscal deficit, external disequilibrium, high inflation rates and mounting external debts during the 1970s (Ali 1985). Thus, the government launched the first version of the stabilization and liberalization programs, which focused on exchange rate devaluation as a key policy tool for economic recovery. As a result, the Sudanese pound underwent a significant devaluation to the rate of one US dollar to 0.35 Sudanese pounds. The main goal of this policy was to reduce the external imbalances through encouraging the volume of exports, and attracting private international capital, such as remittances of Sudanese nationals working abroad (SNWA)[2]. The monetary authority in that period had adopted a dual exchange markets, namely, the official and the parallel markets. Although the parallel exchange market in the beginning was limited to foreign trade, the massive flows of migrants' remittances in the second half of that decade extended the parallel exchange activities and increased the black market premium (Elbadawi 1994).

Throughout the 1980s, the exchange rate in Sudan experienced a series of devaluations, owing to the economic and political instabilities. In the 1980s, the country experienced many factors affecting economic performance as drought and famines in 1984-1985 and the eruption of the second civil war in 1983. The country, therefore, suffered from a severe lack of foreign reserves and relied mainly on foreign aid in financing development projects. As such, the exchange rate was devalued in 1985 by 48 percent, with the official rate set at LS2.5/US$ and the parallel at LS3.3/US$. In early 1987, the exchange rate was devalued further to about LS4.00/US$ and LS5.8/US$, for the official and black market, respectively. In an attempt to attract the remittances of SNWA through the official channels, the monetary authority in 1987-1988, attempted to unify the two rates at LS4.5/US$. However, by the end of 1980s the black market was active, and the speculation on foreign currency and non-tradable goods were the dominant activities thereby causing the black market exchange rate to be set at more than LS20/US$ in late 1989.

In the early 1990s, the economy witnessed several transformations, notably the transition from state control policies that characterized the period of 1970s and 1980s to free market polices. The Salvation Revolution government of 1989 launched many economic recovery programs, which aimed at encouraging the export through stabilizing the exchange rates. The Comprehensive National Strategy (CNS) of 1992-2002 was an ambitious one. The CNS focused on the liberalization of trade and exchange rate, the liberalization of the financial sector, the removal of agricultural subsidies, the reduction of trade tariffs and the privatization of inefficient public enterprises. Accordingly, the exchange rate policy received considerable attention from the government, because it was believed to be a core factor affecting the economic instability. Thus, at the beginning of the economic recovery program of 1990, the black market exchange was prohibited an considered an illegal practice and the government implemented strict punishment for illegitimate exchange dealers. Thus, all foreign exchange transactions were confined to the licensed commercial banks. Yet despite these measures, the exchange rate reported was higher in the early 1990s compared to the 1980s.

As a part of the economic liberalization policies in 1992, the government adopted a floating exchange rate as well as unifying the formal and parallel rate. However, due to the drastic depreciation of the local currency and the subsequent increase in inflation, the floating system was abandoned in October 1993 and replaced by the dual exchange system. The formal rate was set at LS215/US$, while the parallel was set at LS300/US$. Thereafter, the exchange rate underwent continuous devaluations as set by the Bank of Sudan at LS300/$ and LS430/$ in 1994 and 1995, respectively. Therefore, managing the exchange rate during 1990-1995

[2] In the early 1970s Sudan was a major labor exporting country in the Arab Region, with the remittances sent by SNWA accounting for more than three times the foreign exchange earnings from exports (Elbadawi 1994).

was a difficult task for the government owing to the scarcity of foreign exchange and economic distortions. Indeed, in the first half of 1990s, the economy saw many challenges, like the soaring inflation rate of more than 120% in 1995, as well as the decrease of foreign assistance due to political reasons in addition to a reduction in the agricultural exports.

In the second half of the 1990s, the exchange rate stabilized owing to the flow of FDI and the commercial exploitation of oil in 1999. Notably, the flow of oil revenues brought to the economy a huge amount of foreign reserves. As a result, the exchange rate saw substantial stability with a limit rate at LS2650-2600 per US dollar during 2000-2003. It is worth mentioning that oil exports in the early 2000-2007 became the major source of foreign exchange and accounted for around 85% of the total value of exports. Accordingly, during this period the Central Bank of Sudan adopted a managed floating exchange regime. Moreover, during the period that was accompanied by oil exportation, the economy witnessed a favorable economic performance. For example, the country reported a positive and high economic growth rate, leading Sudan to be one of the fastest growing countries in the region (World Bank 2008). The rate of inflation also fell into the one digit range during that period. Nevertheless, other sectors of the economy, like agriculture, suffered severely; this may have been because of the oil windfall, which appreciated the exchange rate and hence, reduced the sector's competitiveness. The appreciation of the exchange rate during that period was assumed to be a symptom of the Dutch disease (Abdallh 2009). In fact, the share of the agricultural sector in GDP and total exports declined sharply after oil exploitation.

During the period 2008-2010, the exchange saw many fluctuations owing to the reduction in oil prices due to global economic crisis. The decline in the inflow of foreign currency that followed led to another split in exchange markets into official and black. Recently, in the aftermath of the secession of South Sudan in July 2011, Sudan has suffered from many economic challenges owing to the sudden stop of oil revenues. As a result, the exchange rate depreciated rapidly, leading to increase in the black market premium. In response to such a situation, in June 2012 the authorities adopted a new exchange rate measure, which devalued the currency to the rate of SDG4.42/US$[3].

Overall, the exchange rate in Sudan had seen a continuous devaluation since 1979, particularly in the period which preceded the oil exploitation. Appendix V, reveals that the nominal exchange rate reported a positive trend with a slight increase during the period 1979-1991 but did not exceed LS500/US$. After the economic liberalization policies of 1992 and up to 1996, the exchange rate depreciated dramatically to about LS2000/US$ in 1997. However, during the period of the managed floating exchange rate regime and oil exploitation (1997-2007), the exchange rate was stable at the rate of 2.5SDG/US$ on average and then decreased subsequently to about SDG2/US$ in 2008.

3. Literature Review

Since the breakdown of the Breton Woods system of pegged exchange rates and the switch to floating exchange rates in the early 1970s, the effect of exchange rate volatility on economic performance has become a subject of interest for both policymakers and researchers. Numerous empirical studies have investigated the effect of exchange rate variability on macroeconomic indicators, such as economic growth, trade and FDI. Yet despite the extensive literature on this issue, the results of empirical study are not all in agreement. This disagreement can be attributed to the difference in model specifications, sample periods, methods of measuring the exchange rate volatility and the macroeconomic indicators considered. In this section, we briefly review the theoretical and empirical arguments on the

[3] In 1999 the official currency, the Pound (LS), was replaced with a new currency, the Dinar (SDD), where 1 SDD =10 LS. The Dinar was used until 2007 but was then replace with the new Pound (SDG), where 1 SDG=100 SDD, or alternatively1 SDG= 1000 LS.

impact of exchange rate volatility on three main macroeconomic variables: economic growth, trade and foreign direct investment.

First, the relationship between exchange rate volatility and economic growth has received relatively little attention from both theoretical and empirical perspectives. This is because the exchange rate is considered a nominal variable and as such not related to the long-term real growth performance (Levy-Yeyati and Sturzenegger 2002; Bayoumi and Eichengreen 1994). However, economists agree that the impact of exchange rate volatility on economic growth depends on the type of exchange rate regime adopted by the economy. Economists who are in favor of a fixed exchange rate regime (e.g. McKinnon 1963; Mundell 1973; Rose 2000; Frankel and Rose 2002) argue that exchange rate stability is conducive to economic growth through its positive impact on trade and investment. In their view, a stable exchange rate reduces price uncertainty and real interest rates volatility and improves the efficiency of price mechanisms at the international level and thus contributes significantly to economic stability and growth (De Grauwe 1998; Schnabl 2007). By contrast, the supporters of a flexible exchange rate (e.g. Meade 1951; Friedman 1953; Fischer 2001; and Levy-Yeyati and Sturzenegger 2002) argued that the volatility of exchange rate reduces the negative impact of real asymmetric shocks on local and external disequilibrium. That is, in a case of real asymmetric shocks, if prices and wages adjust slowly, flexible exchange rates can adjust relative international prices to compensate for output losses (Mundell 1961; Arratibel et al. 2011). Moreover, Ghosh et al. (1996) show that a pegged exchange rate may distort price signals in the economy by creating misalignment of the real exchange rate, and in turn leads to inefficient allocation of resources across sectors.

Empirical evidence on the other hand, also offers mixed findings regarding the impact of exchange rate volatility on growth. For example, Ghosh et al. 1997 studied the growth performance under alternative regimes in 145 IMF-member countries and found that there are no significant differences in output growth across exchange regimes. The study argued that pegged regimes increase investment and volatility of growth and employment but reduce productivity growth and inflation. McKinnon and Schnabl (2004) examined the impact of exchange rate volatility for East Asian countries. It argued that before the Asian crisis of 1997/98 the exchange rate stability contributed significantly to low inflation, sound fiscal position, high investment and boosted long-term growth. Schnabl (2007) examined the impact of exchange rate volatility on growth for a sample of 41 countries. He found that exchange rate fluctuations work against the adjustment of asset and labor markets and in turn reduces economic growth. In contrast, studies by Edwards and Levy-Yeyati (2003) and Levy-Yeyati and Sturzenegger (2002) found that floating exchange rates foster economic growth.

Second, as for the link between exchange rate volatility and trade volume, the literature has provided extensive evidence since the collapse of the Breton Woods system of fixed exchange rate. Fluctuations in exchange rate may negatively affect the competitiveness of tradable goods and in turn reduce the volume of trade and worsen the balance of payments. On the theoretical side, the literature provides many models explaining the association between the exchange rate and the volume of trade. For instance, the earlier model of Clark (1973) and Hooper and Kohlhagen (1978) argued that exchange rate volatility increases the risk-averse traders and then squeezes the volume of trade. Their view is based on the fact that if an exporter agrees on a production contract without knowing the actual situation of exchange rates and cannot hedge this source of predicted risk, therefore an increase in exchange rate volatility negatively affects a risk-averse exporter (Clark 1973). Moreover, another group of theoretical models showed that exchange rate volatility has an ambiguous impact on trade, sometimes positive and other times negative (e.g. Franke 1991; Sercu and Vanhulle 1992; and De Grauwe 1988). De Grauwe (1988) showed that an increase in risk has both a substitution and an income effect. Thus, the dominance of the income effect over the

substitution effect may lead to a positive association between trade volume and exchange rate volatility. De Grauwe concluded that if exporters are sufficiently risk averse, an increase in exchange rate volatility raises the expected marginal utility of export revenue and therefore induces them to increase their exports activities. On the other hand, if producers are not risk averse, higher exchange rate volatility reduces the expected marginal utility of exports revenues, and in turn leads them to produce less for export.

On the empirical front, the evidence on the impact of exchange rate volatility on trade also failed to reach a consensus. A survey of previous literature on this issue yields negative and positive impacts as well as inconclusive results. Some studies have found that exchange rate volatility exerts a negative impact on trade volume (e.g. Akhtar and Hilton 1984; Peree and Steinherr 1989; Chowdhury 1993; and Lee and Saucier 2005). On the other hand, empirical studies by others have found that exchange rate volatility has a positive effect on trade volume (e.g. Klein 1990; Franke 1991; McKenzie and Brooks 1997; and Kasman and Kasman 2005, among others). Moreover, another group did not find any significant association between exchange rate volatility and trade (e.g. McKenzie 1998; and Hooper and Kohlhagen 1978).

Finally, studies on the link between exchange rate volatility and FDI are scant. Most empirical studies have focused on the level of exchange rate (i.e. appreciation and depreciation) as a main determinant of FDI flow to the host countries. However, a group of these studies stressed on the impact of volatility in attracting FDI (e.g. Dixit and Pindyck 1994; and Markusen 1995). Theoretically, the models which link exchange rate volatility to FDI depend on two arguments: the production flexibility argument and the risk aversion argument. According to the production flexibility argument, exchange rate volatility fosters FDI since foreign producers are assumed to be able to adjust the use of one of their variable factors following the realization of a stochastic input in profits (Goldberg and Kolstad 1995). On the other hand, according to the risk aversion theory, FDI decreases as exchange rate volatility increases. The risk aversion theory claims that higher fluctuations in the exchange rate lower the certainty equivalent expected exchange rate, which in turn reduces FDI. The literature, however, stated that using production flexibility approaches versus risk aversion approaches needs to distinguish between short-term exchange rate volatility and long-term misalignments (Goldberg and Kolstad 1995). That is, the risk aversion argument is more appropriate under short-run exchange rate volatility because firms are unlikely to be capable of adjusting factors in the short run. In the short run, factors of production are usually fixed; hence, firms will only be risk-averse to volatility in their future profits. Whereas, the production flexibility argument appears to be more appropriate under the long-term horizon because firms are now able to adjust their use of variable factors.

Likewise, empirical evidence on the impact of exchange rate volatility on FDI flow is mixed. For example, Cushman 1988; Stokman and Vlar 1996; and Foad (2005) argued that exchange rate volatility exerts a positive impact on FDI flow to the host countries. These findings are based on the argument that FDI is considered a substitute to exports. That is, an increase in exchange rate volatility in the host country induces a multinational firm to serve the host country via a local production facility rather than exports, thereby insulating against currency risk. On the other hand, another group of empirical studies stated that exchange rate volatility negatively affects the flow of FDI (e.g. Darby et al. 1999; and Dixit and Pindyck 1994). They claimed that a country with a high degree of exchange rate volatility would have a high degree of currency risk, which converts the flow of FDI to countries with more stable exchange rates.

Overall, the above discussion has revealed that the literature on the impacts of exchange rate volatility on the real macroeconomic indicators is extensive and diversified. However, there

is a dearth of studies on such issue in Arab countries in general and Sudan in particular. This study contributes to the empirical literature on this issue.

4. Model Specification, Data and Methodology

4.1 Measuring Exchange Rate Volatility

Measuring exchange rate volatility is one of the controversial issues in recent economic literature. Therefore, the ambiguous findings on the impact of exchange rate volatility are attributed to the absence of a unique method for measuring volatility (Siregar and Rajan 2004). In the literature, several methods have been used for computing exchange rate volatility, including standard deviations and Autoregressive Conditional Heteroscedasticity (ARCH) techniques. However, methods based on standard deviation suffer from many shortcomings. First, the standard deviation measures of exchange rate volatility ignore relevant information on the random process that generates the exchange rate (Jansen 1989). Second, this method is arbitrary in choosing the order of the moving average and is noted for underestimating the effects of volatility on decisions (Pagan and Ullah 1988). Finally, the standard deviation measure of volatility is characterized by a skewed distribution.

To overcome the methodological deficiencies of standard deviation methods, the study uses ARCH technique introduced by Engle (1982) and later developed by Bollerslev (1986) as the Generalized Autoregressive Conditional Heteroscedasticity (GARCH). The advantage of the ARCH and GARCH methods over the standard deviation measures is their ability to discriminate between predictable and unpredictable elements in the exchange rate formation process, and therefore, they serve as accurate measures of volatility (Arize et al. 2000; and Darrat and Hakim 2000).

Therefore, the conditional variance of GARCH model could be specified as follows:

$$\ln REER_t = a_0 + a_1 lnREER_{t-1} + e_t \quad where\ e_t \sim N(0, h_t) \tag{4.1}$$

$$h_t = a + \beta e_{t-1}^2 + \gamma h_{t-1} + \mu_t \tag{4.2}$$

This equation means that the conditional variance is a function of three terms: the mean α; information about volatility from the previous period measured as the lag of the squared residual from the mean equation e_{t-1}^2 (the ARCH term), and the variance of the previous period's forecast error h_t (the GARCH term). Accordingly, we will estimate GARCH (1,1) conditional variance on annual real effective exchange rate (REER), over the period 1979-2009[4]. The result of the GARCH equation is presented in Annex (VII).

4.2 Model Specification

To investigate the impact of the exchange rate volatility on macroeconomic performance, the study focuses on the effect of exchange rate volatility on three key macroeconomic indicators: real GDP growth, FDI flows and the current account balance. These variables are assumed to reflect the macroeconomic performance. Each macroeconomic variable under investigation will be considered as a dependent variable to be explained by REER volatility beside other relevant control variables, which are supported by theoretical and empirical literature.

First, the impact of exchange rate volatility on real output growth will be examined through estimating the following model:

$$y_t = \beta X_t + \delta EV_t + \varepsilon_t \tag{4.3}$$

[4] Even though many empirical studies have used the nominal or real exchange rate, this study uses the real effective exchange rate, because it reflects a country's international competitiveness.

Where y is the real GDP growth, X is the vector of control variables, EV is the volatility of real effective exchange rate and ε is the error term. The control variables include inflation rate, trade openness, domestic investment and government expenditure**.** The model also involves two dummy variables, one for the shift to flexible and dual exchange rates during 1979-1984 and the other to capture the adoption of a managed floating exchange rate after oil exploitation in 1999[5]. The first dummy variable takes the value of one from 1979 to 1984 and zero otherwise, while the second dummy takes the value of one during 1999-2009. All variables will be expressed in logarithm form, except real GDP growth which bears negative signs in some years. These variables also are selected based on previous studies on the effect of exchange rate volatility on growth (e.g. Arratibel et al. 2011; and Schnabl, 2007)[6].

According to theoretical and empirical literature, the inflation rate may have negative or positive impact on economic growth. The trade openness also has a mixed effect on growth depending on trade policy. The domestic investment is considered an important factor for stimulating growth, hence its impact is expected to be positive. The government spending is assumed to have a positive impact on economic growth. The impact of exchange rate volatility can be either positive or negative as literature provided mixed findings.

Second, regarding the effect of exchange rate volatility on FDI, we estimate the following equation:

$$FDI_t = \beta X_t + \delta EV_t + \varepsilon_t \quad (4.4)$$

Where *FDI* is the ratio of stock of inward FDI to GDP, X is a vector of control variables, EV is the REER volatility and ε is the stochastic error term. In literature, a huge set of explanatory variables have been predicted as significant variables that attract FDI flows into the host country. However, for the purpose of this study we focus on the most important macro determinants of FDI due to the availability of data and their relevance to the case of Sudan. Therefore, the control variables include real per capita GDP as proxy for market size, the level of infrastructure, the inflation rate and trade openness. We examine the impact of structural breaks in exchange rate systems by using two dummy variables one for the adoption of full floating and unification of exchange rate in 1992 and the second for the managed floating system during 1999-2009. All variables are expressed in logarithm form.

The market size measured by real GDP is supposed to increase the flow of FDI, since foreign investors are interested where there is a large market for their product. The levels of infrastructure would be positive as foreign investors prefer a country with good infrastructure. Trade openness is assumed to have positive impact on FDI flow. The impact of oil would be positive as oil exploitation attracted a huge amount of FDI in the last decade. Finally, the sign of exchange rate volatility is inconclusive as most of empirical studies offered ambiguous results.

Finally, with respect to the impact of exchange rate volatility on trade, the analysis will follow Arratibel et al. (2011). Therefore, the estimable current account equation is specified as follows:

$$CA_t = \beta X_t + \delta EV_t + \varepsilon_t \quad (4.5)$$

Where CA_t is the current account balance; X is a vector of control variables which include real per capita growth, trade openness, inflation rate and FDI; EV is REER volatility and ε is

[5] During the period under investigation (1979-2009), the exchange rate policy in Sudan has experienced several transformations as stated in section two. Thus, we use dummy variables to capture these structural breaks. In 1979 the country adopted the system of dual exchange; in 1992 the government adopted full floating regime and during 1999-2009 a managed exchange rate system was followed.

[6] See appendix (I) of definitions and sources of data.

the error term. We also use two structural break dummies to reflect the adoption of dual exchange rate system during 1979-1984 and the second to capture the announcement of full floating exchange rate in 1992.

According to economic theory, GDP growth is expected to have negative impact on the current account balance, as an increase in the level of income raises the import expenditure, which tends to worsen the current account. Trade openness through low trade restriction will improve the current account balance. An increase in inflation will reduce productivity and export competitiveness and thus worsens the current account balance. FDI will increase the capacity of the economy to produce and export more; hence FDI is expected to have a positive impact on the current account. The volatility of exchange rate would be either negative or positive as there is disagreement in the literature regarding the impact of exchange rate volatility on the current account.

4.3 Data and Methodology

The study utilizes the annual time series data covering the period 1979-2009. This period is selected because since 1979 the exchange rate has seen many policy interventions. In addition, by the end of the 1970s, the country had started to suffer from an unfavorable economic situation. Moreover, data on variables under investigation is available for this period. The definitions and sources of data are presented in Annex (I). The statistical description of the variables is also depicted in Annex (II).

To investigate the impact of exchange rate volatility on macroeconomic indicators, the study estimates the previous regression models, using the Two Stages Least Squares method (2SLS). This 2SLS instrumental-variables approach will be employed to avoid the possible endogeneity problem that may arise due to the appearance of possible endogenous variables in the right hand side of the equation.

As is common in time series analysis, prior to estimating regression models, all series are tested for the unit root to avoid the spurious regression. Therefore, the analysis starts with identifying the order of integration of the variables, using Augmented Dickey-Fuller (ADF) and Philips-Perron (PP) tests for unit root. Since the unit root tests are sensitive to the lag length, the study uses the Akaike Information Criterion (AIC) to select the optimal lag length.

For further inference, the study will examine the relationship between exchange rate volatility and macroeconomic variables using Variance Decompositions (VDs) and Impulse Response Function (IRF) analysis, based on the Vector Autoregression (VAR) model. The VDs and IRF analyses will be used to examine the dynamic relationship between exchange rate volatility and macroeconomic variables. The VDs approach identifies the proportion of the movements in the variable under study that are due to their own shocks and shocks to the other variables. On the other hand, IRFs traces the effect of a one standard deviation shock to the orthogonalized residuals of equation on current and future values of the endogenous variables. Thus, IRF measures the responsiveness of the dependent variables in the VAR to shocks to each of the variables. The analysis will be conducted using an unrestricted VAR model with four endogenous variables, including economic growth, FDI, current account and exchange rate volatility.

It is worth mentioning that, the forecast error VDs and IRFs are derived from the VAR. Precisely, VDs and IRFs are the transformation of VAR model into its moving average (MA) representation (Sims 1980). However, the main challenge facing employing VDs and IRFs analyses is the selection of order of the variables in the VAR system. This is because orthogonalization involves the assignment of contemporaneous correlation only to specific series. In other words, the first variable in the ordering is not contemporaneously affected by shocks to the other variables, but shocks to the first one do affect the other variables in the

system; the second variable affects contemporaneously the other variables (except the first one), but it is not contemporaneously affected by them, and so on. Therefore, we follow Sims (1980) which suggested starting with the most exogenous variable in the system and ending with the most endogenous one.

5. Empirical Results and Discussions

The first step in our analysis is to identify the order of integration of the all variables, using Augmented Dickey-Fuller (ADF) and Philips-Perron (PP) tests. The results of the unit root test for each variable with and without trend are reported in table 1 appendix III. The results show that most of the series are non-stationary at level. When taking the variables in their first difference, the results show that all variables are stationary, i.e. integrated of order one *I(1)* at 5% significance level, by both ADF and PP test. Therefore, we can conclude that all the series are integrated of order one. Hence, all regression equations will be estimated using first difference of the series.

5.1 Exchange Rate Volatility and Economic growth

The impact of REER volatility on growth is investigated through the estimation of equation (4.2). The results of 2SLS estimators are presented in table 1.

The results show that the model does not suffer from any econometric problem as indicated by the LM, White and RESET test[7]. The LM test indicates that there is no serial correlation in the model, since the use of Durbin-Watson (DW) test for autocorrelation is inappropriate when the lagged dependent variable appears as an explanatory variable. The White and RESET tests indicate the acceptance of the null hypotheses that there are no heteroscedasticity and specification error problems, respectively. In addition, most of the variables carry their expected signs and fit well with the theory. The results also show that the lagged dependent variable, trade openness, domestic investment and government spending have positive signs, as suggested by previous studies on economic growth. On the other hand, the inflation rate is found to negatively affect the economic growth.

The real effective exchange rate volatility has a negative sign, implying that exchange rate volatility has an adverse impact on economic growth in Sudan. This finding confirms many previous studies on the association between exchange rate and economic growth (e.g. Rose 2000; Frankel and Rose 2002). This result also reveals that exchange rate volatility is one of the major factors responsible for the slow and volatile economic growth in Sudan over the past four decades.

The structural break dummies have positive signs, indicating an increase in output growth during the adoption of the dual exchange rate regime (1979-1984) and over the period of managed exchange rate regime (1999-2009). The sign of the second dummy is significant suggesting that the adoption of managed floating exchange rate in 1999 has played a significant role in stimulating output growth in Sudan.

5.2 Exchange Rate Volatility and FDI

The impact of exchange rate volatility on the flow of FDI is examined through the estimation of equation (4.4). The results of 2SLS analysis are reported in table 2.

The results in table 2 show that the model has a good explanatory power, as indicated by r squared and the significant F statistic. The model also does not suffer from any econometric

[7] LM is Breusch-Godfrey Serial Correlation LM Test, p-values greater than 0.05 means acceptance of null hypothesis (no autocorrelation). White is the White heteroscedasticity test, p-values greater than 0.05 means acceptance of null hypothesis (no heteroscedasticity). RESET is Ramsey test of null hypothesis that the model has no omitted variables (p-values greater than 0.05 means acceptance of null hypothesis (model has no omitted variables).

problem, as indicated by the p-values of basic tests (LM, White and RESET tests). The results indicate that the lagged dependent variable, trade openness and level of infrastructure have positive effects on FDI flows, as suggested by previous empirical studies on FDI. On the other hand, market size measured by real per capita growth exerts a negative influence on FDI flows but its sign is not significant. This finding contrasting with most of the empirical studies could be explained by the fact that the FDI flow into Sudan is not market seeking and most of it is directed toward natural resources sectors such as oil and mining.

Importantly, the sign of exchange rate volatility is negative and significant, indicating that exchange rate volatility discourages the flow of FDI. This result confirms the actual situation in Sudan, since during the period of the stable exchange rate (2000-2007), the country received a huge amount of FDI compared with the period of 1980s and early 1990s, which were characterized by exchange rate fluctuations. This finding also supports most of the previous studies on the link between FDI and exchange rate volatility (Dixit and Pindyck 1994; and Darby et al. 1999).

Moreover, the results reveal that the two dummy variables have positive signs, suggesting an increase in FDI flow in 1992 and 1999-2009. Particularly, the coefficient of the second dummy (managed floating system) is significant, which implies that the adoption of managed floating system had encouraged the flow of FDI into Sudan.

5.3 Exchange Rate Volatility and the Current Account

Regarding the impact of exchange rate volatility on the current account balance, the results of the 2SLS estimation of equation (4.5) are presented in table 3.

The results in table 3 indicate that most of the variables carry their expected signs, except for trade openness and FDI. The model also satisfies all the three basic statistical tests of serial correlation, heteroscedasticity and specification error, as indicated by LM, White, and RESET tests, respectively. The results show that the current account balance is negatively influenced by the lagged dependent variables, GDP growth, inflation and trade openness. Unexpectedly, the results reveal that the sign of exchange rate volatility is positive but not significant. This result implies that volatility of the exchange rate improves the current account balance. This finding, thus, supports the view that flexible exchange rates significantly facilitate the adjustment of current account imbalances over time (Rahman 2008; Arratibel et al. 2011).

Moreover, parameters of structural breaks suggest an improvement in the current account during 1979-1984 (the shift to flexible and dual exchange rate systems). In contrast, there was a significant decrease in the current account balance during the adoption of floating exchange rate policy in 1992. This indicates that unification of the exchange rate in that period distorted the current account via increasing imports and decreasing exports.

5.4 Robustness Checks

The previous analyses examined the impact of exchange rate volatility on macroeconomic variables in the context of a single equation model, using the 2SLS method. For further inference, and to check our results, we investigate the effect of exchange rate volatility through a multivariate analysis, employing variance decompositions and impulse response function based on an unrestricted VAR model.

The analysis proceeds with a cointegration test to examine the long-term relationship between the variables. The cointegration analysis allows the use of a cointegrated VAR model which accounts for non-stationarity and endogeneity problems as it is designed for non-stationary time series, and requires no endo-exogenous division of variables (i.e. all variables entering equation systems are assumed to be endogenous). Therefore, the study uses Johansen and Juselius (1990) multivariate cointegration test. Before undertaking the cointegration tests, the

relevant lag order of the VAR model is specified. Since the sample size is relatively small, we have selected a lag of one for the order of the VAR as suggested by Pesaran and Pesaran (1997).

The results of trace and maximum eigenvalue statistics obtained from the Johansen-Juselius (*JJ*) method using the assumption of linear deterministic trend in the data are presented in table 2 in appendix III. The results of both trace statistics and maximum eigenvalue indicates two cointegration relations between the variables under consideration. Therefore, we conclude that there is a long-term relationship between the REER volatility and the macroeconomic indicators.

The dynamic analysis of variance decomposition and impulse response functions starts with identifying the order of the variables in the VAR model. Following Sims (1980), we choose the following order: EV, CA, FDI and GDP. The result of forecast error variance decompositions and impulse response function are reported in table 4 and figure 1, respectively.

The results of the variance decomposition analysis in table 4 reveal that the response of the current account to exchange rate volatility is relatively small, particularly in the first years and then increases slowly to about 14.7% in the 12^{th} year. Expectedly, the exchange rate volatility represents the largest source of shock to FDI, exceeding its own shock. Specifically, in the first year, the volatility of exchange rate had very little impact on FDI fluctuations, but after that its contribution increased sharply to 66% and 65% in the fourth and twelfth year, respectively. This finding confirms the previous results of the 2SLS estimators, which revealed that exchange volatility has the highest and significant impact. Finally, the result shows that GDP growth has a minimal response to the variability of exchange rate compared to FDI. This result could be explained by the fact that FDI is more sensitive to the distortions of the home economy, particularly exchange instability.

Figure (1) presents the impulse response functions of each macroeconomic variable to one standard deviation in REER volatility over a horizon of 1 to 12 years. The results show that the effect of shocks in exchange rate volatility on the macroeconomic variables supports the results of 2SLS and VDC analysis. The response of GDP growth to exchange rate volatility is negative, supporting the previous findings that volatility exerts an inverse effect on GDP growth. Regarding the response of FDI to exchange rate volatility, the results also reveal a negative response. Similar to the previous analysis, the IRFs analysis indicates that current account balance responds positively to the volatility of REER.

6. Conclusion and Policy Implications

This study investigated the impact of exchange rate volatility on the macroeconomic performance following the continuous changes in exchange rate policies during the last four decades in Sudan. The analysis focused on three key macroeconomic variables: economic growth, FDI and the current account balance during the period 1979-2009.

The empirical results show that REER volatility has a negative impact on economic growth. This result indicates that flexible exchange rates discourage economic growth, which supports many previous studies (e.g. Rose 2000; Frankel and Rose 2002). This finding also suggests that the volatility of exchange rate has played an important role in the fluctuations of growth performance in Sudan in the last decades. In addition, the results indicate that volatility of the exchange rate adversely affects the flow of FDI into Sudan. Unexpectedly, the impact of exchange rate volatility on the current account balance is found to be positive, indicating that exchange rate volatility improves the current account balance. This finding supports the claim that a floating exchange rate may work as an economic stabilizer to

mitigate external disequilibria. Moreover, the robustness checks of Variance Decompositions and Impulse Response Functions analysis supports the findings from 2SLS models.

Based on the findings above, many policy implications can be drawn regarding the relationship between exchange rate volatility and macroeconomic indicators in Sudan. First and foremost, reducing exchange rate volatility is quite crucial to mitigate its negative impact on FDI flows and output growth. Serious attention should be paid to factors that stimulate exchange rate fluctuations like high inflation and budget deficit. Thus, policymakers should consider adopting inflation targeting as a strategy in addition to the autonomy of the monetary policy. Further, authorities should try to avoid systematic currency devaluations in order to maintain the exchange rate volatility at a rate that allows adjustment of the balance of payments.

Considering the current shortage of foreign exchange after the separation of South Sudan, the economy needs an effective exchange rate policy in order to overcome the unfavorable impact of declining foreign reserves. Therefore, an encouraging exchange rate should be offered for foreign transactions and transfers to attract flows of foreign capital such as FDI and migrants' remittances. In addition, diversification of the economy should be considered as a top priority within the development agenda. In this respect, managing a competitive exchange rate would be a crucial tool to enhance productivity of the agricultural and manufacturing sectors. Moreover, trade cooperation with neighboring countries in the region like South Sudan would be helpful in increasing foreign earnings, particularly in the short run.

Finally, to provide a complete view on the exchange rate volatility and its economic impact, this issue needs further research on four aspects. First, a study to explore the channels through which exchange rate volatility affects economic performance would be useful. Second, it would be important to identify the source of exchange rate volatility as the economy has undergone many transformations in the last decades including the advent of oil and the secession of South Sudan. Third, empirical studies need to be conducted to assess the impact of exchange rate volatility on FDI by sector. Finally, it could be useful to identify the *de facto* exchange rate regime for Sudan, which would help in an in-depth understanding of the impact of the exchange rate policy interventions on macroeconomic performance.

References

Abdallh, M. 2009. Measuring the equilibrium exchange rate in Sudan during the period (1980-2009). [In Arabic]. *Almasrefi Journal* vol. 53, September. Central Bank of Sudan.

Ali, A. (ed.). 1985. *The Sudan economy in disarray: Essays on the IMF model*. London: Biddles.

Akhtar, M., and R. Hilton. 1984. Effects of exchange rate uncertainty on German and U.S. Trade. *Federal Reserve Bank of New York Quarterly Review* 9, 7–16.

Arize, A., T. Osang, and D. Slottje. 2000. Exchange rate volatility and foreign trade: Evidence from thirteen LDCs. *Journal of Business and Economic Statistics* 18(1): 10–17.

Arratibel, O., R. Martin, and A. Zdienicka. 2011. The effect of nominal exchange rate volatility on real macroeconomic performance in the CEE countries. *Economic Systems* 35, 261–77.

Bayoumi, T., and B. Eichengreen. 1994. Macroeconomic adjustment under Bretton Woods and the post Breton Woods Float: An impulse-response analysis. *The Economic Journal* 104, 813–27.

Bollerslev, T. 1986. Generalised autoregressive conditional heteroscedasticity. *Journal of Econometrics* 31, 307–27.

Central Bureau of Statistics, Sudan. Statistics Publications, various issues. http://www.cbs.gov.sd

Central Bank of Sudan (CBOS). Annual Review, various issues. http://www.cbos.gov.sd/

Chowdhury, A. R. 1993. Does exchange rate volatility depress trade flows? Evidence from error correction models. *The Review of Economics and Statistics* 76, 700–06.

Clark, P. 1973. Uncertainty, exchange risk, and the level of international trade. *Western Economic Journal* 11(3):302–13.

Cushman, D.O. 1988. Exchange rate uncertainty and foreign direct investment in the United States. Weltwirtschaftliches Archive 124.

Darby J., H. Hallet, J. Ireland, and L. Piscitelli. 1999. The impact of exchange rate uncertainty on the level of investment. *The Economic Journal* 109, pp.55-67

Darrat, A., and S. Hakim. 2000. On the integration of emerging stock markets in the Middle East. *Journal of Economic Development* 25(2), pp.119-129

De Grauwe, P., and G. Schnabl. 2004. Exchange rate regime and macroeconomic performance in Central and Eastern Europe. CESifo Working Paper 1182.

De Grauwe, P. 1988. Exchange rate variability and the slowdown in growth of international trade. IMF Staff Papers 35(1):63–84.

Dixit, A., and R. Pindyck. 1994. *Investment under uncertainty.* Princeton University Press.

Dixit, A. 1989. Hysteresis, import penetration and exchange rate pass-through. *Quarterly Journal of Economics* 26, 309–25.

Domaç, I., K. Peters, and Y. Yuzefovich. 2001. Does the exchange rate regime affect macroeconomic performance? Evidence from transition economies. World Bank Policy Research Working Paper 2642.

Edwards, S., and E. Levy-Yeyati. 2003. Flexible exchange rates as shock absorbers. NBER Working Paper 9867.

Elbadawi, I. 1994. The expatriate workers' remittances, parallel foreign exchange market and macroeconomic performance in Sudan. *Journal of African Economies* 3(3):481–512.

Engle, R. 1982. Autoregressive conditional heteroscedasticity with estimates of United Kingdom inflation. *Econometrica* 50, 987–1008.

Fischer, S. 2001. Exchange rate regimes: Is the bipolar view correct? *Journal of Economic Perspectives* 15, 3–24.

Foad, H. 2005. Exchange rate volatility and export oriented FDI. A Paper from Emory University, Atlanta.

Flood, R., and A. Rose. 1995. Fixing exchange rates: A virtual quest for fundamentals. *Journal of Monetary Economics* 36, 3–37.

Franke, G. 1991. Exchange rate volatility and international trading strategy. *Journal of International Money and Finance* 10 (2):292–307.

Frankel, J. A., and A. K. Rose. 2002. An estimate of the effect of common currencies on trade and income. Mimeo. http://haas.berkeley.edu/˜arose.

Friedman, M. 1953. The case for flexible exchange rates. In *Essays in positive economics* 157–203. Chicago: University of Chicago Press.

Goldberg, L., and C. Kolstad. 1995. Foreign direct investment, exchange rate variability and demand uncertainty. *International Economic Review* 36(4):855–73.

Ghosh, A., Ostry, J., Gulde, A. and Wolf, H. 1997) Does the Exchange Rate Regime Matter for Inflation and Growth? IMF Economic Issues, 2, p.1-19.

Gylfason, T. 2000. Fix or flex? Alternative exchange rate regimes in an era of global capital mobility. *North American Journal of Economics and Finance* 11(2): 173–89.

Hooper, P., and S. Kohlhagen. 1978. The effect of exchange rate uncertainty on the prices and volume of international trade. *Journal of International Economics* 8(4): 483–511.

Jansen, D. 1989. Does inflation uncertainty affect output growth? Further evidence. The Federal Reserve Bank of St. Louis Review, July/August 1989, 43–54.

Johansen, S., and K. Juselius. 1990. Maximum likelihood estimation and inference on cointegration-with application to the demand for money. *Oxford Bulletin of Economics and Statistics* 52, 169–210.

Kasman, A. and A. Kasman. 2005. Exchange rate uncertainty in Turkey and its impact on export volume. *METU Studies in Development* 32 (June): 41–58.

Klein, M. W. 1990. Sectoral effects of exchange rate volatility on the US exports. *Journal of International Money and Finance* 9, 299–308.

Lee K., and P. Saucier. 2005. Exchange rate instability and trade integration -The case of Asia. 5th International Conference International Trade and Logistics Corporate Strategies and The Global Economy, LE HAVRE – 28-29 September.

Levy-Yeyati, E., and F. Sturzenegger. 2002. To float or to fix: Evidence on the impact of exchange rate regimes on growth. *American Economic Review* 12(2):1–49.

McKenzie, M. 1998. The Impact of Exchange Rate Volatility on Australian Trade Flows. *Journal of International Financial Markets, Institutions and Money* 8: 21-38.

Markusen, J. R. 1995. The boundaries of multinational enterprises and the theory of international trade. *Journal of Economic Review* 9: 169–89.

Meade, J. 1951. *The theory of international economic policy: The balance of payment*. Oxford: Oxford University Press.

McKinnon, R., and G. Schnabl. 2004. The East Asian dollar standard, fear of floating, and original sin. *Review of Development Economics* 8: 331–60.

McKinnon, R., and G. Schnabl. 2003. Synchronized business cycles in East Asia and fluctuations in the Yen-Dollar exchange rate. *The World Economy* 26, pp: 1067-1188.

McKinnon, R. 1963. Optimum currency areas. *American Economic Review* 53, 717–24.

McKenzie, M. D., and R. Brooks. 1997. The impact of exchange rate volatility on German-US trade flows. *Journal of International Financial Markets, Institutions and Money* 7, 7387.

Mundell, R. 1995. Exchange rate systems and economic growth. In *Monetary standards and exchange rates* ed. M. C. Marcuzzo, L.H. Officer, and A. Rosselli, 13–37.

Mundell, R. 1973. Uncommon arguments for common currencies. In *The economics of common currencies* ed. H. Johnson and A. Swoboda, 114–32. London: Allen &Unwin.

Mundell, R. 1961. A theory of optimal currency areas. *American Economic Review* 51, 657–65.

Pagan, A. and Ullah, A. 1988. The econometric analysis of models with risk terms. *Journal of Applied Econometrics* 3, pp. 87-105.

Peree, E., and A. Steinherr. 1989. Exchange rate uncertainty and foreign trade. *European Economic Review* 33: 1241–64.

Pesaran, H., and B. Pesaran. 1997. *Working with Microfit 4.0: Interactive econometric analysis*. Oxford: Oxford University Press.

Rahman, J. 2008. Current account developments in new member states of the European Union: Equilibrium, excess and EU-phoria. IMF Working Paper 92.

Rose, A. K. 2000. One money, one market: The effect of common currencies on trade. *Economic Policy* 30, 7–46.

Schadler, S., P. Drummond, L. Kuijs, Z. Murgasova, and R. van Elkan. 2005. Adopting the euro in Central Europe: Challenges of the next step in European integration. IMF Occasional Paper 234.

Sercu, P., and C. Vanhulle. 1992. Exchange rate volatility, international trade, and the value of exporting firms. *Journal of Banking and Finance* 16(1): 155–82.

Sims, C. A. 1980. Macroeconomics and reality. *Econometrica* 48:1–48.

Siregar, R., and R. Rajan. 2004. Impact of exchange rate volatility on Indonesia's trade performance in the 1990s. *Journal of the Japanese and International Economies* 18: 218–40.

Stokman, A., and P. Vlar. 1996. Volatility, International Trade and Capital Flows. *Financial and Monetary Policy Studies* 32, pp 115-132

Schnabl, G. 2007. Exchange rate volatility and growth in small open economies at the EMU periphery. European Central Bank Working Paper Series 773.

UNCTAD. 2008. "World Investment Directory: Volume X- Africa" United Nations Conference on Trade and Development, UN. New York. USA.

World Bank. 2008. Revitalizing Sudan's non-oil exports: A Diagnostic Trade Integration Study. Prepared for the Integrated Framework Program. December, World Bank, Washington, DC.

World Bank. World Bank's World Development Indicators, accessed September, 2012.

Figure 1: Impulse Response Functions Results

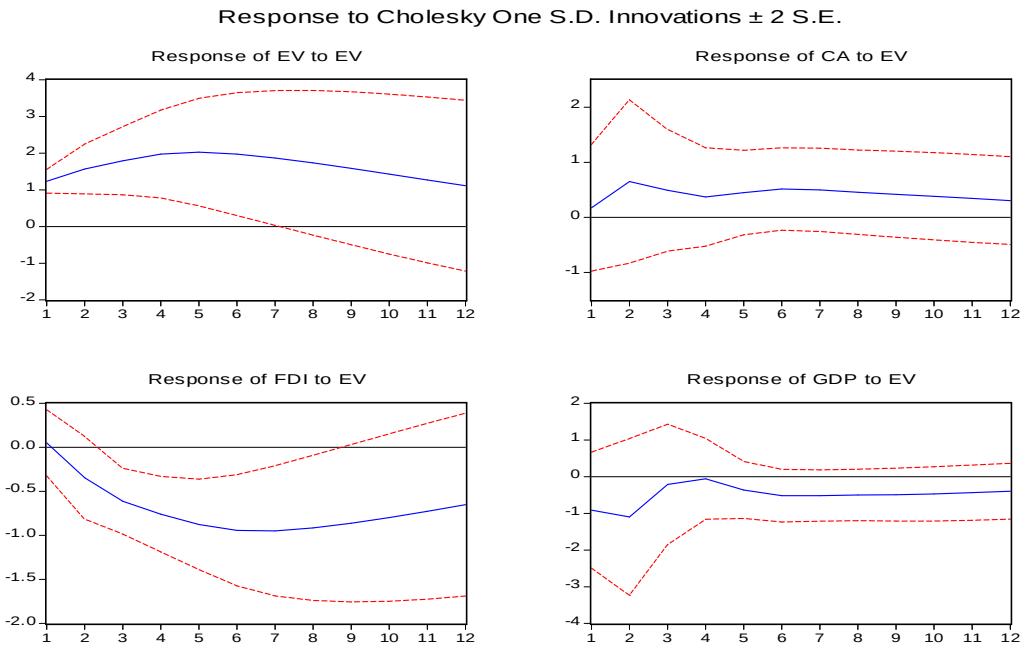


Table 1: The Results of 2SLS (Economic Growth Model)

The dependent variable is the real GDP growth			
Variable	**Coefficient**	**t-statistics**	**P-value**
$DGDP_{-1}$	0.397	1.696	0.1053
DINF	-5.255*	-1.883	0.0742
DOPN	4.794*	1.880	0.0747
DINV	3.127	0.658	0.5176
DGOV	3.480	0.442	0.6628
DEV	-3.582	-0.219	0.8288
Dummy-1979-84	4.113	1.479	0.1546
Dummy-1999-09	0.191**	2.211	0.0388
constant	-1.190	-0.615	0.5451
R^2 48		LM 0.4271	
F 2.26 (0.065)		White 0.3141	
RESET 0.3003			

Note: ** indicates significance at the 5% level and * indicates significance at the 10% level. The instrumental variables consist of 1-4 years lagged values of independent variables except for dummy variable. D is the first difference operator.

Table 2: The Results of 2SLS (FDI Model)

The dependent variable is FDI			
Variable	**Coefficient**	**t-statistics**	**P-value**
$DFDL_1$	0.207	0.961	0.3476
DGDP	-0.0003	-0.869	0.3947
DOPN	0.0103	0.883	0.3874
DINF	-0.014**	-2.415	0.0254
DINRA	0.025**	2.127	0.0460
DEV	-0.094**	-2.466	0.0228
Dummy-1992	0.0001	0.029	0.9770
Dummy-1999-09	0.020**	2.748	0.0124
Constant	0.002	0.652	0.5217
R^2 64		LM 0.2178	
F 4.46 (0.003)		White 0.0829	
RESET 0.2524			

Note: ** indicates significance at the 5% level and * indicates significance at the 10% level. The instrumental variables consist of 1-4 years lagged values of independent variables except for dummy variable. D is the first difference operator.

Table 3: The Results of 2SLS (Current Account Model)

The dependent variable is the Current Account Balance (CA)			
Variable	Coefficient	t-statistics	P-value
DCA-1	-0.144	-0.817	0.4232
DGDP	-0.152*	-1.941	0.0665
DINF	-0.050**	-2.168	0.0423
DFDI	-1.129**	-2.535	0.0197
DOPN	-0.015	-0.111	0.9123
DEV	3.292	0.412	0.6841
Dummy-1979-84	0.413	0.298	0.7688
Dummy- 1992	-1.232*	-1.964	0.0636
constant	0.279	0.289	0.7751
R^2 49		LM 0.0874	
F 3.93 (0.073)		White 0.5914	
RESET 0.9025			

Note: ** indicates significance at the 5% level and * indicates significance at the 10% level. The instrumental variables consist of 1-4 years lagged values of independent variables. D is the first difference operator.

Table 4: Variance Decomposition Results

Period	EV	CA	FDI	GDP
		Variance Decomposition of CA		
1	0.311336	99.68866	0.000000	0.000000
4	6.199128	92.75648	0.240836	0.803560
8	11.89989	85.49128	1.851393	0.757430
12	14.67786	81.84150	2.745266	0.735378
		Variance Decomposition of FDI		
1	0.251501	18.08591	81.66259	0.000000
4	46.66149	11.46156	41.45124	0.425705
8	66.10427	10.10728	23.52190	0.266551
12	65.82682	12.29752	21.58606	0.289605
		Variance Decomposition of GDP		
1	4.497369	2.963363	2.419895	90.11937
2	7.158066	25.27795	8.834671	58.72931
3	9.905036	24.60071	9.041440	56.45281
4	12.11026	24.23144	9.355226	54.30308

Cholesky Ordering: EV, CA, FDI, GDP

Annexes

Annex I: Definitions and Sources of Data Used in the Analysis

Variable	Definition	Source
EV	Is the real effective exchange rate volatility, measured by the ARCH model. The data on REER was obtained from CBOS which is calculated using the following formula. $$REER_t = \frac{\sum_{t=1}^{k} \omega_{it} e_{it} P_{it}^*}{P_t}$$ where ω_{it} is the trade weight corresponding to each trading partner; e_{it} is the real bilateral exchange rate; P_{it}^* is the foreign price index calculated as the weighted CPI index; P_t is domestic CPI for Sudan. The main trade partners of Sudan are: China, Egypt, Germany, India, Saudi Arabia, South Korea, UAE, and United Kingdom (CBOS 2010).	Central Bank of Sudan (CBOS)
GDP	Annual real GDP growth rate	Central Bureau of Statistics, Sudan
FDI	Foreign direct investment, measured as ratio of FDI inflow to GDP	UNCTAD (2008) and Central Bank of Sudan (CBOS)
CA	The ratio of current account balance to GDP	Central Bank of Sudan (CBOS)
OPN	Trade openness, defined as value of exports plus imports divided by GDP	Central Bureau of Statistics, Sudan
INV	Domestic Investment, measured by fixed capital formation as share of GDP %	Central Bank of Sudan (CBOS)
GOV	General spending, is the government final consumption expenditure for purchases of goods and services, measured as share of GDP %	Central Bureau of Statistics, Sudan
INF	Inflation rate, measured by the annual average of inflation rates	Central Bureau of Statistics, Sudan
INFR	Level of infrastructure, measured by the number of telephones per 1,000 people	World Bank's World Development Indicators
FD	Financial deepening, measured by ratio of broad money (M2) to GDP	Central Bank of Sudan (CBOS)

Annex II: Descriptive Statistics of the Variables Used in the Analysis

Variable	Mean	Median	Maxi-mum	Mini-mum	Std. Dev.	Skew-ness	Kurtosis	Jar-Bera	Pro-bability	Obs
GDP	2.154	3.093	11.554	-8.9189	4.7265	-0.6616	3.411	2.399	0.3011	31
FDD	2.279	0.192	9.710	0.250	3.0056	1.0146	2.783	5.205	0.0740	31
CA	-4.624	-4.092	1.234	-13.22	3.3063	-0.4837	2.994	1.170	0.5570	31
EV	0.032	0.0007	0.365	4.20E-05	0.0777	3.1122	12.727	166.700	0.0000	31
OPN	26.392	24.820	46.346	11.087	11.2526	0.1968	1.721	2.237	0.3267	31
INV	13.920	12.083	26.536	5.539	5.3092	1.0201	3.147	5.230	0.0731	31
POP	2.607	2.536	3.364	2.245	0.3313	1.2589	3.391	8.116	0.0172	31
INF	41.763	24.964	132.823	4.871	39.9135	1.0917	2.865	5.981	0.0502	31
INFR	0.686	0.246	2.743	0.2179	0.7034	1.647	4.884	18.008	0.0001	31
FD	16.972	17.339	27.587	6.789	6.7652	0.0806	1.711	2.107	0.3487	31

Source: Eviews5 output.

Annex III:

Table 1: Unit Root Tests –Variables Used in the Regression Models

Variable	ADF		PP	
	Constant	Constant + Trend	Constant	Constant + Trend
FDI	-1.17	-0.523	-0.901	-2.23
GDP	-1.24	-3.28*	-5.01***	-5.20***
OPN	-1.32	-1.76	-1.16	-1.71
INF	-1.15	-1.63	-5.40***	-5.37***
INFR	-2.24	-2.09	-1.00	-1.74
FD	-2.26	-0.30	-1.34	-0.74
INV	-1.81	-2.22	-1.71	-2.17
GOV	-1.44	-1.51	-1.53	-1.40
CA	-2.92	-3.90**	-2.88	-3.15
EV	-3.75**	-3.87**	-3.80**	-3.91**
Δ FDD	-5.86***	-5.61***	-5.36***	-5.10***
Δ GDP	-6.08***	-5.93***	-15.58***	-15.96***
Δ OPN	-7.02***	-7.31***	-6.90***	-7.35***
Δ INF	-3.89***	-3.91**	-5.42***	-5.37***
ΔINFR	-3.07**	-3.61**	-3.69***	-3.63**
Δ FD	-3.92***	-4.22**	-4.08**	-4.20**
ΔINV	-6.57***	-6.50***	-6.88***	-7.59***
ΔGOV	-4.69***	-4.98***	-4.69***	7.09***
Δ CA	-5.20***	-5.09***	-9.87***	-9.47***
Δ EV	-6.25***	-6.13***	-7.45***	-7.33***

Note: ** and *** indicate significance at 5 and 1 percent respectively. Lag 3 is the maximum lag length used in the test, selected by Akaike Information Criterion (AIC). Δ is the first difference operator. All series are expressed in logarithm.

Annex IV: The Cointegration Results

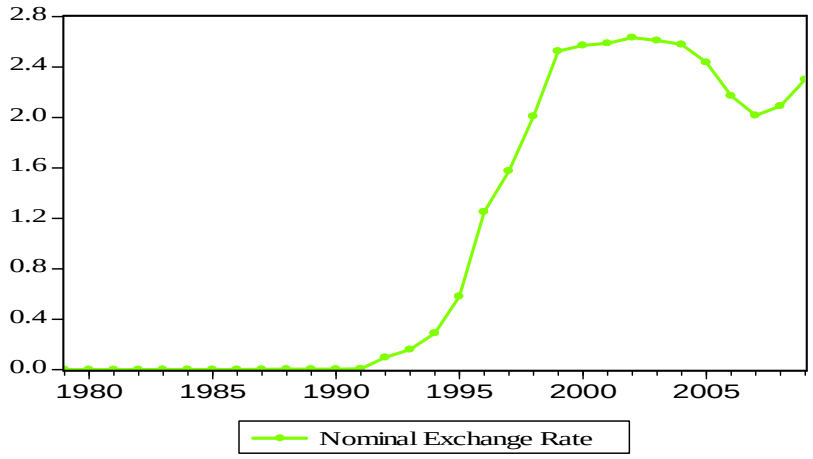
Null hypothesis	Eigenvalue	Trace statistics	95%	Maximum eigenvalue	95%
None	0.988018	190.2793*	47.85613	115.0327*	27.58434
At most 1	0.900144	75.24660*	29.79707	59.90456*	21.13162
At most 2	0.402082	15.34203	15.49471	13.37183	14.26460
At most 3	0.072977	1.970204	3.841466	1.970204	3.841466

Annex V: The Result of ARCH Model

Dependent Variable: LOG(REER)				
	Coefficient	Std. Error	z-Statistic	Prob.
	Variance Equation			
C	4.80E-05***	9.23E-06	5.198031	0.0000
RESID(-1)^2	3.696401***	1.409655	2.622202	0.0087
GARCH(-1)	-0.011016	0.006778	-1.625252	0.1041

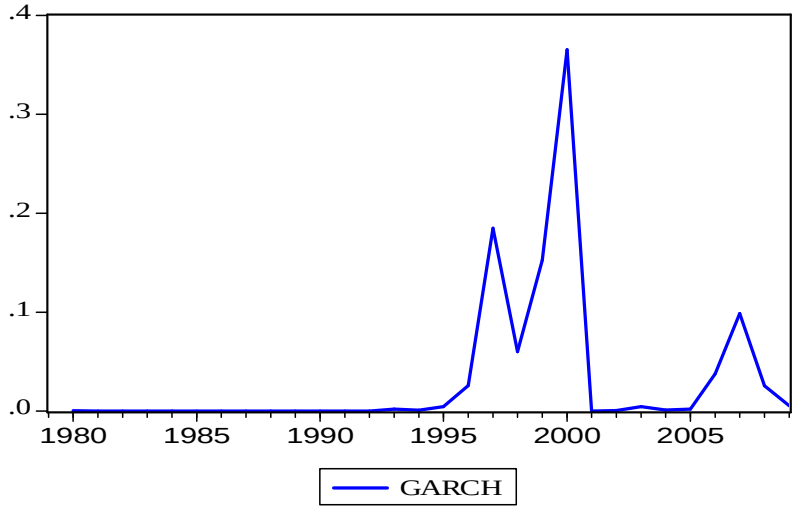
Note: *** significance at 1% level

Annex VI: The Trends of Nominal Exchange Rate in Sudan (1979-2009)



Source: Adopted from the Central Bank of Sudan (COBS) Annual Report- Various Issues

Annex VIII: GARCH (1,1) Volatility of the Real Effective Exchange Rate



Source: Eviews5.