Chapter One

Introduction

1.1 Overview

The research combines macroeconomics theory with International Trade Relations and econometric analysis.

The final result of this research is expected to provide an empirical insight on relationship between country's export and its exchange rate, in particular to examine the impact of the oil revenues and South Sudan secession on the exchange rate, using a large time series data set covering from the period Jan 2003 to Dec 2014.

1.2 Introduction

The Republic of Sudan (Arabic: جمهورية السودان ,Jumhūrīyat as-Sūdān), is a country in North East Africa. It is also considered a part of the Middle East politically and geographically. It is bordered by Egypt to the north, the Red Sea to the northeast, Eritrea and Ethiopia to the east, South Sudan to the south, the Central African Republic to the southwest, Chad to the west, and Libya to the northwest. (http://en.wikipedia.org/wiki/Sudan 27/09/2011 12:58 pm)

Sudan is an overwhelmingly agricultural country. Agricultural production varies from year to year. The government plays a major role in planning the economy. The leading export crops are cotton, sesame, peanuts, and sugar. Other agricultural products include sorghum, millet, and wheat. Sheep, cattle, goats, and camels are raised. The leading products of the country's small mining industry are iron ore, copper, and chromium ore.

Petroleum reserves were developed in the 1970s, but the work was discontinued in the mid-1980s as military conflict in the now independent South Sudan intensified. In the late 1990s, the government sought foreign partners to help redevelop the oil sector, and a pipeline was built from South Sudan to Port Sudan, on the Red Sea. Sudan began exporting crude oil in 1999.

Industry is largely confined to agricultural processing and light manufacturing; the chief products include ginned cotton, textiles, processed food, beverages, soap, footwear, pharmaceuticals, and armaments. There is also some automobile and light-truck assembly. Petroleum is refined and hydroelectric power is produced. The country has a very limited transportation network. Foreign trade is largely conducted via Port Sudan. Chief among the annual imports are food, manufactured goods, refinery and transportation equipment, medicines, chemicals, textiles, and wheat; the principal exports are oil and petroleum products, cotton, sesame, livestock, peanuts, gum Arabic, and sugar. The leading trade partners are China, Japan, Saudi Arabia, and South Sudan. (http://www.answers.com/topic/sudan 27/09/2011 14:20)

1.3 **Problem Statement**

Sudan has diversity of resources such as oil, mining, gum arabic, agriculture, livestock, water and climate. All these resources need capital input in order to generate real production which can positively impact on the balance of payment.

Unfortunately these resources have not appropriate influence the country's macroeconomic indicators. The exports of oil sector were not less than 50% of the total country's export, and this means that the sector has a significant impact on the exchange rate and balance of payments.

The research will investigate the relationship and the actual impact of oil revenues on the exchange rate especially after secession of South Sudan.

The research will answer the following questions:

Is there a long run equilibrium relationship between oil revenues and exchange rates?

What is the effect of oil revenues impact on exchange rate in Sudan?

Has secession of South Sudan effected exchange rate fluctuations?

1.4 The Importance

The export sector plays a very significant role in macroeconomic situation, and it has a great contribution in the foreign trade balances. In this context, the research will discuss the importance of the export diversification for the economy which will reduce the influence of one industry domination.

1.5 **The Objectives**

The research aims to achieving the following objectives:

- Explaining the relation between the exchange rate and the oil revenues. The impact of Oil Revenues on the Exchange Rate.
- Stressing the importance of export diversification and its impact on a Macroeconomic Policy to stabilize key economic indicators such as Inflation, Balance of Payment, Gross Domestic Production and FDI.

1.6 **The Hypothesis**

The research is based on the following hypothesis:

Existence of long run relation or equilibrium between oil revenues and exchange rate.

Oil revenues has a negative effect on the exchange rate “when oil revenues increase the local exchange rate appreciate”.

Secession of Sudan has caused exchange rate deterioration.

Any decline in oil demand will affect the exchange rate as well as the other key macroeconomic indicators such as inflation rate and Gross Domestic Product.

1.7 **The Methodology**

The research adopted an analytical and econometric methods.

An empirical methods based on econometric methodology such as regression time series modeling through examining co-integration, Error Correction Model (ECM), Autoregressive Distributive Lags (ARDL) and Vector Autoregression (VAR).

1.8 Statistical Software

Eviews 9 was conduct for statistical analysis.

1.9 **The Scope**

The area of research is on exchange rate and oil revenues from Jan 2003 to Dec 2014, for Republic of Sudan.

1.10 **The Research Structure**

The research contains four chapters, first chapter is focusing the research problems, importance, hypothesis and objectives. Chapter two is a briefing on Sudan economics. Chapter three deal with the theoretical framework and chapter four reviewed empirical analysis.

Chapter One: Introduction

Chapter Two: Sudan Economics

Chapter Three: Theoretical Concept

(Data and Methodology)

Chapter Four: Empirical Analysis, Results and Recommendations

Chapter Two

Sudan Economics

2.1 Overview

Sudan's real gross domestic product (GDP) grew by 3.6% in 2013, up from 1.4% in 2012, driven by agriculture and mining as well as the inflows from oil transit fees and the Transitional Financial Arrangement (TFA) with South Sudan. However, inflation remained high (36.2%), reflecting the combined effect of inflationary financing, the devaluation of the currency and high energy prices. It is estimated that real growth will recede slightly in 2014 to 2.7% and is projected at 3.8% in 2015. Inflation dropped by 9.4 percentage points in 2014, and increased about at 23.2% for 2015. However, the credibility of the government's disinflation programme relies on addressing the contractionary effects of fiscal consolidation and boosting value addition in agriculture, manufacturing and mining.

The repercussions of the July 2011 secession continue to aggravate the challenges of economic management. The resulting high external and internal deficits, coupled with the sustained United States sanctions continue to threaten macroeconomic stability. In September 2013 austerity measures were introduced to supplement the 2013 budget, including the devaluation of the currency by 29% and removal of fuel subsidies worth SDG 3.6 billion (Sudanese pounds) about 1.2% of GDP.

(http://www.afdb.org/en/countries/east-africa/sudan/sudan-economic-outlook/ May20, 2014 11:25)

The secession of South Sudan induced multiple economic shocks. The most important and immediate was the loss of the oil revenue which accounted for over half of government revenues and 95% of exports. This has left huge macro-economic and fiscal challenges, much reduced economic growth, and double-digit consumer price inflation which, together with increased fuel prices in September 2013.

(Macroeconomics Concept)

A large number of empirical studies have been conducted during the early studies to investigate the role of exchange rates on exports, emphasizing how the exchange rates devaluation/depreciation or revaluation/appreciation effects on exports in international markets.

The approach of this research emphasizes the opposite side; how the revenue gaining from country's export impact on the exchange rates, by another meaning how the deficit/surplus of trade balance effects on the value of the local currency. So, the primary goal is to examine how the exchange rate as a dependent variable and one of the most macroeconomic indicators reacts to the fluctuations in the oil revenue as an independent variable.

The Exchange Rate

The exchange rates are determined by the interaction of currency demand and supply, it's flexible without direct intervention by government authorities and it's fixed with direct intervention by government authorities.

The nominal exchange rate is the rate at which a person can trade the currency of one country for the currency of another. Real exchange rate is the rate at which person can trade the goods and services of one country for the goods and services of another. (Mankiw 2008 p 399 - 400).

Types of Exchange Rate

Nominal Exchange Rate

The nominal exchange rate is the number of units of foreign currency that can be obtained for one unit of domestic currency. The real exchange rate is the number of units of foreign goods that can be obtained for one unit of domestic good. The idea that similar foreign and domestic goods should have same prices in terms of the same currency is called purchasing power parity, (PPP). (Abel, Bernanke and Richmond 2008 p 480).

The nominal exchange rate is the rate at which a person can trade the currency of one country for the currency of another and the nominal exchange rate is expressed in two ways:

1. In units of foreign currency per one SDG.
2. In units of SDG per one unit of the foreign currency.

So, if the exchange rate between the SDG and U.S. dollar is 5.7 SDG to one dollar, then: one U.S. dollar trades for 5.7 SDG and one SDG trades for 1/5.7 which is equal to 0.175 of a dollar.

Appreciation refers to an increase in the value of a currency as measured by the amount of foreign currency it can buy, and depreciation refers to a decrease in the value of a currency as measured by the amount of foreign currency it can buy. So, if a SDG buys more foreign currency, there is an appreciation of the SDG, and if it buys less there is a depreciation of the dollar.

Real Exchange Rates

The real exchange rate is the rate at which a person can trade the goods and services of one country for the goods and services of another; the real exchange rate compares the prices of domestic goods and foreign goods in the domestic economy. If one good in specific country is twice as expensive as another country, the real exchange rate is 1/2 of specific country per another country.

The real exchange rate is a key determinant of how much a country exports and imports.

Real exchange rate = Nominal exchange rate * Domestic price / Foreign price

A depreciation (fall) in the home currency real exchange rate means that home goods have become cheaper relative to foreign goods, this encourages consumers both at home and abroad to buy more home goods and fewer goods from other countries. As a result, home country exports rise, and imports fall, and both of these changes raise home country net exports; this is if home country produces goods and services can compete the international productions, by another meaning if the home country goods are elastic.

Terminology for Changes in Exchange Rates

Type of exchange rate system	Exchange rate increases (currency strengthens)	Exchange rate decreases (currency weakens)
Flexible exchange rates	Appreciation	Depreciation
Fixed exchange rates	Revaluation	Devaluation

2.2 (Abel, Bernanke and Richmond 2008 p 480)

2.2 **Current Macroeconomic Indicators**

The years before international financial crises the trade balance surplus was increasing especially 2007 and 2008, and then the impact of the financial crises appeared in 2009 where the trade balance reached deficit (1,433,813). The main reason for this increasing/decreasing was from the exported oil. The oil was the most important component of trade balance items.

The % of petroleum export from the total exports (prepared by the student)

Year	Petroleum Export	Non Petroleum Export	Total Export	Trade Balance (In US$000'S)	% Petroleum Export
2008	11,094,111	576,393	11,670,504	2,318,964	95.06
2009	7,236,787	1,020,318	8,257,105	(1,433,813)	87.64
2010	9,692,262	1,712,018	11,404,280	1,359,510	84.98
2011	7,304,362	2,384,479	9,688,841	452,833	75.38
2012	954,988	3,111,511	4,066,499	(5,163,819)	23.48
2013	4,013,032	3073,187	7,086,219	(2,831,849)	56.63

In 2009 when the oil prices fall from above 140 USD / barrel to less than 30 USD / barrel deficit in trade balance was recoded (1,433,813) and oil revenue fall to 7,236,787 instead of 11,094,111 in 2008, this affected to the exchange rate, and it depreciated from 2.0965 to 2.3259 in 2008 to 2009 respectively

After south Sudan secession in the middle of 2011 the oil exports fall and in 2012 trade balance deficit recorded (5,163,819), the non-oil exports increased from 2,384,479 to 3,111,511 in 2011 and 2012 respectively.

Year	**GDP %**	**M2 %**	**INF %**	**Average of Exchange Rate**	**Trade Balance (In US$000'S)**	**Balance of Payments (In US$000'S)**
2008	6.4	16.3	14.3	2.0913	2,318,964	21.1
2009	5.9	23.5	11.2	2.3173	(1,433,813)	(502.00)
2010	5.2	25.4	13.1	2.3701	1,359,510	(54.2)
2011	1.9	17.9	18.1	2.6666	452,833	(644.5)
2012	1.1	40.2	35.1	3.5736	(5,163,819)	0.1
2013				4.9442	(2,831,849)	

(prepared by the student)

From the table above the rate of GDP going down and the M2 and Inflation are increasing, the exchange rate depreciating and the deficit noted in trade balance continuously.

2.3 Exchange Rates and Macroeconomic Policy

The depreciation/devaluation of local currency from its required level directly affects the prices of imports; production inputs and other goods, and this necessarily raises both of the imported and local inflation. **(** see more details in: Daniels, VanHoose, 2005 p 298-323) and Abel, Bernanke and Richmond 2008 p 499- 518)

With flexible exchange rates, government can use its monetary and fiscal policies to pursue whatever economic goals it chooses. Under a fixed rate regime, the government may have to take contractionary (expansionary) monetary and fiscal policies to correct the BOP deficit (surplus) at the existing exchange rate.

A nation's supply of exports and demand for imports determine its demand for and supply of foreign exchange. If capital flows occur only to finance current account transactions, then the supply and demand for foreign exchange is determined by a nation's imports and exports of goods and services. When a nation's residents import goods and services, they must pay for these imports with foreign exchange. Hence, the nation's residents supply foreign exchange. Likewise, when a nation's residents export goods and services, they require foreign exchange as payment for these exports, which yields their demand for foreign exchange. (Daniels, VanHoose, 2005 p 287)

A flexible exchange rate system, the value of the nominal exchange rate is determined by supply and demand in the foreign exchange market. Foreigners demand the domestic currency to buy domestic currency to obtain the foreign currency needed to buy foreign goods and assets. Domestic resident supply the domestic currency to obtain foreign currency needed to buy foreign goods and assets. When other factors held constant, an increase in domestic output leads domestic residents

In a fixed exchange rate system, nominal exchange rate is officially determined. If the officially determined exchange rate is greater than the fundamental value of the exchange rate as determined by supply and demand in the foreign exchange market, the exchange rate is said to be overvalued. The central bank can maintain the exchange rate at an overvalued level for a time by using official reserves “such as gold, foreign currency and bank deposits” to buy in the foreign exchange market. A country that tries to maintain an overvalued exchange rate for too long will run out of reserves and be forced to devaluate its currency.

In general there are several possible strategies to deal when the official exchange rate is different from the fundamental value of its exchange rate as follows:

1. The country can change the official value so that it equals, or is close to, its fundamental value;

2. The government could restrict international transaction “using both fiscal and monetary policies’ by limiting or taxing imports or financial outflows, such policies reduce the supply of the domestic currency to the foreign exchange market and sometimes to prohibit people from trading currency;

3. The central bank may intervene directly to the exchange market to become a demander or supplier for the currency in order to maintain the local currency.

Oil revenue in most oil-exporting countries is paid directly to the government as the guardian of the natural resources. Hence, the government becomes the conduit for the oil revenues into the economy and the effect of the revenues on the real exchange rate depends on the saving/investment behavior it induces. If the revenue is unstable and/or transitory and spills over into fiscal policy, then the real exchange rate will be unstable and the natural resource blessing could become a curse. Over time, these effects will lead to specialization in the economy's productive structure in favor of nontradables. This will make the economy more vulnerable to oil price volatility particularly in the presence of capital market imperfections (Hausmann and Rigobon, 2003). Fiscal policy is therefore a key element, for most countries, in causing or preventing the resource curse (Devlin and Lewin, 2004). To insulate the economy from oil revenue volatility requires de-linking fiscal expenditures from current revenue. So, an “oil revenue fund” (or more generally, a “natural resource fund”) is one such institutional mechanism for managing the oil revenues. Moreover, if macroeconomic policies to insulate the economy from oil price volatility are implemented, then diversification of the

Economy (real sectors) away from oil will occur, other things equal, through the normal process of saving and investment. The role of government in promoting such diversification is no different in principle from promoting economic development in general. (Mohsen Mehrara , Kamran Niki Oskoui , The sources of macroeconomic fluctuations in oil exporting countries: A comparative research, Institute for Development and Economic Researches, University of Tehran, Iran Accepted 25 August 2006)

It is useful to emphasize the economic reality that the monetary policy “or central bank intervention” alone cannot achieve the required stability to the exchange rate of the local currency. Economic policies should be directed consistently with monetary policy to support the national currency by encouraging investment and increasing productivity, reducing the cost and raising the quality of the local products to be more competitive (price and quality) in the global market, and this will raise the level of exports, and as a result the exchange rate of the local currency will appreciate.

Monetary policy or fiscal policy can make a positive impact on the exchange rate in the desired direction in the short term only, where the assigned task of achieving exchange rate stability over the long term coming from the economic policy in the first and secondly from other policies.

If the policies taken by the authorities are affected the exchange rate positively it will appear from the results of the analyzed data in the upcoming chapters.

Chapter Three

Theoretical Concept

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(Abel, Bernanke and Richmond 2008 p 480)

3.3 Exchange Rate and Balance of Payments Determination

There are two traditional approaches to exchange rate and balance of payments determination, namely the Marshal Lerner Condition or "elasticity" approach and the "absorption" approach.

3.3.1 Marshall Lerner Condition MLC:

Marshall Lerner Condition MLC: if price elasticity demand for export PEDxn > 1 then a depreciation of currency will lead to an improvement in the current account balance towards surplus.

And, if PEDxn < 1 then depreciation or devaluation of the currency will lead to a worsening in the current account balance towards deficit.

Assumptions:

1. The current account measures the revenues from the sale of exports X mines expenditures on imports M;
2. The revenue from net exports TRxn increases if X grows faster than M, and decreases if M grows faster than X;
3. If a nation's currency depreciates, its current account balance tends to improve, or move towards surplus.

3.3.2 Absorption Approach:

The absorption approach emphasizes changes in real domestic income as a determinant of a nation's balance of payments and exchange rate, because it treats prices as constant, all variables are real measures.

3.4 Time Series Regression Modeling

Regression modeling with financial time series requires some care, because the time series properties of the data can influence the properties of standard regression estimates and inference methods. In general, standard regression techniques are appropriate for the analysis if I (0) / stationary data. (Eric Zivot and Jiahui Wang, 2006, p.181).

In this part of the dissertation the discussion will deal with some issues related to our analyzing tools for the realization of the stochastic process such as Stationary and non-stationary Process, Unit Root Test, Spurious Regression, Cointegration and Error Correction Model.

3.5 Stationary and Nonstationary Time Series

Historically the nation of a stationary process has played an important role in the analysis of time series .A stationary Time Series process is one whose probability distributions are stable over time in the following series: if we take any collection of random variables in the sequence and then shift that sequence ahead h time periods, the joint probability distribution must remain unchanged. (Jeffrey M. Wooldridge, 2009, p 378)

Stationary is important because if the series is non-stationary then all the typical results of the classical regression analysis are not valid in most times. Regression with non-stationary series may have no meaning and therefore called “Spurious”.

Shocks to a stationary time series are necessarily temporary; over time, the effects of the shocks will dissipate and the series will revert to its long-run mean level. As such long term forecasts of a stationary series will converge to the unconditional mean of the series (Dimitrios and Stephen, 2007, p 230)

Spurious regressions in econometrics are usually associated with I(1) processes, which were explored in Phillips’s well-known theory and in the best known simulations, what is less appreciated is that the problem can also occur, although less clearly, with stationary processes. (Steven & Lawrence 2010, p 267)

The stationary is the most vital common assumption in time series and the basic idea of stationary is that probability laws governing the process do not change with time.

3.5.1 Stationary Time Series:

A stochastic process is said to be stationary if its mean and variance are constant over time and the value of the covariance between the two periods depends only on the distance or gap or lag between the two time periods and not the actual time at which the covariance is computed. (Gujarati, 2004, p.787).

3.5.1.1 Weakly Stationary (Covariance Stationary):

- Constant Mean:

  $E(y_t) = u$

- Constant Variance:

$$V(Y_t) = E[(y_t - u)^2 = \sigma^2$$

- Autocovariance:

$$Cov(y_t, y_{t+k}) = cov(y_t, y_{t-k}) = E\{(y_t - \mu)(y_{t+k} - \mu)\} \\ = \gamma_{k,} \forall t$$

3.5.1.2 Strictly Stationary: $Y_t \sim iid\, N(0, \sigma^2) \equiv GWN\ (0, \sigma^2)$

But the strictly stationary process is called the white noise process / Gaussian white noise process, and this process has zero mean, constant variance σ^2 and is serially uncorrelated.

3.6 Spurious Regressions:

Most macroeconomic time series are trended and therefore in most cases are non-stationary. The problem of non-stationary or trended data is that the standard OLS regression procedures can easily lead to incorrect calculations. It can be shown a very high values of R^2 (sometimes even higher than 0.95) and very high values of t-ratios (sometimes even higher than 4) and very low values of Durbin-Watson test, while the variables used in the analysis have no interrelationships. (Dimitrios and Stephen, 2007, p. 291)

When non-stationary time series are used in regression model, the results may spuriously indicate a significant relationship when there is none. In this case least square estimator and least square predictor do not have their usual properties and t-statistics are not reliable.

Testing whether a series is stationary or non-stationary the most popular method is Dickey-Fuller test, and through co-integration methods may be deal with nonstationary data to fit for regression analysis.

3.7 Unit Root:

Consider the AR(1) model:

$$y_t = \emptyset y_{t-1} + u_t \quad 3.1$$

Where e_t is a white-noise process and the stationaryity condition is $|\emptyset| < 1$

In general we can have three possible cases:

Case 1. $|\emptyset| < 1$ and therefore the series is stationary;

Case 2. $|\emptyset| > 1$ where in this case the series is explodes;

Case 3. $|\emptyset| = 1$ where in this case the series contains a unit root and is nonstationary.

So, if $\emptyset = 1$ then y_t contains unit root. And the model is:

$$y_t = y_{t-1} + e_t \qquad 3.2$$

The above equation 3.1 called random walk model. This model shows that each realization of the random variable y_t contains last period's value y_{t-1} plus an error e_t. These time series are called random walks because they appear to wander slowly upward or downward, with no real pattern; the values of sample means calculated from subsamples of observations will be dependent on the sample period.

Having $\emptyset = 1$ and subtracting y_{t-1} from both sides of equation 3.2 we get:

$$y_t - y_{t-1} = y_{t-1} - y_{t-1} + e_t \qquad 3.3$$

$$\Delta y_t = e_t \qquad 3.4$$

While e_t is a white noise process then Δy_t is stationary series. Therefore after differencing y_t we obtained stationary series.

3.8 Unit Root Test:

There are different ways for testing whether a series is stationary or non-stationary, the most method for unit root test is a Dickey – Fuller test. This test depends on three different elements such as; the model formula, sample size and the significant level.

3.8.1 **No Constant No Trend:**

Consider again the AR(1) model:

$$y_t = \emptyset y_{t-1} - e_t \qquad 3.5$$

Where the e_t are independent random errors with zero mean and constant variables σ_e^2, we can test for nonstationaritybу testing the null hypothesis that $\emptyset = 1$ against the alternative that $\emptyset < 1$

By another meaning subtracting y_{t-1} from the both sides equation above 3.5 to obtain:

$$y_t - y_{t-1} = \emptyset y_{t-1} - y_{t-1} + e_t \tag{3.6}$$

$$\Delta y_t = (\emptyset - 1)y_{t-1} + e_t \tag{3.7}$$

Let $\rho = \emptyset - 1$

Then,

$H_0: \emptyset = 1 \equiv H_0: \rho = 0$

$H_1: \emptyset < 1 \equiv H_1 \rho < 0$

The null hypothesis is that the series is non-stationary. If we do not reject the null hypothesis we conclude that it is a non-stationary process; if we reject the null hypothesis that $\rho = 0$, then we conclude that the series is stationary.

3.8.2 With Constant but no Trend:

In this case the model includes with constant, and the equation is:

$$\Delta y_t = \alpha + \rho y_{t-1} + e_t \tag{3.8}$$

And the hypothesis as the same as before.

3.8.3 With Constant and With Trend:

The equation to test is:

$$\Delta y_t = \alpha + \rho y_{t-1} + \gamma t + e_t \qquad 3.9$$

And the hypothesis as the same as before.

To determine a suitable equation from three above equations a useful step is to plot the time series of the original observations on the variable and choose the equation on the basis of a visual inspection of the plot.

If the series appears to be wandering or fluctuating around a sample average of zero, use test equation 3.7;

If the series appears to be wandering or fluctuating around a sample average that is non-zero, use test equation 3.8;

If the series appears to be wandering or fluctuating around a linear trend, use test equation 3.8. (R. Carter, William E. and Guay C. 2008, page. 336).

3.8.4 The Augmented Dickey-Fuller Test (ADF Test)

Dickey and Fuller extended their test procedure suggesting an augmented version of the test which includes extra lagged terms of the dependent variable in order to eliminate autocorrelation. The lag length on these extra terms is either determined by the Akaike Information Criterion (AIC) or Schwartz Bayesian Criterion (SBC), or more usefully by the lag length necessary to whiten the residuals (i.e. after each case we check whether the residuals of the ADF regression are autocorrelated or not through LM test and not the DW test). (Dimitrios and Stephen, 2007, p.297)

So, using ADF test instead of DF test is to ensure the errors are uncorrelated.

(Additional information see Gujarati, 2004, p. 814 -819)

3.9 Co-intergration:

Co-integration analysis allows non-stationary data to be used if it integrated in same order, so that spurious results are avoided. It also provides applied econometricians an effective formal framework for testing and estimating long-run models from actual time-series data.

If an OLS regression is estimated with non-stationary data and residuals, then the regression is spurious. To overcome this problem the data has to be tested for a unit roots (i.e. whether it is stationary). If both sets of data are I(1) (non-stationary), then if the regression produces an I(0) error term, the equation is said to be co-integrated.

Co-integration implies that y_t and x_t share similar stochastic trends, and, since the difference e_t is stationary they never diverge too far from each other.

3.9.1 Co-integration Test

Testing for co-integration is necessary step to check if the model empirically meaningful relationships.

If variable have different trend process, they cannot stay in fixed long run relation to each other, implying that you cannot model the long run and there is usually no valid base for inference based on standard distributions

The null hypothesis of no co-integration is tested, such as;

N. Hypothesis: No Co-integration

A. Hypothesis: Co-integration exsist

3.9.2 The Engle-Granger Two-Step Modeling Method (EGM)

This called by the approach of the approach for the bivariate case, and it has to steps as follows:

In the first step, all dynamics are ignored and the co-integrating regression is estimated by the OLS. Let us now write the long-run (co-integrating) regression:

$$Y_t = \beta X_t + u_t \tag{3.10}$$

where both Y_t and X_t are nonstationary variables and integrated of order one (i.e. $Y_t \sim$ I(1) and X_t ~I(1)). In order for Y_t and X_t to be co-integrated.

In the second step, is the necessary condition, is that the estimated residuals from Eq. (1) should be stationary (i.e. $u_t \sim$ I(0)).

So that, The Engle-Granger Two-Step Modeling Method To test for co-integration between two or more non-stationary time series, it simply requires running an OLS regression, saving the residuals and then running the ADF test on the residual to determine if it is stationary. The time series are said to be c-ointegrated if the residual is itself stationary. In effect the non-stationary I(1) series have cancelled each other out to produce a stationary I(0) residual.

3.9.3 The Johansen Maximum Likelihood (ML) Vector Autoregressive (VAR) Method (Multivariate Co-integration):

If we have more than two variables in the model, then there is possibility of having more than one co-integrating vector. Then these variables in the model might form several equilibrium relationships governing the joint evaluation of all the variables. In general, for n number of variables can have only up to n – 1 co-integrating vectors. Therefore, when n = 2, which is the simplest case, we can understand that if co-integration exist then the co-integrating vector is unique.

Having n > 2 and assuming that only one co-integrating relationship exists, where there are actually more than one, is a very serious problem that cannot be resolved by the EG single equation approach. Therefore, an alternative to the EG approach is needed and this is the Johansen approach for multiple equations. (Dimitrios and Stephen, 2007, p. 319)

$$Y_t = \beta_1 + \sum_{j=1}^{n} \beta_j X_{tj} + u_t \qquad 3.11$$

When testing for multivariate co-integration, one of the approaches has been to test for co-integration using a Vector Autoregressive (VAR) approach. This assumes all the variables in the model are endogenous, although it is possible to include exogenous variables as well, although these do not act as dependent variables. The main difference with the Engle-Granger approach is that it is possible to have more than a single co-integrating relationship; the test itself produces a number of statistics which can be used to determine the number of co-integrating vectors present.

Regression When There is no Co-integration

We have shown that regression with I(1) variables is acceptable providing those variables are co-integrated, allowing us to avoid the problem of spurious result, we also know that regression with stationary I(0) variables is acceptable.

What happens when there is no co-integration between I(1) variables? In this case the sensible thing to do is to convert the non-stationary series to stationary series and to use the techniques of Autoregressive lag model ARL or Autoregressive Distributive Lag Model ARDL to estimate dynamic relationships between the stationary variable.

3.10 Error Correction Model

If y_t and x_t are both I(1) ‘ integrated of order one’, and the linear combination between y_t *and* x_t is I(0) ‘integrated at the level’, then y_t *and* x_t are cointegrated.

This allows expressing the relationship between y_t *and* x_t with an ECM which its specifications as follows:

$$\Delta y_t = \beta_1 + \beta_2 \Delta x_t - \beta_3 u_{t-1} + \varepsilon_t \quad 3.12$$

Where

$$u_{t-1} = y_{t-1} - \beta_1 - \beta_2 x_{t-1} \quad 3.13$$

The equation above is the ECM equation, and it states that Δy_t depends on Δx_t and u_{t-1} ‘the equilibrium error term’. In this model, β_2 is the impact multiplier (short-run effect) that measures the immediate impact that a change in x_t will have on a change in y_t, and the β_3 is the adjustment effect, and It refers to the amount of change in the dependent variable as a result of the deviation of the value of the independent variable in the short-term equilibrium value by one unit in the long term, or it shows how much of the disequilibrium is being corrected, so β_3 is expected to be negative to correct the equilibrium error, and it shows the direction ratio of short-run to long-run.

3.10.1 The Importance of ECM

The ECM is important for some reasons, such as:

1. It is a convenient model measuring the correction from disequilibrium of the previous period which has very good economic implication;
2. Having co-integration ECMs are formulated in terms of first differences eliminate trends from the variables involved, and the resolve the problem of spurious regression;
3. It is easy fitting;
4. The disequilibrium error term is stationary variable by co-integration definition. Because of this, the ECM has important implications: the fact that the variables are co-integrated implies that there is some adjustment process which prevents the errors in the long-run relationship becoming larger and larger. (Dimitrios and Stephen, 2007, p. 310-311)

3.11 Non Cointegrated Series

If the series not cointegrated, both of ECM and ARDL Bounds Test will fall, thus VAR is recommended to apply for analysing.

3.12 Vector autoregressive models (VARs)

Vector autoregressive models (VARs) were popularised in econometrics by Sims (1980) as a natural generalisation of univariate autoregressive models. A VAR is a systems regression model (i.e. there is more than one dependent variable) that can be considered a kind of hybrid between the univariate time series models and the simultaneous equations models. VARs have often

> been advocated as an alternative to large-scale simultaneous equations structural models. Chris 2014, p 326

Using VARs allow the value of a variable to depend on more than just its own lags or combinations of white noise terms, so VARs are more flexible than univariate AR models; the latter can be viewed as a restricted case of VAR models. VAR models can therefore offer a very *rich structure*, implying that they may be able to capture more features of the data.

The VAR can be estimated through single equation methods like OLS, which would be consistent, and under the assumption of normality of the errors, efficient (see Canova 1995a, b). *Hilde Christiane Bjørnland* VAR Models in Macroeconomic Research Statistics Norway Research Department Oct 2000.

While the traditional econometric approach allows disturbances or shock to structural equations to be correlated, the VAR methodology insists that structural shocks ought to be independent of one another. Steven & Lawrence p 378, 2010

3.13 Impulse responses and variance decompositions

An impulse response gives the response of one variable, to an impulse in another variable in a system that may involve a number of other variables as well.

Block F-tests and an examination of causality in a VAR will suggest which of the variables in the model have statistically significant impacts on the future values of each of the variables in the system. But F-test results will not, by construction, be able to explain the sign of the relationship or how long these effects require to take place. That is, F-test results will not reveal whether changes in the value of a given variable have a positive or negative effect on other variables in the system, or how long it would take for the effect of that variable to work through the system. Such information will, however, be given by an examination of the VAR's impulse responses and variance decompositions.

3.13.1 Impulse responses trace out the responsiveness of the dependent variables in the VAR to shocks to each of the variables. So, for each variable from each equation separately, a unit shock is applied to the error, and the effects upon the VAR system over time are noted. Thus, if there are g variables in a system, a total of $g2$ impulse responses could be generated. The way that this is achieved in practice is by expressing the VAR model as a VMA -- that is, the vector autoregressive model is written as a vector moving average (in the same way as was done for univariate autoregressive models). Provided that the system is stable, the shock should gradually die away.

3.13.2 Variance decompositions offer a slightly different method for examining VAR system dynamics. They give the proportion of the movements in the dependent variables that are due to their 'own' shocks, versus shocks to the other variables. A shock to the i th variable will directly affect that variable of course, but it will also be transmitted to all of the other variables in the system through the dynamic structure of the VAR. Variance decompositions determine how much of the s-step-ahead forecast error variance of a given variable is explained by innovations to each explanatory variable for s = 1, 2, . . . In practice, it is usually observed that own series shocks explain most of the (forecast) error variance of the series in a VAR. To some extent, impulse responses and variance decompositions offer very similar information. Chris Books 2014, p 336

Chapter Four

Empirical Analysis and Results

Empirical Analysis

4.1 Data:

The data for the variables in this research are obtained from the site of the central Bank of Sudan http://www.cbos.gov.sd/en the sample period spans from the January 2003 to the December of 2014, the variables used the followings:

LEXR: Natural Log of Exchange rate

LOILR: Natural Log of Oil Revenues

4.2 Plotting Series

The figure (4-1) in the appendix are plotting of the two series ‘LLExR and LOilR’ to research the behavior of the series respectively and its obviously nonstationary at the levels.

4.3 Test for Stationarity

Table 4-1 presents the result of unit root tests for the two series LExR and LOilR respectively using the Augmented Dickey-Fuller test. The result supports the presence of unit roots in all series, this confirmed by the fact that the null hypothesis for the series are not rejected at the levels of both variables. After differencing the series LExR is I (1) and LOilR is I (1).

After taking difference and plotting the series became stationary as figure 4-2 noted.

4.4 Long Run Relationship Using Cointegration

To avoid a spurious regression for non-stationary time series and to check the long relationship equilibrium between the variables the Co-integration test is done. The Johansen Cointegration Test procedure is used to examine the existence of cointegration between the two series. According to the results in table 4-2 both of trace and Max-eigenvalue test indicates no cointegration at the significant level of 5%.

Error correction model not possible to use to know the potential equilibrium relationship between the two series while the cointegration condition is not exist. The Autoregressive distributive lags with fractional integration for PHILLIPS-PERRON "PP TEST" was failed due to the absence of cointergration under the bounds test. Thus, Vector Autoregressive (VAR) is applied to analyze the impact after taking the first difference for the data.

4.5 The Model:

Then, the model as follows:

$$LExR = f(\text{LOilR}, DMY) \qquad 4.1$$

Where LExR is the log of exchange rate, LOilR is the log of oil revenue and DMY is Dummy Variable and equal to Zero before the South Sudan Secession and One after the Secession. Then, the VAR system as follows:

$$LExr_t = \alpha + \sum_{t=1}^{k} \varphi_i LExr_{t-i} + \sum_{t=1}^{k} \theta_i LOilR_{t-i} + u_t$$

$$LOilR_t = \beta + \sum_{i=0}^{k} \emptyset_i LExr_{t-i} + \sum_{i=0}^{k} \emptyset_t LOilR_{t-i} + u_t$$

4.6 Correlation:

In table 4-3 correlation between exchange rates and oil revenue is negative and significant as expected.

4.7 VAR Model

The optimum lag of the model is lag 4 where this lag has the minimum number among the examined lags and AIC equal to 4.24. Table 4-4 is VAR model and by the stability testing no roots lies outside the unit roots which means the VAR model satisfies the stability condition as table 4-5 showed.

4.8 Impulse Response:

According to figure 4-3 it's clear that the positive shock on oil revenue has a negative impact on the exchange rate and vice versa, this means when the oil revenue was contributing the country reserve the exchange rate was decreasing "local currency was appreciating" and when the country losses most of reserves earning from oil revenue exchange rate was increasing "local currency was depreciating" or devaluating by the monetary authorities.

4.9 Variance Decomposition

Table 4-6 shows that in the short-run "quarter 1,2 and 3" shock to LOIR cause 2.46%, 6.11% and 8.5% fluctuations on the LEXR but in the long-run near to constant.

4.10 Granger Causality Test

Using granger Causality test in table 4-7 could reject the hypothesis that there was bilateral causality between exchange rate and oil revenue. Thus, oil revenue only has Granger cause to exchange rate.

4.11 System Estimation Analysis

According to table 4-8 R-Squared is too small 16.41% but the relation between exchange rate and oil revenue with lagged variable is negative which is compatible with the hypothesis, C(5) ,C(6) and C(10) are significant, the model is significant where porb (F) is less than 5%, by using Wald Test in table 4-9 all oil revenue variables with dummy variable are jointly significant.

Referring to tables 4-10 and 4-11, respectively the model neither serial correlation nor heteroskedasticity because of null hypothesis were accepted.

Conclusion and Results

This research inspected how oil revenues and South Sudan secession has effects on the exchange rate. The absence of long run relation by using co-integration obstructed the most important method for analyzing which was VECM. The reason for the absence of co-integration could be the large gab represented in the exchange rate between the official and the unofficial market.

Both of oil revenues and secession of South Sudan has significant impacts on the exchange rate. According to the model; the decrease of oil revenues and the secession of South Sudan led to depreciation in the local currency.

To overcome the current situation, the research recommends two steps that are necessary to apply;

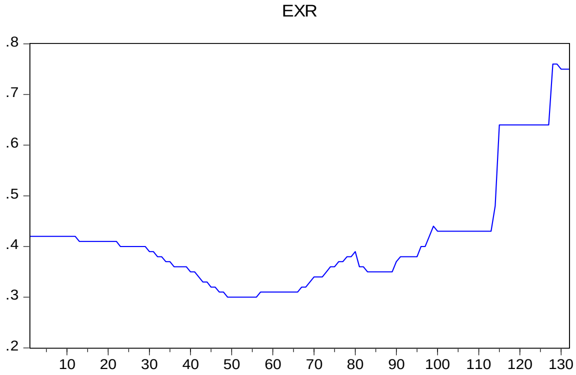
- In short term: authorities should provide foreign currency for the basic needs of essential commodities in order to cover the gap between exports and imports to decrease the trade balance deficit firstly and, enhance balance of payments secondly, by using effective monetary and fiscal policies.

- In medium and “long term”: authorities should develop the country’s production capacities, review the economic structure and deal with the economic problems from its roots by setting efficient economic policies.

Appendix

Figure 4-1

The Series at the level



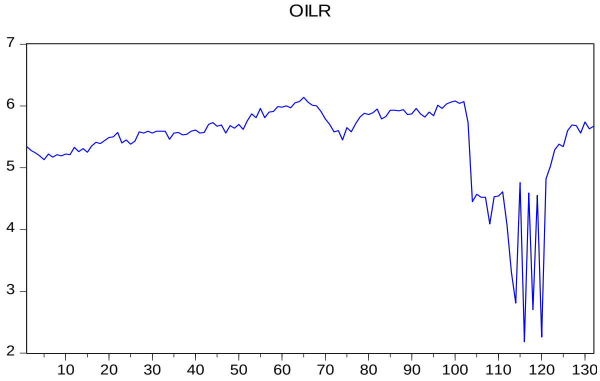


Table 4-1

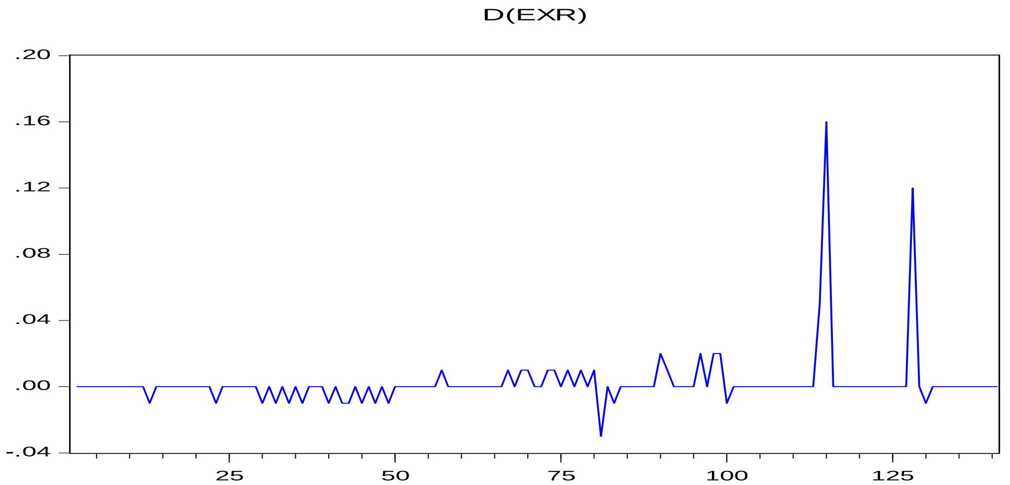
Augmented Dickey Fuller Test

	Level			1st Difference		
Variable	None	Intercept	Intercept and Trend	None	Intercept	Intercept and Trend
LexR	1.722	0.899	-0.849	-9.824***	-9.929***	-10.263***
LoilR	-0.366	-1.908	-2.116	-30.021***	-29.914***	-29.825***

*** implies significance at the 1, 5 and 10 % levels.

Figure (4-2)

The Series after differencing one level.



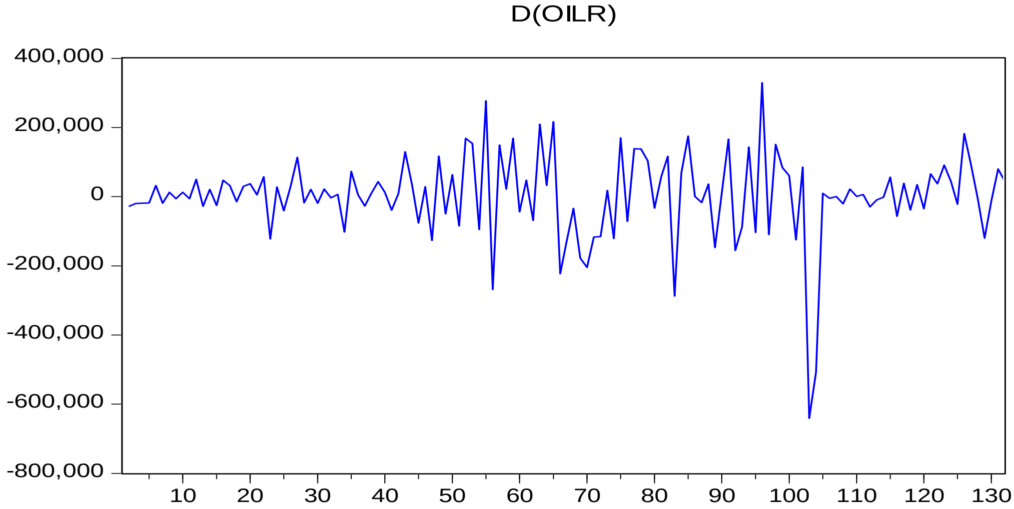


Table 4-2

Sample (adjusted): 6 141

Included observations: 136 after adjustments

Trend assumption: Linear deterministic trend

Series: EXR OILR

Lags interval (in first differences): 1 to 4

Unrestricted Cointegration Rank Test (Trace)

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None	0.058923	8.624933	15.49471	0.4012
At most 1	0.002684	0.365570	3.841466	0.5454

Trace test indicates no cointegration at the 0.05 level

* denotes rejection of the hypothesis at the 0.05 level

**MacKinnon-Haug-Michelis (1999) p-values

Unrestricted Cointegration Rank Test (Maximum Eigenvalue)

Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	0.05 Critical Value	Prob.**
None	0.058923	8.259363	14.26460	0.3529
At most 1	0.002684	0.365570	3.841466	0.5454

Max-eigenvalue test indicates no cointegration at the 0.05 level

* denotes rejection of the hypothesis at the 0.05 level

**MacKinnon-Haug-Michelis (1999) p-values

Unrestricted Cointegrating Coefficients (normalized by b'*S11*b=I):

EXR	OILR
1.639359	1.887861
9.023912	0.547916

Unrestricted Adjustment Coefficients (alpha):

D(EXR)	-0.003102	0.000615
D(OILR)	-0.076426	-0.009441

1 Cointegrating Equation(s):	Log likelihood	312.4271

Normalized cointegrating coefficients (standard error in parentheses)

EXR	OILR
1.000000	1.151585
	(0.38212)

Adjustment coefficients (standard error in parentheses)

D(EXR)	-0.005085
	(0.00251)
D(OILR)	-0.125290
	(0.05194)

Table 4-3

Correlation

Sample: 1 141

Included observations: 141

Correlation	OILR	EXR
OILR	1.000000	
EXR	-0.431793	1.000000

Probability	OILR	EXR
OILR	-----	
EXR	0.0000	-----

Table 4-4

VAR (System Estimation)

Estimation Method: Least Squares

Sample: 6 141

Included observations: 136

Total system (balanced) observations 272

	Coefficient	Std. Error	t-Statistic	Prob.
C(1)	0.162789	0.093396	1.743003	0.0826
C(2)	-0.083716	0.096595	-0.866672	0.3869
C(3)	-0.005524	0.093374	-0.059158	0.9529
C(4)	-0.033997	0.090060	-0.377496	0.7061
C(5)	-0.011735	0.004432	-2.647629	0.0086
C(6)	-0.014019	0.005112	-2.742159	0.0065
C(7)	-0.006950	0.005250	-1.323903	0.1867
C(8)	-0.001888	0.004402	-0.428777	0.6685
C(9)	0.000390	0.001820	0.214103	0.8306
C(10)	0.006608	0.003666	1.802733	0.0726
C(11)	-3.438631	1.966851	-1.748293	0.0816
C(12)	2.360745	2.034227	1.160512	0.2469
C(13)	0.080376	1.966392	0.040875	0.9674
C(14)	1.355990	1.896597	0.714960	0.4753
C(15)	-0.605383	0.093341	-6.485743	0.0000
C(16)	0.033497	0.107665	0.311121	0.7560
C(17)	-0.074915	0.110561	-0.677589	0.4987
C(18)	0.028195	0.092713	0.304109	0.7613
C(19)	0.015202	0.038325	0.396662	0.6920
C(20)	-0.065740	0.077194	-0.851616	0.3952
Determinant residual covariance		3.53E-05		

Equation: D(EXR) = C(1)*D(EXR(-1)) + C(2)*D(EXR(-2)) + C(3)*D(EXR(-3)) + C(4)*D(EXR(-4)) + C(5)*D(OILR(-1)) + C(6)*D(OILR(-2)) + C(7)*D(OILR(-3)) + C(8)*D(OILR(-4)) + C(9) + C(10)*DMY

Observations: 136

R-squared	0.135989	Mean dependent var	0.002426
Adjusted R-squared	0.074274	S.D. dependent var	0.018599
S.E. of regression	0.017895	Sum squared resid	0.040349
Durbin-Watson stat	1.994295		

Equation: D(OILR) = C(11)*D(EXR(-1)) + C(12)*D(EXR(-2)) + C(13)*D(EXR(-3)) + C(14)*D(EXR(-4)) + C(15)*D(OILR(-1)) + C(16)*D(OILR(-2)) + C(17)*D(OILR(-3)) + C(18)*D(OILR(-4)) + C(19) + C(20)*DMY

Observations: 136

R-squared	0.564308	Mean dependent var	-0.002279
Adjusted R-squared	0.533187	S.D. dependent var	0.551571
S.E. of regression	0.376854	Sum squared resid	17.89439
Durbin-Watson stat	1.962427		

Table 4-5

Stability Condition (Stability Test)

Roots of Characteristic Polynomial

Endogenous variables: D(EXR) D(OILR)

Exogenous variables: C DMY

Lag specification: 1 4

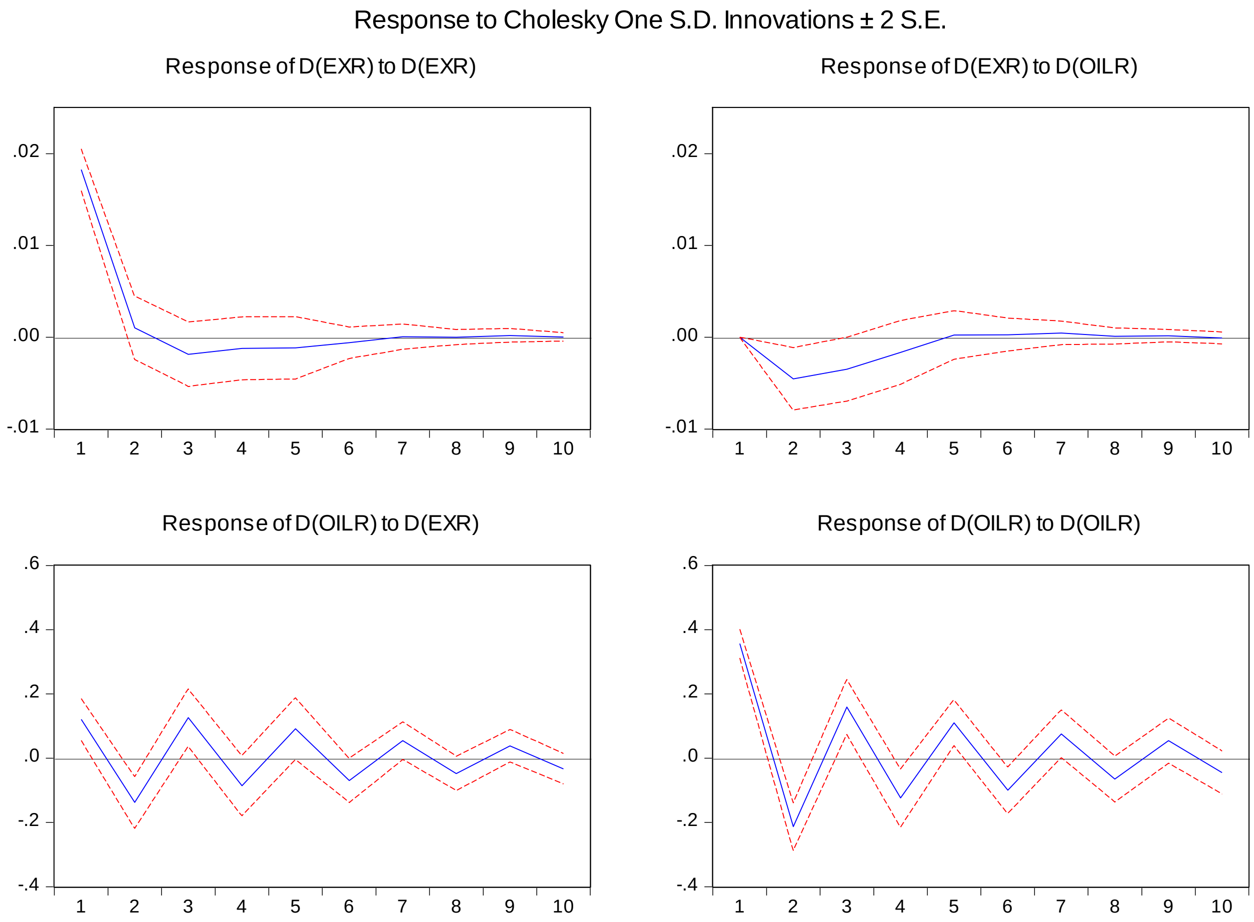
Date: 02/23/15 Time: 12:21

Root	Modulus
-0.820397	0.820397
0.483516 - 0.344073i	0.593443
0.483516 + 0.344073i	0.593443
0.008494 - 0.462150i	0.462229
0.008494 + 0.462150i	0.462229
-0.224480 - 0.338446i	0.406124
-0.224480 + 0.338446i	0.406124
-0.157259	0.157259

No root lies outside the unit circle.

VAR satisfies the stability condition.

Figure 4-3



Response to Cholesky One S.D. Innovations ± 2 S.E.
Response of D(EXR) to D(EXR)
Response of D(EXR) to D(OILR)
Response of D(OILR) to D(EXR)
Response of D(OILR) to D(OILR)
.02
.01
.00
-.01
.6
.4
.2
.0
-.2
-.4
1 2 3 4 5 6 7 8 9 10

Table 4-6

Variance Decomposition

Variance Decomposition of EXR and OILR

Period	S.E.	EXR	OILR
1	0.017694	100.0000	0.000000
2	0.026316	97.53642	2.463583
3	0.032403	93.88588	6.114122
4	0.037118	91.43758	8.562425
5	0.040986	90.48880	9.511198
6	0.044229	89.97281	10.02719
7	0.047010	89.76728	10.23272
8	0.049406	89.62908	10.37092
9	0.051506	89.60208	10.39792
10	0.053357	89.59558	10.40442

Period	S.E.	EXR	OILR
1	0.350459	9.670030	90.32997
2	0.361615	9.692663	90.30734
3	0.433413	10.32316	89.67684
4	0.437393	10.13701	89.86299
5	0.467617	11.48453	88.51547
6	0.469557	11.63139	88.36861
7	0.483879	13.20970	86.79030
8	0.485674	13.71094	86.28906
9	0.493599	15.24711	84.75289
10	0.495755	15.96572	84.03428

Cholesky Ordering EXR OILR

Table 4-7

Pairwise Granger Causality Tests

Sample: 1 132

Lags: 4

Null Hypothesis:	Obs	F-Statistic	Prob.
D(OILR) does not Granger Cause D(EXR)	127	3.19654	0.0156
D(EXR) does not Granger Cause D(OILR)		1.10262	0.3587

Table 4-8

Dependent Variable: D(EXR)

Method: Least Squares

Sample (adjusted): 6 132

Included observations: 127 after adjustments

D(EXR) = C(1)*D(EXR(-1)) + C(2)*D(EXR(-2)) + C(3)*D(EXR(-3)) + C(4)
*D(EXR(-4)) + C(5)*D(OILR(-1)) + C(6)*D(OILR(-2)) + C(7)*D(OILR(-3))
+ C(8)*D(OILR(-4)) + C(9) + C(10)*DMY

	Coefficient	Std. Error	t-Statistic	Prob.
C(1)	0.139992	0.097061	1.442313	0.1519
C(2)	-0.102639	0.100000	-1.026384	0.3068
C(3)	-0.021928	0.096449	-0.227355	0.8205
C(4)	-0.062265	0.093336	-0.667113	0.5060
C(5)	-0.012710	0.004709	-2.699191	0.0080
C(6)	-0.015595	0.005419	-2.877649	0.0048
C(7)	-0.008205	0.005611	-1.462196	0.1464
C(8)	-0.002311	0.004684	-0.493323	0.6227
C(9)	0.000433	0.001857	0.233014	0.8162
C(10)	0.010261	0.004251	2.413986	0.0173

R-squared	0.164191	Mean dependent var	0.002598
Adjusted R-squared	0.099898	S.D. dependent var	0.019240
S.E. of regression	0.018254	Akaike info criterion	-5.093428
Sum squared resid	0.038984	Schwarz criterion	-4.869476
Log likelihood	333.4327	Hannan-Quinn criter.	-5.002439
F-statistic	2.553800	Durbin-Watson stat	1.997679
Prob(F-statistic)	0.010243		

Table 4-9

Wald Test:

Equation: Untitled

Test Statistic	Value	df	Probability
F-statistic	3.827314	(5, 117)	0.0030
Chi-square	19.13657	5	0.0018

Null Hypothesis: C(5)=C(6)=C(7)=C(8)=C(10)=0

Null Hypothesis Summary:

Normalized Restriction (= 0)	Value	Std. Err.
C(5)	-0.012710	0.004709
C(6)	-0.015595	0.005419
C(7)	-0.008205	0.005611
C(8)	-0.002311	0.004684
C(10)	0.010261	0.004251

Restrictions are linear in coefficients.

Table 4-10

Breusch-Godfrey Serial Correlation LM Test:

F-statistic	1.155567	Prob. F(4,113)	0.3343
Obs*R-squared	4.990789	Prob. Chi-Square(4)	0.2882

Test Equation:
Dependent Variable: RESID
Method: Least Squares
Date: 02/17/15 Time: 21:56
Sample: 6 132
Included observations: 127
Presample missing value lagged residuals set to zero.

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C(1)	-0.176573	2.021430	-0.087350	0.9305
C(2)	2.201866	1.782434	1.235314	0.2193
C(3)	-1.498598	1.123148	-1.334284	0.1848
C(4)	0.109435	0.586708	0.186524	0.8524
C(5)	-0.000484	0.004749	-0.101963	0.9190
C(6)	-0.001914	0.026410	-0.072490	0.9423
C(7)	0.024701	0.031859	0.775315	0.4398
C(8)	0.018027	0.015341	1.175065	0.2424
C(9)	-0.000313	0.001975	-0.158344	0.8745
C(10)	-0.006109	0.016865	-0.362244	0.7178
RESID(-1)	0.161531	2.019391	0.079990	0.9364
RESID(-2)	-2.177495	1.673800	-1.300929	0.1959
RESID(-3)	1.215818	0.974088	1.248160	0.2146
RESID(-4)	0.313564	0.449866	0.697017	0.4872

R-squared	0.039298	Mean dependent var	9.05E-19
Adjusted R-squared	-0.071226	S.D. dependent var	0.017590
S.E. of regression	0.018205	Akaike info criterion	-5.070526
Sum squared resid	0.037452	Schwarz criterion	-4.756994
Log likelihood	335.9784	Hannan-Quinn criter.	-4.943142
F-statistic	0.355559	Durbin-Watson stat	2.024008
Prob(F-statistic)	0.980336		

Table 4-11

Heteroskedasticity Test: ARCH

F-statistic	0.060973	Prob. F(4,118)	0.9930
Obs*R-squared	0.253702	Prob. Chi-Square(4)	0.9926

Test Equation:
Dependent Variable: RESID^2
Method: Least Squares
Date: 02/17/15 Time: 21:59
Sample (adjusted): 10 132
Included observations: 123 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.000327	0.000170	1.928706	0.0562
RESID^2(-1)	0.027174	0.092035	0.295254	0.7683
RESID^2(-2)	-0.014259	0.092039	-0.154924	0.8771
RESID^2(-3)	-0.024664	0.092035	-0.267981	0.7892
RESID^2(-4)	-0.021097	0.092025	-0.229250	0.8191

R-squared	0.002063	Mean dependent var	0.000317
Adjusted R-squared	-0.031766	S.D. dependent var	0.001742
S.E. of regression	0.001770	Akaike info criterion	-9.796162
Sum squared resid	0.000370	Schwarz criterion	-9.681846
Log likelihood	607.4640	Hannan-Quinn criter.	-9.749727
F-statistic	0.060973	Durbin-Watson stat	2.000356
Prob(F-statistic)	0.993045		

REFERENCES

Ericzivot, Jiahviwang (2006). Modeling Financial Time Series with S.PLUS *Springor Second Edition*

Abel, Bernanke and Richmond (2008). Macroeconomics, Pearson 6th Edition

Jeffrey M Wooldrige (2009). Introductory Econometrics - A Modern Approach, South-Westren 5th Edition

Damodar N. Gujarati (2004). *Basic Econometrics.* Tata McGraw. Hill, 6th Reprint

Dimitrios and Stephen, 2007. Applied Econometrics A Modern Approach using Eviews and Microfit. PALGRAVE MACMILLAN Revised Edition.

R. Carter, William E and Guay C Lim (2008), Principles of Econometrics. 3rd Edition

Jeseph P Daniels and David D Vanhoose (2005), International Monetary and Financial Economics, South-Western College Pub, 3rd Edition

Steven N Durlauf and Lawrence E Blume (2010) Macroeconometrics and Time Series Analysis. Macmillan Publishers LTD 2nd Edition

Chris Books (2014) Introductory Econometrics for Finance. Cambridge University Press 3rd Edition

Hilde Christiane Bjørnland VAR Models in Macroeconomic Research Statistics Norway Research Department Oct 2000

(http://www.afdb.org/en/countries/east-africa/sudan/sudan-economic-outlook/ May20, 2014 11:25)

http://www.cbos.gov.sd/en