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Modeling the Relationship between Exchange Rate and Balance of Trade Components in Rwanda (2005-2012)

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Abstract: Exchange rate stability affects foreign investments, price stability and stable economic growth. Rwandan currency has depreciated overtime. General objective of this study was to model the relationship between exchange rate and BOT in Rwanda. Specific objectives were to test for the stationarity of exchange rate and BOT components, to determine the relationship between exchange rate and BOT components and to investigate the effects of BOT components on exchange rate in Rwanda. The study utilized monthly time series data from 2005 to 2012 sourced from BNR and NISR. The study carried out ADF and PP unit root tests, Johansen cointegration test, Quantile regression and impulse response function tests. The results of ADF and PP tests revealed partial stationarity at level and full at first difference. Johansen cointegration tests revealed a long run relation exists between exchange rate and BOT components. Quantile regression results revealed positive significant effect of BOT components on exchange rate. The impulse response results also confirmed the same. The study recommends adoption of import reduction strategies and export expansion strategies.

Key words: Exchange rate, BOT, Exports, Imports (c.i.f), Imports (f.o.b), Quantile regression

I. INTRODUCTION

Background of the study

Exchange rates play an important role in linking a country to the global supply chains. Exports generally include high import content and the impact of these imports and exports on exchange rate depreciation or appreciation is therefore complex. Theory posits that exports makes the countrys currency to appreciate while imports causes depreciation of currency. Although exchange rate hedging mechanisms are available, they are probably somewhat prohibitive for some particularly small and medium-sized enterprises, which may have less long-term visibility of their foreign exchange needs. The economic crisis has had a differentiated impact on the world economies and on their trade, thereby changing trade patterns significantly in some cases. In the context of low employment related to recession, some policymakers want to stimulate their exports, thereby hoping to improve their trade and current account balances.

Policymakers interested in implementing such policies have taken a closer look at exchange rate movements. Simply stated, depreciation of a country's currency makes its exports cheaper and its imports more costly. In the reality of a globalized economy, however, industries are vertically integrated, and exported products contain a large proportion of imported components. Imported components therefore become more costly for any given exporter and are not necessarily substitutable with domestically-produced products. In addition, exchange rate levels have important implications for debt servicing and foreign investment flows. Depreciation in a country's currency implies that the nominal value of debt denominated in foreign currencies increases relative to the country's resources in local currency whereas its local-currency denominated debt decreases in value for foreign creditors. Capital investments become cheaper to foreign investors when the currency is depreciated, this is particularly important for large economies that attract capital investments like the United States and, to a lesser extent, the European Union.

If depreciation is the result of a loss of confidence in the economy, however, foreign investors may be more hesitant to invest. Exchange rate changes affect firms within a given country differently. Firms face a number of risks when engaging in international trade, in particular economic and commercial risks that are determined by macroeconomic conditions over which they have little control, such as exchange rates and their volatility. Risk management tools are available to help firms mitigate the impact of such risks, especially in the short term. These techniques for securing exchange rate risk are sometimes complex, however, and do not cover all commercial and financial operations. Besides, such tools may not be available to all firms, and the cost of using them may be significant, especially for small firms and in situations of high volatility.

Since the beginning of floating exchange rate regimes in 1973, many papers, both theoretical and empirical, have analyzed the effects of exchange rates and exchange rate volatility on trade but few have analysed the exchange rate determinants yet its also vital given the fact that since the adoption of floating exchange rate regime,there has been massive depreciation of currencies of most African nations.. As regards the effect of trade balance on Exchange rate, empirical studies find somewhat differing results, some find BOT as significant in influecing exchange rate while others find insignificant effect.

Rwanda had an administered economy, which imposed severe restrictions on trade and foreign exchange transactions and a fixed exchange rate regime (1961-1990). By the early 1990s the average tariff rate was 34.8%, with 5 different tariffs ranging from 0-60%. Every import and every importer was subject to a quota, and all import operations were subject to a license authorizing external currency disbursement. Exporters had to repatriate currency generated by the sale of exports as a

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legal requirement. Export licenses were authorized only by the *Banque Nationale du Rwanda* (BNR). More importantly, all export earnings were transferred to and managed by the BNR.

The period from 1991 until 1994 corresponds to the beginning of the removal of restrictions on trade and foreign exchange transactions, and the gradual revival of a market economy, Rwanda embraced a market economy characterized by continuation of trade reforms and a liberalization of the monetary and financial regimes. Tariffs were reduced considerably with the average rate decreasing to 18%, and there remained four tariff bands with a maximum of up to 30% by 2003. This is a significant reform when compared with an average tariff rate of 34.8%, with 5 different tariffs ranging from 0-60% prior to 1994

Liberalization of the monetary and financial sector led to the adoption of new currency exchange regulations, the creation of new private commercial banks, and the privatization of state-owned banks. Imports, exports and services were liberalized, and some of the previous restrictions on capital flows were either reduced or eliminated.

Flexible exchange rates were also introduced during the period 1995 to 2003, the commitment of the government to trade, financial, and exchange reform was much more credible and stable. The period of flexible exchange rate was characterized by the fluctuation in exchange rate. As evidence, in

January 2003, the average exchange rate stood at 511.2168 RWF for 1$, but by end of the year, the exchange rate was at 574.83RWF for 1$. The depreciation rate stood at 11.6% from one year to another. If we compare the average exchange rate of 2002 and 2008, the index is 115.2 in six years, from the exchange rate of 475.32 FRW for 1$ in 2002 to 547.61 FRW for 1$ in 2008. Indeed, this exchange rate can be compared to 220 RWF for 1$ in 1994. According to NBR ,annual report *July 2012- June 2013*The FRW depreciated by 4.9%, trading between 612.42 and June 2012 and 642.67 end June 2013 against a depreciation of 2.2% recorded for the last fiscal year 201/2012. In the same period, the FRW depreciated by 2.0% and 11.3% against the GBP and EURO respectively. Similarly, the RWF depreciated against KES and TZS respectively by 2.6% and 3.0%, while appreciated against Ugandan shilling and Burundian franc by 0.1% and 3.5% respectively. Following an appreciation recorded in the second half of fiscal year 2011/2012, the Real Effective Exchange Rate (REER) has depreciated during the first half of fiscal year 2012/2013 then remained quite stable in the second half of 2012/2013. The moderate bilateral depreciation against USD, EURO and GBP recorded during the period has been offset by a moderate inflation differential with most of Rwanda's trading partners. (NBR, Annual Report, 2008)

Rwanda's exports remained dominated by traditional products such as coffee, tea and minerals like tin, coltan (Colombo tantalite), wolfram and cassiterite. Rwanda's main exports partners are China, Germany and United States. Rwanda imports mainly food products, Raw materials, machinery and equipment, construction materials, petroleum products and fertilizers. Main imports partners are Kenya, Germany, Uganda and Belgium[1]. This study will examine the impact of trade flows bothexports and imports on exchange rate.

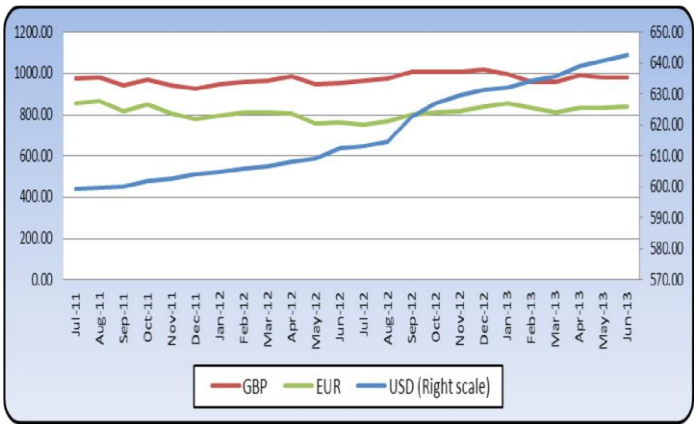

Figure 1: Evolution of Nominal Exchange Rate, Leading Currencies against USD
Source: BNR, Annual Report 2013

Balance of trade

Trade, in general connotation, means the purchase and sales of commodities. In International Trade, purchase and sale are replaced by imports and exports. Balance of Trade is simply the difference between the value of exports and value of imports. Thus, the Balance of Trade denotes the differences of imports and exports of a merchandise of a country during the course of year. It indicates the value of exports and imports of the country in question. If the value of its exports over a period exceeds its value of imports, it is called favorable balance of trade and, conversely, if the value of total imports exceeds the total value of exports over a period, it is unfavorable balance of trade. The favorable balance of trade indicates good economic condition of the country.

Types of Balance of trade

Based on sale and purchase of goods and services, balance of trade can be divided into following three groups:

Import Trade: Import trade refers to purchase of goods by one country from another country or inflow of goods and services from foreign country to home country. For example, the purchase of oil, clothes, computers, vehicles, etc. by Rwandans from abroad.

Rwandan imports include two types of imports: **Imports f.o.b** stands for **Free on Board**, it refers to the physical location that title to the goods changes hands from the shipper to the recipient at that point, the recipient assumes the risk of loss and takes responsibility for any shipping charges. The second one is **Imports c.i.f**, stands for **Cost, Insurance and Freight**, the cost of goods plus insurance and freight charges, normally to the port of embarkation unless a different f.o.b point is specified.

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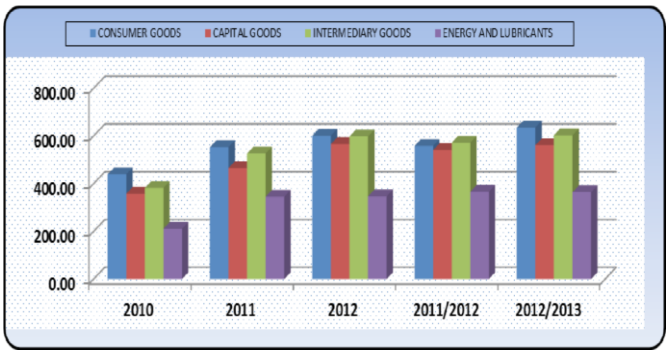

Figure 2: Structure of Rwanda Imports Developments (value in USD million)
Source: BNR, Annual Report 2011

Export Trade: Export trade refers to the sale of goods by one country to another country or outflow of goods from home country to foreign country. For example, the sale of Tea, Coffee, pyrethrum, etc. by Rwandan companies abroad.

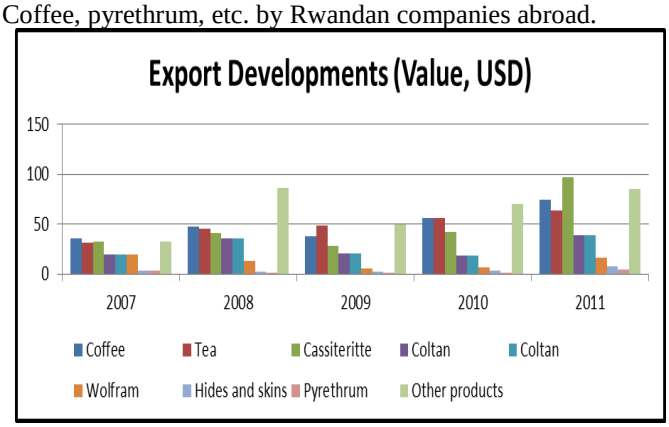

Figure 3: Major exports Developments(Value in USD million and volume in tons)
Source: BNR, Annual Report 2011

Problem statement

The exchange rate fluctuation implicates an up down movement of currency value of any given country. The depreciation of currency in any imports based economy decreases capital inflow and increases capital outflow and vice versa (Eric, 2016). Hence, exchange rate stability becomes one of the main factors influencing foreign (direct and portfolio) investments, price stability and stable economic growth. Many authors include Jhingan posited that to maintain both internal and external balance, a country must control its exchange rate, (Nelson, 2013). Changes in exchange rate have pervasive effects, with consequences for prices, wages, interest rates, production levels, and employment opportunities. Fluctuations in the value of currencies of different economies have increased after the collapse of Bretton Woods System. Especially short term variability has dramatically increased following the shift from fixed to flexible exchange rate in early 1970's and after. High volatility and sudden changes in exchange rate is one of the hurdles for the success of macroeconomic policy, hence a model with theoretical and empirical validity needs to be developed.

The Rwandan Franc depreciated against all major currencies, since April 2010 the Rwf depreciated by 3.7 percent against the US$, a larger movement than observed over the entire year 2009 (2.2 percent). Throughout 2010 the Rwf showed a mix of movements against other major international currencies (the Euro and the British Pound) which originated in the strengthening of the US$ during that period. By end 2010, the Rwf had depreciated by 1.6 percent against the Euro and by 6.0 percent against the British pound. (W.Bank, April 2011). This gradual depreciation of the Rwf with time has attracted attention of researchers to analyze the determinants of exchange rate.

Several studies have been carried out regarding exchange rate determinants. Researchers have analyzed various determinants of exchange rate using various methods and the results appear divergent from one researcher to another. However in Rwanda little has been done regarding exchange rate with the existing researches identifying news and selected macroeconomic variables as determinants of exchange rate, (Eric, 2016).

BOT is one of the major macroeconomic factors that could have a major impact on exchange rate. Theory states that exports strengthen a country's currency while the opposite is true for imports. Despite this importance of BOT in influencing exchange rate, no study has been done in Rwanda to analyze the relationship between the two which can help in policy formulation to reverse the trend of depreciation of Rwf. It is in this context that the study seeks to analyze the relationship between exchange rate and BOT components using the quantile regression approach.

Objectives of the research

General objective:

The general objective of this study is to model the relationship between currency exchange rate and balance of trade components in Rwanda.

Specific objectives:

i. To test for stationarity of exchange rate and balance of trade components in Rwanda.
ii. To investigate the relationship between exchange rate and each of the BOT components in Rwanda.
iii. To determine the influence of BOT components on exchange rate in Rwanda.

II. RESEARCH METHODOLOGY

Research design

Bryman, (2001), defined research design as the scheme, outline or plan that is used to generate answers to the research problem. Descriptive research design was used in this study. It was appropriated because of it is specific in nature and fact that it facilitates a general understanding and interpretation of the problem and describes the state of affairs as it is in that particular time.

Data Collection and sources

The study will use monthly time series secondary data for a period of 12 years from 2005 to 2016 due to availability of data within this period for all the variables under study from National Bank of Rwanda.

Data Processing and Analysis techniques

Babbie (2010) stated that data analysis is carried on the data collected in order to transform it to a form suitable for use in drawing conclusions that reflect ideas and theories that initiated the inquiry. In order to analyze the relationship between BOT and exchange rate in Rwanda, Augmented

Dickey Fuller (ADF) was used to test stationarity of variables; Johansen Cointegration method was used to estimate long run relationship between the BOT and exchange rate. Quantile regression Method was applied to determine the influence of BOT components on exchange rate.

Model Specification

In this study the three explanatory variables that is exports, imports (c.i.f) and imports (f.o.b) affecting exchange rate were presented in the equation (1) below to estimate the relationship of variables. The model connects BOT components that is exports and imports and exchange rate.

$$RER = \beta o + \beta 1E + \beta 2Ic + \beta 3If + \varepsilon t \quad \text{……………………………………………………………(1)}$$

Where

$RER \Rightarrow$ Real exchange rate

$E \Rightarrow$ Exports

$Ic \Rightarrow$ Imports (cost, insurance and freight)

$If \Rightarrow$ Imports (free on board)

$\beta o \Rightarrow$ Constant

$\beta 1, \beta 2, \beta 3 \Rightarrow$ Coefficients of independent variables

$\varepsilon t \Rightarrow$ Error term

Unit root test

A series is said to be stationary if its mean and variance are constant over time and the value of the covariance between the two time periods depends only on the distance or lag between the two time periods, not on the time at which the covariance is calculated Gujarati, (2003). The unit root test is necessary for time series data because a regression carried out with non-stationary series gives spurious results Gujarati, (2003), i.e. if two variables are trending over time, regression could have a high R2 even if the two are totally unrelated. In addition Brooks, (2008) added that use of non-stationary data also violates the standard assumptions for asymptotic analysis, meaning that the t ratios don't follow a t distribution while the F statistic does not follow the F distribution.

In this study, Augmented Dickey Fuller (ADF) test and Philips -Perron unit root test were used to detect the stationary of the variables. This study also adopted Philips - Perron unit root test and the Augmented Dickey Fuller both at I(0) and (1) for more confirmatory test because the ADF assume no autocorrelation of the error term biases, hence its control ensures that the error term is a white noise according Wooldridge, (2003). Unlike the ADF, the PP method corrects for autocorrelation using non-parametric statistical methods without adding lagged difference terms Gujarati, (2003).

Cointegration tests

There are two models for testing cointegration, Engel and Granger (1987) model and Johansen and Joselius (1990) model. Engle and Granger's model represents two step error correction processes while Johansen's method allows testing cointegration in the system in one step and doesn't require to carry errors from the first to second steps which result in more efficient estimators of cointegrating vectors. Another important implication is that Johansen method allows avoiding necessary assumption of endogenity/exogenity of variables in the model. The researcher will therefore use Johansen Cointegration test method to test for existence of long-term relationship (co-movement) between variables in a non-stationary series. Before testing for cointegration, it is important to determine the order of integration of the individual time series. A variable X_t is integrated of order d (1d) if it becomes stationary for the first time after being differenced d times (Hjalmarsson and Österholm, 2007). Cointegration also asserts that 1(1) can be estimated using OLS method and produce non spurious results.

Quantile Regression model

Quantile regression is a recent model developed by Koenker and Bersset in 1978 who found that the unconditional quantile regression model is applied to many research areas in econometrics and statistics. It is an extension of the ordinary classical OLS. its widespread use is due to advantages that it has over the OLS. Compared with conventional mean regression, QR can characterize the entire conditional distribution of the outcome variable, may be more robust to outliers and misspecification of error distribution, and provides more comprehensive statistical modeling than traditional mean regression. QR models could not only be used to detect heterogeneous effects of covariates at different quantiles of the outcome, but also offer more robust and complete estimates compared to the mean regression, when the normality assumption is violated or outliers and long tails exist, (Huang et al, 2017).The study therefore used QR model to analyze the effects of BOT components on exchange rate.

III. FINDINGS AND DISCUSSION

Stationarity test results

One of the objectives of this study was to test for stationarity of the variables under study that is exchange rate, exports and imports. This was achieved by carrying out ADF and PP tests of stationarity and the results are shown in the table 4.4 below.

Table 1: Unit root Test results summary

	Augmented Dickey Fuller Test	Philips Peron Test
	Probability at level probability at 1st dif	Probability at level probability at 1st dif
Exchange rate	0.7506	0.7708 0.0000
exports	0.0035	0.0039 0.0000
Imports cif	0.0072 0.0000	0.0108 0.0000
Imports fob	0.0001 0.0000	0.0001 0.0000

Source: researcher, 2018

From the above table, the ADF and PP probabilities for exports, imports (cif) and imports (fob) are less than 5% while for exchange rate it is greater than 5% at level. At first difference all the probabilities for both ADF and PP is 0.0000 which is less than 5%. The null hypothesis of presence of unit root is rejected at level for all variables except Exchange rate since its probability value is greater than 5%.at first difference

the null hypothesis was rejected for all variables since the probability is less than 5% all through.

The presence of unit root confirms absence of stationarity and vice versa. In this case, the variables are stationary at level and at first difference except Exchange rate which was not stationary at level for both tests but became stationary at first difference. These results confirm the findings of most of the previous literature on time series analysis which have always revealed stationarity at first difference, (Amos, 2017).

Cointegration test

The second objective of this study sought to investigate existence of relationship between exchange rate and BOT components that is exports and imports. This was achieved by carrying out Johansen system cointegration test which exhibits both trace statistic and maximum Eigen value statistic. Cointegration is the existence of long run relationship between two or more variables. The results for the cointegraton test are shown in the below table

According to table 2, the results for trace statistic and maximum Eigen value statistic for cointegration test. The probability of no cointegrating equations for trace and maximum Eigen value are 0.0042 and 0.0401 respectively which are less than 0.5. The null hypothesis of none of the equations are cointegrated is rejected for both methods.

This implies that there is cointegration between exchange rate and BOT components. Along run relationship exists between exchange rate, exports and imports. This confirms the theory that exchange rate depends heavily on BOT of a country since BOT involves trading in foreign currency through exports and imports and this causes fluctuations in the value of domestic currency of a country.

Quantile Regression model

The last objective of this research sought to determine the effects of BOT components on exchange rate. This was achieved by running a quantile regression model. The model was preferred over the ordinary least squares model due to its robustness, its free from the effects of serial correlation and heteroscedasticity which are prone with OLS. The results are shown in the table below.

Table 3: Quantile regression results

Source: researcher, 2018

From the results above, it's evident that BOT components are highly significant in influencing exchange rate. This is supported by the corresponding probabilities for exports, imports (cif) and imports (fob) of 0.0095, 0.0102 and 0.0252 respectively. The quantile regression coefficients for exports, imports (cif) and imports (fob) are 8.36E-07, 1.52E-07 and 1.38E-07 respectively.

Exports have a positive effect on exchange rate. A unit increase in exports increases the value of exchange rate by 8.36E-6 and vice versa. This positive influence of exports on exchange rate goes against the theory which states that exports makes the domestic currency strong and hence appreciation of currency. However this scenario could be explained by the fact that most of the exports from EAC are in small quantity and still agriculture based and hence fetches less in the external market. The net effect could therefore be positive causing depreciation of currency.

A unit increase in imports (cif) and imports (fob) increases the value of exchange rate by 1.52E-06 and 1.38E-05 respectively. This positive effect is in line with the theoretical review since imports bring high demand of foreign currency and hence the local currency loses value leading to depreciation. The results however show that imports (fob) have a greater effect than imports (cif) on exchange rate.

The study adopted the following linear model to show the effects of BOT components on exchange rate.

$$RER = \beta o + \beta 1E + \beta 2Ic + \beta 3If + \varepsilon t \quad \ldots\ldots\ldots\ldots\ldots (1)$$

Given the above coefficients, the model becomes

$$RER = 532.381 + 8.36E - 07e + 1.52E -$$

From the figure above it is evident from the graphs in the first raw that the response of exchange rate to a change in BOT components is positive shown by the increasing blue lines above the zero baseline. This confirms the results of the quantile regression discussed above.

IV. CONCLUSION AND RECOMMENDATION

Conclusion

The study sought to analyze the relationship between exchange rate and BOT. Balance of trade components included exports, imports (cif) and imports (fob). From the results the following conclusions were deduced;

The exchange rate and BOT components are stationary at first difference and hence the data can be used in model fitting without giving spurious results which can be misleading.

The cointegration test results reveals existence of a long run relationship between exchange rate and BOT components. They exhibit a common long run trend. This is a confirmation that there is association between exchange rate and BOT components.

There is a positive significant effect of BOT components on exchange rate. BOT components influences exchange rate from the Quantile regression results and the impulse response functions affirms a positive response of exchange rate to BOT components.

Recommendations

BOT components are very critical in influencing exchange rate. The government should focus much on adjustment in terms of trading in exports and imports.

Exports affect exchange rate positively from the results and this could be due to the fact that Rwanda exports less and the bulk of exports are mainly agriculture based which fetches less in the market hence resulting into a positive impact on exchange rate. The government should embark on strategies that improve the quantity and quality of exports so that more manufactured goods can be exported which fetches good prices in the market. This can be done by setting up export processing zones, setting more industries in the manufacturing sector in order to produce more industrial products and improve on value addition to the manufactured goods in order to fetch high prices. This would see an appreciation of Rwf since the income from exports will increase.

Imports both c.i.f and f.o.b have positive significant effects on exchange rate. This is not surprising since imports lead to high demand of foreign currency over local currency hence

depreciation of local currency. The government of Rwanda should come up with strategies that reduce imports. This can be done by first of venturing in education sector to improve quality of education so that the youths are able to acquire skills to exploit the idle resources to produce goods and services hence increase domestic production hence limiting imports.

The government should also impose heavy tariffs on importation of goods which are otherwise manufactured locally. These goods may be imported at cheaper prices and low quality and hence compete unfavorably with the local production. The government should only allow importation of those commodities which the country is not able to produce or the country's production is not able to meet the domestic demand.

This research concentrated on the effect of BOT components on exchange rate. Microeconomic factors could also have effect on Exchange rate hence more research can be done on that line. This research utilized Quantile regression approach to model the relationship between exchange rate and BOT components. More research can be done in this area using other methods and the results compared if they give consistent results.

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Table 2: Cointegration test results
Source: researcher, 2018

Date: 01/27/18 Time: 15:16
Sample (adjusted): 2005M04 2012M12
Included observations: 93 after adjustments
Trend assumption: Linear deterministic trend
Series: EXCHANGE_RATE EXPORTS IMPORTS_C_I_F IMPORTS_F_O_B
Lags interval (in first differences): 1 to 2

Unrestricted Cointegration Rank Test (Trace)

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None	0.198823	42.16380	47.85613	0.0042
At most 1	0.140069	21.54818	29.79707	0.3243
At most 2	0.077465	7.514208	15.49471	0.5187
At most 3	0.000168	0.015638	3.841466	0.9003

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	0.198823	20.61562	27.58434	0.0401
At most 1	0.140069	14.03397	21.13162	0.3622
At most 2	0.077465	7.498569	14.26460	0.4320
At most 3	0.000168	0.015638	3.841466	0.9003

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

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Table 3: Quantile regression results

Dependent Variable: EXCHANGE_RATE
Method: Quantile Regression (Median)
Date: 02/03/18 Time: 08:35
Sample: 2005M01 2012M12
Included observations: 96
Huber Sandwich Standard Errors & Covariance
Sparsity method: Kernel (Epanechnikov) using residuals
Bandwidth method: Hall-Sheather, bw=0.21218
Estimation successfully identifies unique optimal solution

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	532.3816	5.390327	98.76611	0.0000
EXPORTS	8.36E-07	3.16E-07	2.648029	0.0095
IMPORTS_C_I_F	1.52E-07	1.13E-07	1.350369	0.0102
IMPORTS_F_O_B	1.38E-07	1.82E-07	0.758296	0.0252

Pseudo R-squared	0.500739	Mean dependent var	572.8326
Adjusted R-squared	0.484459	S.D. dependent var	26.60734
S.E. of regression	15.01912	Objective	527.1620
Quantile dependent var	564.2800	Restr. objective	1055.885
Sparsity	37.17430	Quasi-LR statistic	113.7825
Prob(Quasi-LR stat)	0.000000		

Impulse Response Function

The researcher carried out impulse response functions to back up the quantile regression results. The response of exchange rate to a 2 standard deviation change in BOT components are shown in the figure below.

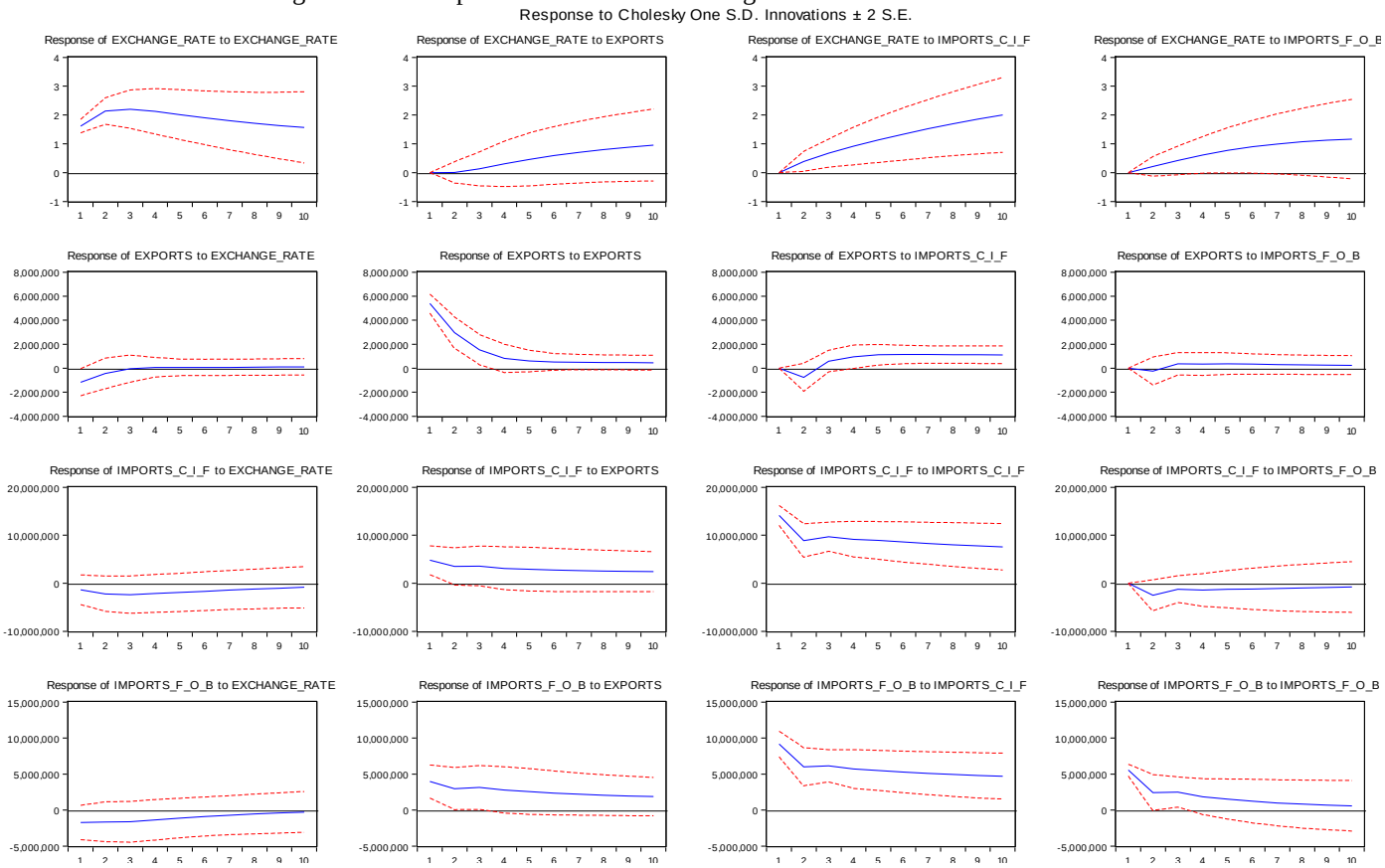

Figure 4: Impulse Response Functions
Source: Researcher 2018