

IMPACT OF EXTERNAL DEBT SERVICING ON ECONOMIC GROWTH IN NIGERIA: AN ARDL APPROACH

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Abstract

Nigeria was unbound since debt overhang, due to \$18 billion debt write off; there is an alarm of another foreign debt problem in the country, considering its debt profile. This study investigates the impact of external debt servicing on Nigeria's economic growth, a time-series data between 1985 to 2018 was managed with Autoregressive Distributive Lag (ARDL) model. Results of the study indicated that, in the long-run external debt servicing, affects economic growth negatively. That is an increase in external debt servicing lead to a decline in economic growth. The study suggests that debt service requirement should not be allowed to increase above the debt stock and, the contracted loan should be devoted to infrastructure development through efficient and judicious utilization.

Keywords: Autoregressive Distributive Lag, External debt servicing, external debt stock.

1. INTRODUCTION

Sustainable economic development remained concern to many countries, particularly Developing Countries that known to have low capital development, as a result of their level of domestic savings and investment. They probable choose borrowing from external sources in order to augment the inland savings, (Aluko & Arowolo, 2011; Safdari & Mehrizi, 2011; Sulaiman & Azeez, 2011). Borrowing remained the only alternative for them in order to fill the gap created by the projected fiscal expenditure and the anticipated revenue within a fiscal period. Certainly, different regimes borrow to finance public projects that will raise welfare and promote economic growth. It also borrow for higher spending without increase in taxes. This means that a government can meet a momentary shortage, rather than to cut back its expenditure. It makes government more flexible in such a way that it can sustain wages and spending commitments without a cut in the overall expenditure.

In recessionary periods, economy becomes sluggish, government tax revenue falls, individual income reduces, unemployment surges while budget deficit distends. Therefore, a government has to spend on unemployment and other social schemes to boost the economy. In this regards, to disregard borrowing in recession periods, make the situation worse and widen the income disparity. Furthermore, higher tariffs and lower expenditure will shrink the level of domestic demand and make the recession severe. That means, during economic downturn, borrowing rises while taxes are trimmed down.

The fiscal deficit faced by Nigerian government is responsible for her borrowing. And this budget deficit is largely caused by the swift crash of oil prices at the global market, around 1980s to early 1990s when the oil prices began to rise. Since the economy heavily depends on oil revenue to meet its finances. Borrowing is the major instrument employed by Nigerian governments to finance budget deficit and hasten economic growth, more so when the domestic financial earnings are inadequate, and require increases with funds from both local and foreign sources.

Multilateral Agencies such as International Bank for Reconstruction and Development (IBRD), European Development Fund (EDF), International Fund for Agricultural Development (IFAD), etc. are sources of Nigeria's foreign debt. While from the Consensual Coalition, there is Paris Club of Creditors and Non-Paris Club of Creditors, the country is also indebted to Private Creditors such as Promissory Holders and the London Club Group. Also Nigeria does acquire her external debt through the sale of Eurobonds (CBN, 2016).

Crisis on foreign debt in Nigeria received attention and concern on its administration, it acquired substantial amount of external debt in the past two decades, and this posed severe problems to the nation's development. For instance, external debt during the early 1980s increased Nigeria's official debt from \$4.1 billion at the end of 1980 to \$264.6 billion by the end of 1986. In 1999, Nigeria had an outstanding debt of \$28.4 billion, debt service payments amounted to \$1.72 billion and payment arrears of \$19 billion. Foreign debt stock stood at \$32.92 billion at the end of December, 2003, \$35.94 in 2004 as well as \$10.72 billion as at December, 2015, and it rose by 2.3% to \$81.27 billion as at March 2019 from \$79.437 billion recorded in December 2018 (DMO, 2014; 2019). Therefore, the intrinsic nature and weakness of the Nigeria's economy can be reflected in its openness, which is seen responsible for the decline of foreign exchange earnings and unpredictable terms of trade.

Studies reviewed, mainly assessed the impact of external debt stock on economic growth only, using different econometric models, while this study seek to identify the effects of external debt servicing on Nigeria's economic growth taking RGDP as proxy for economic growth this makes it different with previous researches on external debt and economic growth. This paper investigates the impact of external borrowing servicing on economic growth of Nigeria, therefore, seek to answer the following question:

To what extent does external debt servicing affect the Nigeria's economic growth?

The main objective of the study is to determine the impact of external debt servicing on Nigeria's economy. However, other specific objective is:

To determine the extent to which external debt servicing affects the Nigeria's GDP growth.

The study will focus on the Nigeria's external debt servicing and its impact on the economy. The study covered the period of 1986-2018. This period is chosen because it covers a period of deficit financing, and recessionary periods which were characterized by significant fall in oil prices which led to the shortfall in forex earnings, high inflationary pressures and unemployment.

1.1 Conceptual Literature

External debt is seen as that part of a nation's liability, owed to creditors outside the country. It also that portion of a country's debt acquired from sources such as: foreign corporations and government or financial institutions. Gap between domestic saving and investment causes external debt, as it widens, debt accumulates and makes the country to frequently borrow increasing amounts in order to stay financially buoyant (Arnove, et al., Ogbeifin, 2005, 2007).

Clements, et' al, 2005; DMO, 2016; viewed external debt servicing as a form of embedded tax, which make investment virtually impossible and suffocates economic growth. In Nigeria, the percentage of interest payments in total debt service has been very high and it is still on the increase and constitute a major cause of concern in the country's debt servicing.

1.2 Nigeria's External Debt History

Nigeria's external debt history originates dates back 2nd May, 1958, when the sum of \$28 was secured from the World Bank group for the construction of 1780 miles railway lines in the northern part of the country and between 1958 and 1977 the level of foreign debt was marginally contracted. There were concessional debts from bilateral and multilateral sources with longer repayment periods and lower interest rates throughout that period. While the country's income increased despite the available loans due to increase in the prices of oil at the global market in the 1970s.

The military government at that time propagated the Decree No.30, which smooth manner for borrowing up to \$5 billion. As a result, Nigeria borrowed the sum of \$1 billion from the International Capital Market on commercial terms, thereby increasing the total debt stock to \$2.2 billion (AFRODAFD, 2007; DMO, 2006). Around 1980s, due to the increasing external debt service payments the nation's debt profile had begun to extremely rise where it stood at \$8.5 billion and nearly reached \$19 billion in 1985, showing an increase of about 45.02% these resulted in mounting of trade debts arrears. The nation's debt stock stood at \$27.09 billion: \$18.98 billion Paris Club debt; \$4.37 billion multilateral debt; \$1.61 billion Promissory notes and \$0.79 billion non Paris Bilateral debt, in 1997 (Federal Ministry of Finance, 1997).

External debt stock composition in Nigeria raised to its highest in 2004, \$30.8 billion from the total outstanding debt was from the 14-member Paris Club, \$2.8 billion from the London Club while \$2.2 billion derived from the multilateral institutions (Ajab, & Audu, 2006). However, by the country's exits from Paris Club in 2006, the external debt figure dropped to \$3.5 billion and \$3.4 billion in 2006 and 2007 respectively and it has been on a steady increase since that time; \$3.7 billion in 2008, \$3.9 billion in 2009, \$4.5 billion in 2010, \$5.7 billion in 2011, \$6.5 billion in 2012, and \$9.00 billion in 2013, this gives a clear picture of the country's debt stock position, from the previous debauched debt sustainability level to another within a short period of time. As at 31st December, 2015 the external debt situation of the country reached up to \$10.72 billion, Debt Management Office (DMO, 2014).

2. LITERATURE REVIEW

Part of the studies reviewed, that found external debt to impact negatively and contribute negatively to economic growth such as (Moh'd Al-Tamimi, & Mohammad, 2019; Festus, and Saibu, 2019). While Hassan, et al, 2019; Senadza, Fiagbe, & Quartey, 2018; Inna, & Viktoriia, 2018; Faraji & Makame, 2013, found a significant and positive impact of external debt on the Economic growth and total debt service to have significant and negative impact. Their studies further revealed that there exist debt overhang and Crowding-out effects due to increasing External debt accrual and its service.

Saungweme, Talknice, & Odhiambo, (2018) investigate the relationship between public debt and economic growth in Nigeria and found it to be an inverted U-shaped Paul, (2017), discovered that debt service payment has negative and insignificant impact on Nigeria's economic growth while, external debt stock has positive and significant effect on Nigeria's growth. In a similar study, (Ada, Chigozie, & Godwin, 2016), found a long-run relationship between annual growth rate of real GDP,

ratio of external debt to GDP, ratio of debt service stock to GDP, ratio of national expenditure to GDP and real exchange rate.

Consequently, Austin, (2014) investigated the correlation between debt servicing and economic and found that debt payments to Nigeria's creditors have significant negative impact on GDP. Ejigayehu, (2013), analysed eight selected heavily indebted African countries, through the debt overhang and crowding out effect and found that external debt affects economic growth through debt crowding out rather than debt overhang.

Atique & Malik, (2012), found a significant inverse relationship between domestic debt and economic growth, and external debt and economic growth in Pakistan. In a similar study, Ajayi, and Oke, (2012), using the ordinary least square method and found that external debt liability had an adverse effect on revenue and per capita income of the nation.

2.1 Theoretical Framework

There are several theories postulated with regards to external debt and economic growth, which are significant to this study and other research works. As such, the Dual-gap theory will lead this study. This model posits that developing economies faced with two major challenging gaps in their economy they need to fill. The first is between savings and investments. A developing economy starts with very low savings, and it has to engage in a big push by investing heavily. Therefore, what should be the possible ways by which these countries can fill this gap between savings and investments? Here, there are lots of debates among economists. Some argued that developing countries require aid from developed countries. Others were of the view that these countries need to engage into trade in order to gain trade surpluses, which could then be used to fill the gap. However, for the second gap, this takes us to the difference between exports and imports. Thus, for Nigeria to overcome these two gaps, government need to kick start the industrialization process. The East Asian Tigers represent the best examples for such state-led industrial development.

3. METHODOLOGY

This study used annual time series data for a period of 1985 to 2018, sourced from the Central Bank of Nigeria Statistical Bulletins, the Federal Bureau of Statistics, the IMF, the World Bank development indicators (WDI) and the Debt Management Office. Pre estimation tests of Augmented Dickey Fuller (ADF) unit root test and Phillip Perron were carried out before estimating the long run and the ARDL bound test for Co-integration as well as the short run estimates. Post estimation tests such as hetroscedasticity, serial correlation and multicollinearity tests to ensure the stability of the model were also conducted. Similarly, from the bounds test result, the variables were found to be cointegrated; both short-run and long-run dynamics were captured in the specified model.

3.1 Model specification

A modest macroeconomic debt growth model was adopted from the work of Boboye, & Ojo, (2012). Specified mathematically in the functional form as follows:

$$RPY = f(EDSTOCK, EDSERV, GNEXP EXCHR) \quad (1)$$

To make the above mathematical expression estimable, it will be transformed into a stochastic form as equation (2) below:

$$\ln RPY_t = \beta_0 + \beta_1 \ln EDstock_t + \beta_2 \ln EDServ_t + \beta_3 \ln GNExp_t + \beta_4 \ln EXchR_t + \mu_t \quad (2)$$

Where: β_0 = a constant

$\beta_1, \beta_2, \beta_3$ = Coefficients of the independent variables,

$\ln RPY_t$ = Real Per capita GDP

$\ln EDstock_t$ = external debt as a percentage of GNI

$\ln EDserv_t$ = external debt service as a share of exports

$\ln GNE_{exp_t}$ = Gross national expenditure as a percentage of GDP.

$\ln EXchR_t$ = real exchange rate.

\ln = logarithm

μ = Error term.

The following ARDL model was specified and estimated for cointegration relationship to test between the variables under the study as follows:

$$\begin{aligned} \Delta \ln RPY_t = & C_0 + \delta_1 \ln RPY_{t-1} + \delta_2 \ln EDY_{t-1} + \delta_3 \ln EDE_{t-1} + \delta_4 \ln GNE_{t-1} + \delta_5 \ln EXR_{t-1} \\ & + \sum_{i=1}^p \phi_i \Delta \ln RPY_{t-i} + \sum_{j=0}^{q1} \phi_j \Delta \ln EDY_{t-j} + \sum_{i=0}^{q2} \phi_j \Delta \ln EDE_{t-i} + \sum_{i=0}^{q3} \gamma_i \Delta \ln GNE_{t-i} \\ & + \sum_{i=0}^{q4} \gamma_j \Delta \ln EXR_{t-i} + \varepsilon_t \end{aligned} \quad (3)$$

Where δ_i the long run multipliers C_0 is the intercept ε_t are white noise errors

Having established the existence of cointegration, the conditional ARDL (p, q1, q2) long-run model for RPY_t can be estimated as:

$$\begin{aligned} \ln RPY_t = & C_0 + \sum_{i=1}^p \phi_i \ln RPY_{t-i} + \sum_{j=0}^{q1} \phi_j \ln EDY_{t-j} + \sum_{i=0}^{q2} \phi_j \ln EDE_{t-i} + \sum_{i=0}^{q3} \gamma_i \ln GNE_{t-i} \\ & + \sum_{i=0}^{q4} \gamma_j \ln EXR_{t-i} + \varepsilon_t \end{aligned} \quad (4)$$

It encompasses lag length selecting orders of the ARDL (p, q1, q2) model using Akaike Information Criteria (AIC). This is followed by obtaining the short-run dynamic parameters through estimating an error correction model associated with the long-run estimates. This is specified as:

$$\begin{aligned} \Delta RPY_t = & \mu + \sum_{i=1}^p \phi_i \Delta \ln RPY_{t-i} + \sum_{j=0}^{q1} \phi_j \Delta \ln EDY_{t-j} + \sum_{i=0}^{q2} \phi_j \Delta \ln EDE_{t-i} + \sum_{i=0}^{q3} \gamma_i \Delta \ln GNE_{t-i} \\ & + \sum_{i=0}^{q4} \gamma_j \Delta \ln EXR_{t-i} + \varepsilon_t \end{aligned} \quad (5)$$

Here ϕ , ϕ , and γ are the short-run dynamic coefficients of the model's convergence to equilibrium and ϑ is the speed of adjustment.

3.2 Measurement of Variables

Real Gross Domestic Product adjusted for inflation, used as proxy of GDP in this study while, External Debt Stock as the amount the debt contracted, is a proxy for capturing external debt liability. Negative relationship between Real Growth Domestic Product and External debt Stock is expected. External Debt Service Payments is the amount used in repaying the debt, proxy for capturing external debt burden. Negative relationship between Real Growth Domestic Product and External Debt Service Payments is also expected. Meaning that, the higher the debt service payments, the lower the economic growth of a nation. Exchange Rate was included in the model as a macroeconomic indicator. Positive relationship between Real Growth Domestic Product and Exchange Rate is expected.

4. RESULTS AND DISCUSSION

Table1. Unit Root Test

ADF @ 5%			
Variable	Level	1st Diff.	Integration order
<i>lnRGPD</i>	-0.096430	-4.467957	I(1)
<i>lnGROSSEX</i>	-4.729745	-8.392029	I(0)
<i>lnEDSTOCK</i>	-0.748626	-4.924462	I(1)
<i>lnEDSERV</i>	-1.487310	-6.005925	I(1)
<i>lnEXCH_RATE</i>	-3.986205	-6.751687	I(0)
PP @5%			
<i>lnRGPD</i>	-0.232824	-4.438889	I(1)
<i>lnGROSSEX</i>	-4.674555	-17.83065	I(0)
<i>lnEDSTOCK</i>	-0.806977	-4.931031	I(1)
<i>lnEDSERV</i>	-1.445740	-6.011763	I(1)
<i>lnEXCH_RATE</i>	-3.988145	-7.075720	I(0)

Source: Researcher's Computation Using Eviews 10 (2020)

Table 1. Above, presents results of Augmented Dickey-Fuller (ADF) and Phillip Perron tests for stationary, null hypothesis is $H_0 = \beta = 0$ (i.e., β has a unit root), and the alternative hypothesis is $H_1 = \beta < 0$ were implemented. The results is shown for level and differenced variables for both tests. The tests fail to reject the presence of unit root in for the data series in levels, on some variables, while the null hypothesis was rejected on other variables indicating that these variables are mixture of I(0) and I(1).

Table. 2 Bound Tests for Co-integration

F- statistic	Lower bound	Upper bound	K(n-1)	Sign.lev.	Remarks
9.3522294	2.2	3.09	3	10%	Cointegration

2.79	3.67	5%
3.29	4.37	1%

Source: Researcher's Computation Using Eviews10 (2020)

Table 2. Above, present result for ARDL bound test with F-statistic value of 9.3522294. It is greater than the lower and upper bounds t-statistic at 5% level of significance using Pesaran, *et al.* (2001). this warrants the rejection of the null hypothesis of "no Cointegration". Hence, there exists a long-run relationship among all the variables under study. As such, the ARDL cointegration approach was used to estimate the short-run and long-run relationship.

Table 3. Result of estimated Long Run Coefficients

Variable	Coefficient	Strd.err.	t- statistic	Prob.
Constant	8.784564	5.431738	1.617266	0.1195
lnEDSTOCK	-0.404262	0.188827	-2.140916*	0.0431
lnEDSERV	-0.130578	0.169821	-0.768913	0.4498
lnEXCH_RATE	-0.003695	0.212391	-0.017399	0.9863
lnGROSSEXP	-0.082830	1.291113	-0.064154	0.9494
ECT	-0.315441	0.082064	-3.843841**	0.0008

Source: Researcher's Computation Using Eviews10 (2020)

Table 3 above presents the long-run estimates of the variables, -0.404262 coefficient implies that an increase in external debt as a percentage of GNI by 1%, GDP will, on average, decrease by -4% keeping all other variables constant. Hence, there is negative relationship between external debt as a percentage of exports and the gross domestic product and it's statistically significant. -0.130578 coefficient implied a unit increase in external debt service as a percentage of exports will decrease gross domestic product by -1.3%, as such, there exist insignificant negative relationship between the external debt service as a percentage of exports and the GDP. Similarly, -0.003695 coefficient implied that a percentage increase in exchange rate will lead to a decrease of gross domestic product by 0.003% holding other variables constant. This implied that there is insignificant positive relationship between exchange rate and the GDP.

However, the coefficient of the Error Correction Term (-0.315441) which represents the speed of adjustment towards the long-run equilibrium, is negative and statistically significant. The adjustment process is very fast. Thus, the model adjusts itself towards equilibrium by 3.1%.

Table 4. Short Run Result ARDL (1, 1, 0, 2, 0)

Variable	Coefficient	Standard error	t- statistic	p. value
Constant	2.771009	2.223745	1.246100	0.2253
$\Delta \ln RGDP_t(-1)$	0.684559	0.187061	3.659559**	0.0013
$\Delta \ln EDSTOCK_t$	-0.384062	0.076361	-5.029527**	0.0000
$\Delta \ln EDSTOCK_t(-1)$	0.256541	0.105008	2.443049*	0.0227
$\Delta \ln EDSERV_t$	0.022130	0.037346	0.592578	0.5592
$\Delta \ln EDSERV_t(-1)$	-0.063320	0.031210	-2.028842*	0.0542
$\Delta \ln GROSSEXP_t$	-0.026128	0.403365	-0.064775	0.9489
$\Delta \ln EXCH_RATE_t$	-0.001166	0.067352	-0.017307	0.9863

R-squared 0.985379
Adjusted R-squared 0.980929

Source: Researcher's Computation Using Eviews10 (2020) Prob. (F-statistic): 0.000000, Durbin-Watson stat: 1.728535

Table 4. Presents the short run estimated result. Per capita GDP lagged one year revealed a positive and significant impact on its current value. It has an impact on itself by 6.8% with coefficient 0.684559 which is statistically significant. External debt stock has a negative and statistically significant value on the dependent variable, that is, a unit increase in external debt stock will reduce GDP by -3.8% External debt service has a positive and statistically insignificant impact on real per capita GDP. i.e., a unit increase in external debt service will reduce real per capita GDP by -3.8%. As for the external debt service lagged one revealed negative and statistically significant relationship with real percapita Gdp. While, government expenditure revealed a negative and statistically significant relationship with real percapita Gdp, government expenditure lagged one also revealed a negative and statistically in significant relations with real per capita Gdp and the same government expenditure lagged two revealed a negative and statistically significant relationship with real percapita Gdp while, for exchange rate, it is positively related to the real per capita GDP, but statistically insignificant. A unit increase in exchange rate will increase real per capita GDP by -0.001%. As for the gross national expenditure, it is positive and statistically significant. A unit increase in expenditure will stimulate growth by -0.001%.

Table 4.5 Validity tests

*Breusch-Godfrey Serial Correlation LM Test:			
F-statistic	0.285080	Prob. F(1,20)	0.5993
Obs*R-squared	0.421610	Prob. Chi-Square(1)	0.5161
**Heteroskedasticity Test: Breusch-Pagan-Godfrey			
F-statistic	1.852204	Prob. F(8,21)	0.1231
Obs*R-squared	12.41090	Prob. Chi-Square(8)	0.1338
Scaled explained SS	6.465681	Prob. Chi-Square(8)	0.5952
***Ramsey RESET Test			
Equation: UNTITLED			
Specification: GDP GDP(-1) LINEDSERV LEDSERV(-1) LEDSTOCK GROSSEXP GROSSEXP(-1) GROSSEXP(-2) EXCH_RATE C			
Omitted Variables: Squares of fitted values			
	Value	Df	Probability
t-statistic	4.081123	20	0.2226
F-statistic	16.65556	(1,20)	0.2226

Sources: Researcher's Computation (2019) Using E Views 2010

*Durbin Watson stat; **indicates; model is Homoskendastic, ***Ramsey test result

Table 5 above present the diagnostic tests, it confirm that, the model passes all the post estimation tests. The model is free from serial correlation and normally distributed. The result of CUSUM test and cumulative sum of squares (CUSUMQ) of the recursive residuals as proposed by (Brown *et al.*, 1975). The plots (CUSUM and CUSUMQ) remain within the critical limits of 5% significance level (see appendix).

5. CONCLUSION

The study is set to determine the impact of external debt servicing on economic growth in Nigeria. The study regressed real GDP per capita on external debt as a percentage of GNI, external debt service as a percentage of exports, real exchange rate and the gross national expenditure as a percentage of GDP. Part of the findings of the study indicated that external debt stock was negatively related with economic growth in Nigeria in both short-run and long-run, and it is statistically significant. External debt service was found to be negatively associated with economic growth, and statistically insignificant in both short and long-run. Real exchange rate, was used as a control variable, also has positive influence on real per capita GDP, but it was statistically insignificant. Gross national expenditure, was found to have been positively related with economic growth, and statistically significant in the short-run, and insignificant in the long-run.

The study, however, found a long-run relationship between external debt service payment and the real gross domestic product. As such, from the findings of the study, it was found that external debt service payment negatively associated with the real gross domestic product in Nigeria. This, commensurate with empirical findings such as (Moh'd Al-Tamimi, & Mohammad, 2019; Festus, and Saibu, 2019; & Inna, & Viktoriia 2018). This cannot be unconnected with fact that servicing external debt in Nigeria consumes a significant proportion of the Nigerian revenue, which could have been utilized to move the gross domestic product to a higher level.

The paper poster the following policy recommendations:

1. Parts of its plan, government should ensure that major determinant of the amount to be contracted as a loan facility is actual tax revenue, and not the overall size of the GDP. When contracting external loan. This cannot be unconnected with the fact that GDP size does not pay debt, but tax revenue does.
2. The country should place more emphasis on diversifying the economy in order to move away from depending on oil earnings. This will secure it against external shocks that have their genesis from oil prices. This diversification should be: (a) tax diversification – by tax diversification, it implies that government should make effort to identify other new taxable bases while holding the tax rate constant. This, if well implemented, will provide government with alternative funds for financing capital projects instead of securing loan as from external sources. (b) Agricultural diversification –will make the country become self-sufficient in food production. Not only that, the economy stands a good chance to earn forex for exporting the surplus of agricultural produce to other countries of the world. This, however, will go a long way to discourage importation and which will subsequently improve the status of our balance of payments.
3. Having established that debt stock has positive relationship with real gross domestic product, government, as a matter of policy bid, should direct what was borrowed to capital projects which improve gross domestic product through employment and income generation in the long-run. That means, borrowed funds should not be used in financing consumptions in the

name of salaries, political spending, or other recurrent expenditure that has no long term positive effects on the economy.

4. A sound borrowing policy should be enacted by Debt Management Office in collaboration with legislature in order to impose legal limit on external borrowings. The policy should be subject to review so as to meet the predominant realities of the economy. A condition where executive arm of government has a free hand to borrow funds from the external sources as much as they wish will not go down well with economy.

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APPENDIX

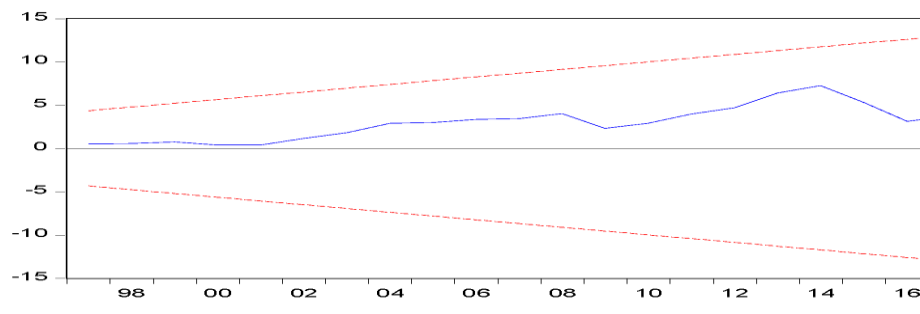


Figure 1. CUSUM Test

Source: Computed by author's E-views 10

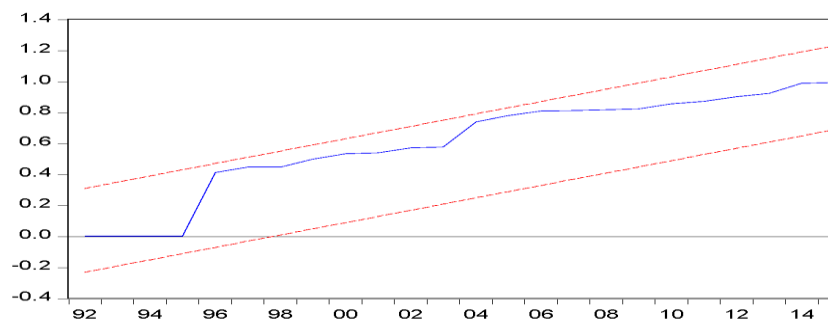


Figure 2: CUSUMSQ Test

Source: Computed by author's E-views 10