A Dynamic Analysis of the Link between Public Expenditure and Public Revenue in Nigeria and Ghana

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Abstract

This paper investigated the nature of the relationship between government expenditure and government revenue for Nigeria and Ghana within a dynamic framework. The major empirical and methodological contribution of this study is the use of Dynamic Ordinary Least Squares (DOLS) proposed by Stock and Watson (1993). Dynamic OLS becomes better than OLS by coping with small sample and energetic sources of bias. An Engle-Granger two-step methodology for error correction was employed. The models for revenue and expenditure for the two countries reveal causation running in both directions to and from revenue and expenditure. However, the conclusion drawn from the study supports the fiscal synchronisation hypothesis which is in dissension with views held by earlier researchers. Further, results indicate that lagging, leading and coincident effects of revenue on expenditure and vice versa are present for the two countries. On the other hand, changes in expenditure have a negative impact on revenue for the Nigerian economy and a positive impact for the Ghanaian economy. Moreover, changes in past values of expenditure impact positively on changes in revenue. This finding is peculiar to the Nigerian economy.

Keywords: Dynamic ordinary least squares, fiscal synchronisation, hypothesis, error correction.

1. Introduction

The link between government revenue and expenditure has been a major concern for governments and policy makers alike. Research on this nexus has become more important and relevant since governments in both developed and developing countries have been incurring continuous budget deficits. One of the broader macroeconomic policy instruments that can be used to prevent or reduce short-run fluctuations in output, income and employment is fiscal policy. A misalignment of revenue and expenditure leads to a budget deficit or a budget surplus. Budget deficits emanate from two main sources; rising demand for public expenditures for infrastructure and social sector investment on one hand, and lack of capacity to raise revenue from domestic sources to finance the increased expenditure primarily due to a narrow tax base. Therefore, a good understanding of the relationship between government revenue and government expenditure is very important, especially, in addressing fiscal imbalances (Eita and Mbazima, 2008).

The study of the causal link between government revenue and government expenditure has resulted in four hypotheses that have been under empirical scrutiny in the literature. This debate has been an issue over the past and has generated scores of studies the world over. The four hypotheses are: the revenue-spend hypothesis (where there is a unidirectional causality from government revenue to government expenditure); the spend-revenue hypothesis (where there is a unidirectional causality from government expenditure to government revenue); the fiscal synchronisation hypothesis (where there is bidirectional causality between government revenue and government expenditure); and the institutional separation hypothesis (where there is no causality between government revenue and government expenditure).

This study is particularly important for two reasons. First, it goes beyond contributing to the literature in the area and confirming the existing hypotheses, but comparative study of an oil economy and a non-oil economy. This study puts in perspective lessons for Ghana and also expectations about the future since Ghana has become an oil exporting economy. This new environment will have several implications at the macroeconomic, sectoral and household levels. A study of this sort will provide a useful guide for fiscal policy analysts regarding future fiscal occurrences and challenges in the Ghanaian economy.

The objective of this paper is to investigate the link between government spending and government revenue in a dynamic setting. The main methodological contribution of this study is the use of the Dynamic Ordinary Least Squares (DOLS) estimation methodology by Stock and Watson (1993). This method is by contrast a robust single equation approach which corrects for regressors endogeneity by inclusion of leads and lags of first difference of the regressors.

The rest of the paper is organised as follows. Section 2 is a review of relevant literature. The methodology and theoretical framework is presented in section 3. Section 4 presents and discusses the results of the study. Finally, section 5 is the conclusion of the study.

2. Literature review

2.1 Theoretical review

There are four hypotheses put forward that form the basis for public revenue and public expenditure relationship. Firstly, Friedman (1978) put forward the tax and spend hypothesis which states that changes in government revenue bring about changes in government expenditure. It is characterized by unidirectional causality running from government revenue to government expenditure. By this, Friedman noted that increases in tax or revenue will lead to increases in public expenditure, and this may result in the inability to reduce budget deficits (Chang, 2009).

Secondly, Peacock and Wiseman (1961, 1979), writing on the spend and tax hypothesis, noted that changes in public expenditure bring about changes in public revenue. This is characterized by a unidirectional causality running from public expenditure to government revenue. They argued that temporary increases in government expenditures due to economic and political forces can result in permanent increases in government revenues from taxation; a phenomenon usually referred to as the displacement effect.

Thirdly, the fiscal synchronisation hypothesis, associated with Musgrave (1966) and Meltzer and Richard (1981), is based on the belief that there is a joint determination of public revenue and public expenditure decisions. Chang (2009) notes that it is characterized by a contemporaneous feedback or bidirectional causality between government revenue and government expenditure. It is opined that voters compare the marginal costs and marginal benefits of government services when making a decision in terms of the appropriate levels of government expenditure and government revenue.

Lastly, the fiscal independence or institutional separation hypothesis, advocated by Baghestani and McNown (1994), has to do with the institutional separation of the tax and expenditure decisions of government. It is characterised by non-causality between government expenditure and government revenue (Chang, 2009). This situation implies that government expenditure and government revenue are independent of each other.

2.2 Empirical review

A plethora of empirical literature shows that there are mixed findings on the nature of the relationship or direction of causation between government expenditure and government revenue. Different studies have come up with findings that provide support for the different hypotheses for different countries. Von Furstenberg, et al (1986) for the United States of America; Hondroyiannis and Papapetrou (1996) for Greece; Wahid (2008) for Turkey; and Carneiro, et al (2004) for Guinea-Bissau provide support for the spend and tax hypothesis.

Moreover, studies that provide support for the tax and spend hypothesis include: Eita and Mbazima (2008) for Namibia; Darrat (1998) for Turkey; and Fuess, et al (2003) for Taiwan. In the study for Turkey, Wahid (2008) applied the standard Granger causality test whereas Darrat (1998) used the Granger causality test within an error correction modeling framework. Further, with respect to the fiscal synchronisation hypothesis, the studies that provide support for the hypothesis include Chang and Ho (2002) for China; Maghyereh and Sweidan (2004) for Jordan. For the institutional separation hypothesis, the study by Barua (2005) supports the hypothesis at least in the short-run for Bangladesh.

Based on the experiences of thirteen (13) African countries, Wolde-Rufael (2008) investigated the public expenditure-public revenue nexus. The study was carried out within a multivariate framework using Toda and Yamamoto (1995) modified version of the Granger causality test. The results of the study provided evidences supporting the fiscal synchronisation hypothesis for Mauritius, Swaziland and Zimbabwe; institutional separation hypothesis for Botswana, Burundi and Rwanda; the tax and spend hypothesis for Ethiopia, Ghana, Kenya, Nigeria, Mali and Zambia; and the spend and tax hypothesis for Burkina Faso.

For Some African countries, Nyamongo et al. (2007) investigate the relationship between revenue and expenditure in the context of Vector Autoregressive (VAR) approach and conclude that revenue and expenditure are linked bidirectionally in the long run, indicating fiscal synchronisation hypothesis, while no evidence of causation is seen in the short run which points to fiscal separation hypothesis. Aregbeyen and Ibrahim (2012) using an Autoregressive Distributed Lag (ADRL) bound test, found the existence of a long-run relationship between government expenditures and government revenues. Their findings confirmed the tax-spend hypothesis for the Nigerian economy. They asserted that this was attributable perhaps to oil revenue dominance in Nigeria's government revenue profile and fiscal operations over time.

For the Ghanaian economy, Amoah and Loloh (2008) using Cointegrating regressions and error correction indicated the presence of a unidirectional causality running from revenue to expenditure in the short run. Their findings further supported the tax-spend hypothesis for Ghana. However, Doh-Nani and Awunor-Vitor (2012) assert that there is bi-directional causality such that both government expenditure and government revenue of Ghana have temporal precedence over each other. However, they do not explicitly express support for any of the hypotheses in the literature.

3. Methods and materials

3.1 Model and Methodology

From the theoretical and empirical expositions in the literature, two empirical models that connect revenue and expenditure as both a regressor and a regressand are discernable. In general terms, they are expressed as:

$$G_t = f(R_t) \quad (1a)$$

$$R_t = f(G_t) \quad (1b)$$

where G_t and R_t are Government expenditure and revenue respectively.

Annual data for the period 1980 to 2010 was used for the study. For both countries, data for expenditure and revenue are general government expenditure and revenue. Before estimating the model, the series were investigated for stationarity using the Augmented Dickey-Fuller, Philips Perron and KPSS tests. These investigations are both with and without a deterministic trend. If the series are integrated of the same order, Johansen's (1988) procedure can then be used to test for the long run relationship between them. The theorem of Granger representation states that if a set of variables is cointegrated (*I, I*), it implies that the residual of the cointegrating regression is of order *I*(0), thus there exists an Error Correction Mechanism (ECM) describing that relationship. The ECM specifications of the series are expressed as:

$$\Delta \ln G_t = \alpha_0 + \alpha_1 \Delta \ln R_t + \alpha_G GECT_{t-1} + u_t \quad (2a)$$

$$\Delta \ln R_t = \beta_0 + \beta_1 \Delta \ln G_t + \alpha_R RECT_{t-1} + v_t \quad (2b)$$

Here, *GECT* is error correction term for Government expenditure and *RECT* is error correction term Government revenue. Also, both short-run and long-run information are included in the specification. In the models, α_1 and β_1 are the impact multipliers (the short-run effect) that measures the immediate impact of a change in the regressors on a change in the regressand. Meanwhile, α_G and α_T is the feedback effect, or the adjustment effect for expenditure and revenue respectively. It also shows how much of the disequilibrium is been corrected, i.e. the extent to which any disequilibrium in the previous period affects any adjustments in expenditure and revenue.

Furthermore, to estimate, equations (1a) and (1b) are formulated in a Dynamic Ordinary Least Squares (DOLS) framework. This estimation procedure is more robust in small range of samples compared to alternative approaches. According to Stock and Watson (1993), the presence of leads and lags of different variables which has integration vectors, eliminates the bias of simultaneity within a sample. Also, the DOLS estimates have better small sample properties and provide superior approximation to normal distribution. The Stock-Watson's DOLS model is commonly specified as follows:

$$Y_t = \beta_0 + \vec{\beta} X_t + \sum_{j=-q}^{p} \vec{d} \Delta X_{t-j} + u_t \quad (3)$$

where Y_t dependent variable, X_t matrix of explanatory variables, $\vec{\beta}$ is a cointegrating vector; i.e., representing the long-run cumulative multipliers or, alternatively, the long-run effect of a change in X on Y. *p is* lag length *q is* lead length.

The Lag and lead terms included in DOLS regression serve the purpose of making its stochastic error term independent of all past innovations in stochastic regressors. Finally, unit root tests are performed on the residuals of the estimated DOLS regression, in order to test whether it is a spurious regression. In the unit-root literature, a

regression is technically called a spurious regression when its stochastic error is unit-root non-stationary. (Choi et. al., 2008, p. 327.) With reference to equation (3), the model for revenue and expenditure linkage is presented as follows:

NIGERIA					
		Level		First Difference	
TEST	**Variable**	**Constant**	**Constant +Trend**	**Constant**	**Constant +Trend**
ADF TEST	LnG LnR	-0.441880 -0.989117	-1.683475 -2.881660	-7.525923* -6.863554*	-3.904895** -3.945312**
Phillips-Perron test	LnG LnR	0.210999 -0.022095	-3.231423 -2.881660	-7.377624* -6.934767*	-7.218412* -6.777348*
KPSS	LnG LnR	0.709736** 0.712586**	0.105939* 0.112464*	0.169296 0.125471	0.154320 0.121324
GHANA					
		Level		First Difference	
TEST	**Variable**	**Constant**	**Constant +Trend**	**Constant**	**Constant +Trend**
ADF TEST	LnG LnR	-3.399591** -2.294504	-0.779432 -1.536673	-4.680594* -4.284196*	-6.290395* -4.860048*
Phillips-Perron test	LnG LnR	-2.226266 -3.687041*	-0.527378 -1.274712	-4.164902* -4.280671*	-10.07881* -4.861183*
KPSS	LnG LnR	0.727896** 0.726693**	0.182266** 0.174752**	0.258816 0.362457	0.178814 0.085701

$$\ln G_t = \alpha_0 + \alpha_1 \Delta \ln R_t + \sum_{i=l}^{l} \delta_i \Delta \ln R_{t-i} + u_t \quad (4a)$$

$$\ln R_t = \alpha_0 + \alpha_1 \Delta \ln G_t + \sum_{i=l}^{l} \delta_i \Delta \ln G_{t-i} + u_t \quad (4b)$$

In the models above, variables are in natural logarithm where G_t is government expenditure, R_t is government revenue. In the practical studies, the optimal lag structure can be determined by using information criteria based on Akaike and Schwarz criterion through an unrestricted VAR estimation.

4. Empirical findings

4.1Unit roots tests

The Augmented Dickey-Fuller (ADF) and Phillips-Perron (PP) tests for stationarity reveal that in first difference,

the null hypothesis of a unit root is rejected at least at 0.05 significance level. The inference drawn from this is that the variables are unit root non-stationary. Furthermore, the KPSS test confirms this assertion. According to the KPSS tests results, the null hypothesis of a stationary process can be rejected for the series in level, but cannot be rejected for the series in first difference. These results are presented in table 1.

Table 1. Results of stationarity tests
Source: Authors construct
ADF and PP: Null hypothesis is that the variable being examined is non-stationary.
KPSS: Null hypothesis is that the variable being examined is stationary.
* and ** denotes statistical significance at 1% and 5% levels, respectively.

4.2 Cointegration and Error Correction estimation

In order to determine if the variables are cointegrated, we perform a Dickey-Fuller test on the residual series to check for the order of integration. It is found that the error terms are I(0) and we reject the null hypothesis that the variables are not cointegrated. The cointegration test results are shown in table 2.

Table 2. Cointegration test results

NIGERIA		
Residual	**Augmented Dickey fuller test statistic**	**Prob.-value**
$\mathbf{G_t}$	-2.14487**	0.0331
$\mathbf{R_t}$	-2.082069**	0.038
GHANA		
Residual	**Augmented Dickey fuller test statistic**	Prob.-value
$\mathbf{G_t}$	-2.912458*	0.005
$\mathbf{R_t}$	-3.053233*	0.0035

Source: Authors' construct
* and ** denote statistical significance at 1% and 5% levels, respectively.

The basic error correction models of equation were then estimated to observe the short run dynamics and long run characteristics of the models. For Nigeria, the speed of adjustment for the spend-tax model was a high of -0.82, and that for Ghana as -0.37. Both were statistically significant and had the required sign for dynamic stability. For the tax-spend hypothesis, the speed of adjustment for Nigeria was -0.55 and that for Ghana as -0.28. In all cases the response to disequilibrium caused by short-run shocks of the previous period are quicker for Nigeria than for Ghana although both are statistically significant. The conclusion that can be drawn from this investigation is that the fiscal synchronisation hypothesis prevailed in both Nigeria and Ghana for the period under investigation. This finding differs from earlier studies on the two economies with regard to the revenue-expenditure nexus. The reason for this difference in findings rests on the specification of the error correction model. These results are presented in table 3.

Table 3. Results of error correction models

NIGERIA					
Dependent Variable: ΔlnG_t	**Coefficient**	**t-statistic**	**Dependent Variable: ΔlnR_t**	**Coefficient**	**t-statistic**
C	0.094517** (0.051709)	1.827859	C	0.097502 (0.061215)	1.59278
ΔlnR_t	0.437211* (0.140102)	3.120650	ΔlnG_t	0.613948* (0.193143)	3.178725
ECT_{t-1}	-0.546301* (0.183585	-2.975734	ECT_{t-1}	-0.816776* (0.175232)	-4661116
Adj. R^2 = 0.26, DW = 1.75			**Adj. R^2 = 0.45, DW = 2.11**		
GHANA					
Dependent Variable: ΔlnG_t	**Coefficient**	**t-statistic**	**Dependent Variable: ΔlnR_t**	**Coefficient**	**t-statistic**
C	0.176956* (0.034457)	5.135601	C	-0.011726 (0.076278)	-0.153733
ΔlnR_t	0.423883* (0.087772)	4.829336	ΔlnG_t	1.08864* (0.221658)	4.91135
ECT_{t-1}	-0.2765* (0.07575)	-3.650165	ECT_{t-1}	-0.374428 (0.128213)	-2.920353
Adj. R^2 = 0.55, DW = 2.16			**Adj. R^2 = 0.45, DW = 2.06**		

Source: Authors' construct

* and ** denote statistical significance at 1% and 5% levels, respectively.

4.3 Dynamic ordinary least squares estimation

Selection of maximum lag length is based on the unrestricted VAR estimation using the Akaike Information Criteria (AIC) and the Schwarz Bayesian Criteria (SBC). It is observed that the maximun lag length for the Ghanaian model is 3 while that for the Nigerian economy is 5. This outcome is presented in Table 4.

Table 4. Selection of lag length

Lag Order	Akaike Information Criterion (AIC)	Schwarz Bayesian Criteria (SBC).
GHANA		
2	-1.148518	-1.007073
3	-1.482272$^{(m)}$	-1.291957^{m}
4	-1.446793	-1.206823
NIGERIA		
2	0.188844	0.330288
3	0.218284	0.408599
4	0.022221	0.262191
5	-0.298884$^{(m)}$	-0.008555^{m}
6	-0.235506	0.105779

(m) refers to the maximum lag length

Source: Authors' construct

The models results show intriguing results for the two countries. Results indicate that lagging, leading and coincident effects of revenue on expenditure and vice versa are present for the two countries. Variations of the impacts of changes in revenue on expenditure on one hand and expenditure on revenue on the other hand are shown. For both countries, the elasticity of revenue assumes positive sign and are significant at the 1% level. The coefficient of revenue was 0.50 for Nigeria and 0.34 for Ghana. The impact of changes in revenue for the Nigerian economy is larger than that of the Ghanaian economy. Further, a change in the lagged values of revenue positively affects changes in current government expenditure for the Nigerian economy only. These effects are insignificant[1] for the Ghanaian economy.

On the other hand, changes in expenditure have a negative impact on revenue for the Nigerian economy and a positive impact for the Ghanaian economy. Furthermore, changes in past values of expenditure impact positively on changes in revenue. This finding is peculiar to the Nigerian case only. These results are presented in table 5. The CUSUM test and CUSUM of Squares test results show that the models are stable. These stability tests results are presented in the appendix.

Table 5. DOLS estimations results for Nigeria and Ghana

NIGERIA					
Dependent Variable: ΔlnG	**Coefficient**	**t-statistic**	**Dependent Variable: ΔlnR**	**Coefficient**	**t-statistic**
ΔlnR_t	0.509327** (0.098335)	5.179522	ΔlnG_t	-0.457193* (0.257825)	-1.773271
ΔlnR_{t-2}	0.168649* (0.138091)	-1.973521	ΔlnG_{t-2}	1.064702** (0.243571)	4.371222
ΔlnR_{t-4}	0.357962** (0.091008)	3.933310	ΔlnG_{t+1}	-0.518887* (0.272433)	-1.904645
ΔlnR_{t+1}	-0.218435* (0.096871)	-2.254917	ΔlnG_{t+3}	0.801046** (0.230154)	3.480484
ΔlnR_{t+2}	0.388625** (0.082436)	4.714251			
Adj. R^2 = 0.78, DW = 2.63			**Adj. R^2 = 0.60, DW = 2.52**		
GHANA					
Dependent Variable: ΔlnG	**Coefficient**	**t-statistic**	**Dependent Variable: ΔlnR**	**Coefficient**	**t-statistic**
ΔlnR_t	0.335825** (0.111961)	2.999475	Constant	-0.349057* (0.189096)	-1.845928
ΔlnR_{t+1}	0.276423* (0.117864)	2.345281	ΔlnG_t	0.938070** (0.294849)	3.181532
Adj. R^2 = 0.31, DW = 2.15			**Adj. R^2 = 0.37, DW = 2.33**		

Source: Authors' construct

* and ** denote statistical significance at 1% and 5% levels, respectively.

5. Conclusion

The link between government revenue and expenditure has been an important issue due to the recurrence of budget deficits in both Nigeria and Ghana. Annual data for the period 1980 to 2010 was used for the study. The study found that fiscal synchronisation hypothesis prevailed in both Nigeria and Ghana for the period under

[1] Only elasticities that are significant at the 1% and 5% level are reported.

investigation. Further, lagging, leading and coincident effects of revenue on expenditure and vice versa were present for the two countries. It is thus imperative for policy makers to consider the effects of current and past changes in both expenditure and revenue when formulating fiscal policy.

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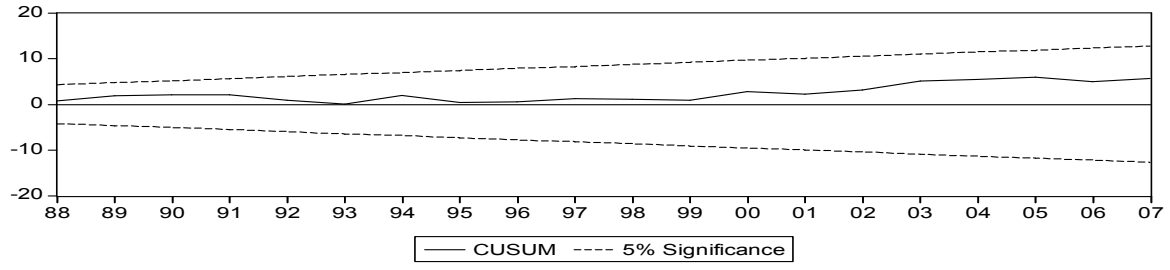
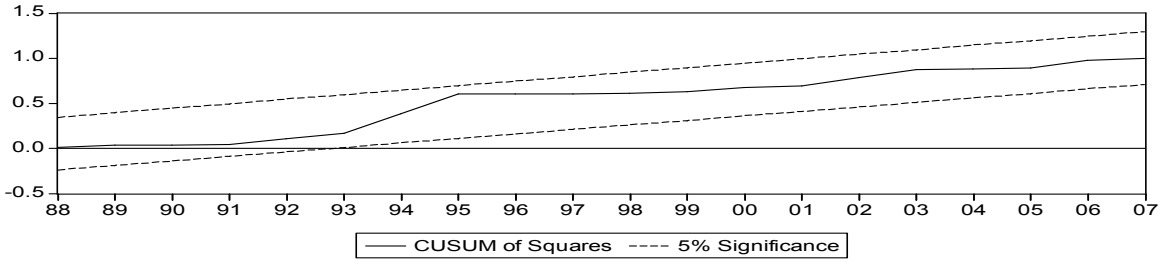
Appendix

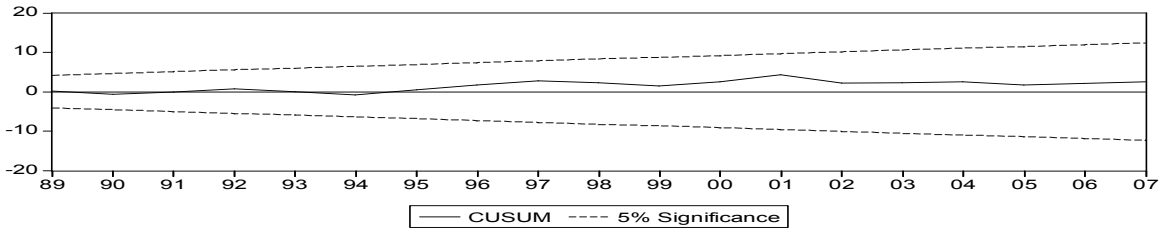
Ghana; R=f(G): CUSUM Cumulative Histogram



Ghana; R=f(G): CUSUM of Squares Cumulative Histogram



Ghana; G=f(R): CUSUM Cumulative Histogram



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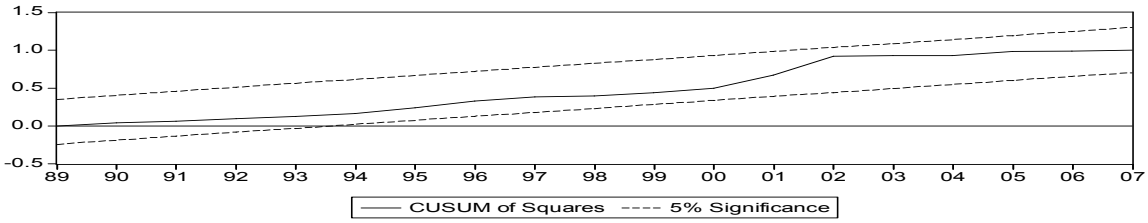
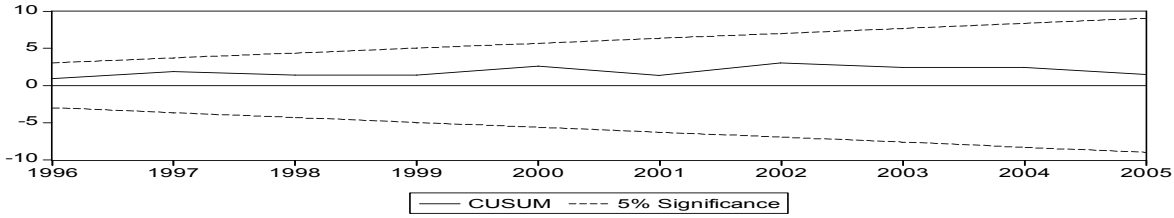
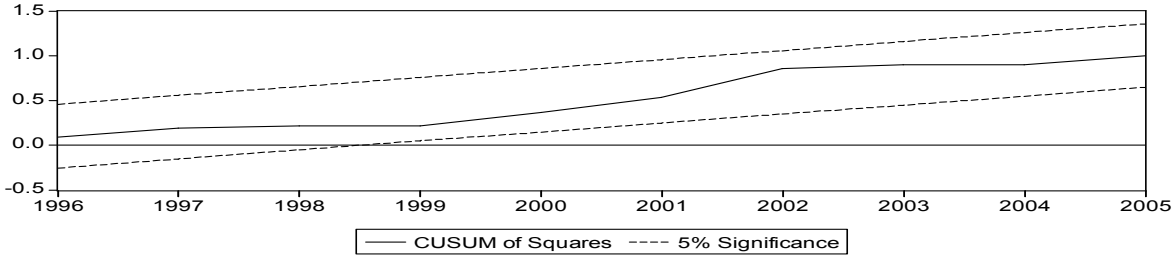


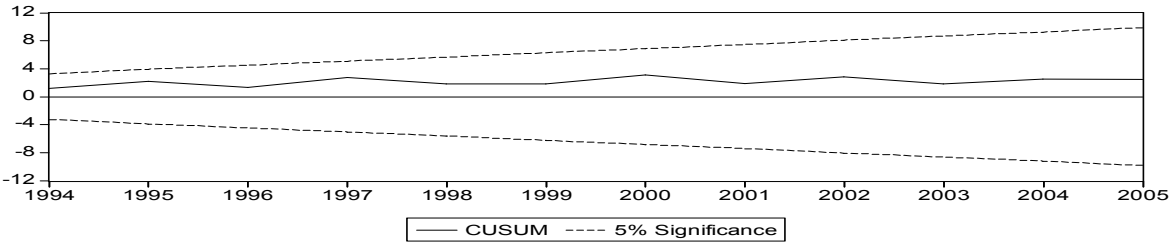
Nigeria; G=f(R): CUSUM Cumulative Histogram



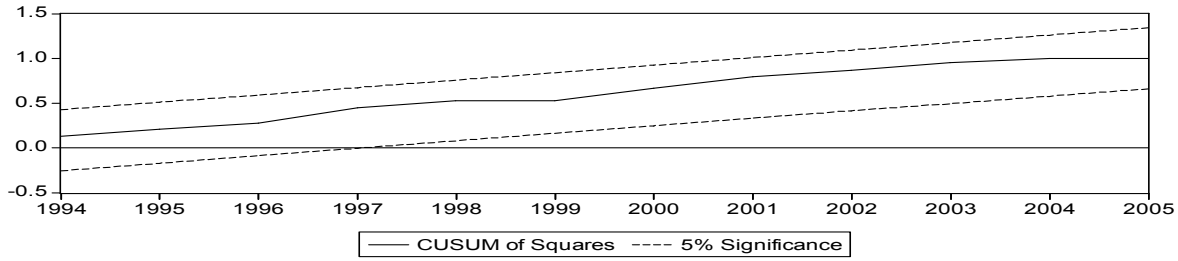
Nigeria; G=f(R): CUSUM of Squares Cumulative Histogram



Nigeria; R=f(G): CUSUM Cumulative Histogram



Nigeria; R=f(G): CUSUM of Squares Cumulative Histogram



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