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Inflation in Sierra Leone: An Empirical Analysis of the Impact of Interest Rate on Price Level Changes

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Abstract

This research intends to investigate the impact of interest rate on inflation in Sierra Leone. The research used of Autoregressive Distributed Lag model (ARDL) on time series Data, for the period 1970 – 2016. The results show that interest rate is inflationary in both the short-run and long-run as its positively and significantly influence inflation in the two periods which is in conformity with the arguments of the fiscal policy supporters but contrary to the arguments of the monetary policy supporters. The findings, of the study, are limited to the 1970 – 2016-time series data of Sierra Leone used as well as the econometric method of data analysis adopted – ARDL. The research's findings imply that interest rate in Sierra Leone is inflationary. Increase in the rate of interest will lead to an increase in the inflation rate. Therefore interest rates should be adjusted with caution, and it also implies that fiscal policy will be very effective in converting inflation in the country. The research attempted to investigate the nature of the effect of interest rate on inflation. As it could be inflationary (as claimed by fiscalist) or disinflationary (as claimed by monetarist) which the empirical results accord the arguments of the fiscal policy supporters in both the short-run and long-run having a positive influence on inflation significantly.

Key words   ARDL, Fiscal policy, Inflation, Interest rate, Sierra Leone

JEL Codes: E31, E40

1. Introduction

The nature of the effect of interest rate on inflation globally is not yet settled. The theoretical account of this argument (effect of interest rate on inflation) is conflicting. The supporters of monetary policy – the monetarist – perceived interest rate to have inverse effects on inflation. Whereas, those who support fiscal policy – the fiscalist – argued that the nature of the effect of interest rate on inflation is direct and positive. The reports from empirical findings by researchers are more conflicting, because, in addition to positive and negative effects of the interest rate on inflation reported, some researchers also reported the insignificant effect of interest rate on inflation.

Sierra Leone is among the countries located in West Africa and a member of Commonwealth West African countries. It has been having high rate inflation and high rate of lending interest rate for many decades. An inflation rate is high if the rate is above nine percent in another word if it is double-digit (Babalola *et al.*, 2015; Phiri, 2012; Anwar and Islam, 2011; Risso and Sanchez-Carrera, 2009). Observing the trend of the inflation rate, in the form of consumer price index, in the country for the period 1970 – 2016, Figure 1 is presented for this purpose. Inflation rate remains high in Sierra Leone for the majority of the periods observed because out of the 47 years, only nine years recorded single-digit inflation rates, as depicted in Figure 1.
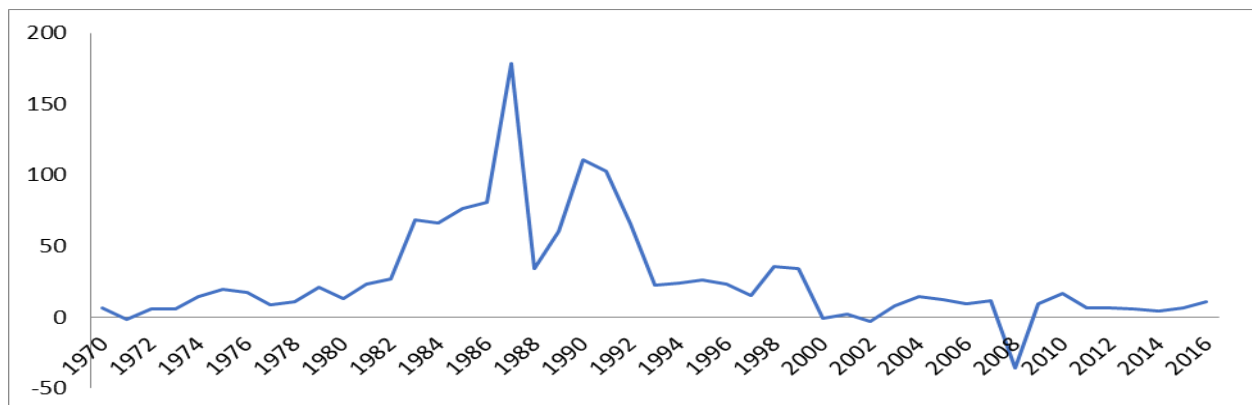

Figure 1. Inflation rate in Sierra Leone 1970 – 2016

Meanwhile, Figure 2 observed the trend of interest rate in the country. The Figure indicates that from 1970–1975 the rate is more of stagnant and it started trending upward from 1976 and read it peak in 1992. The downward trend started in 1993 up to 1994, and it maintains steady fluctuations to last year observed which is the year 2016, could that be one of the reasons why Sierra Leone unable to maintain single-digit inflation rate?
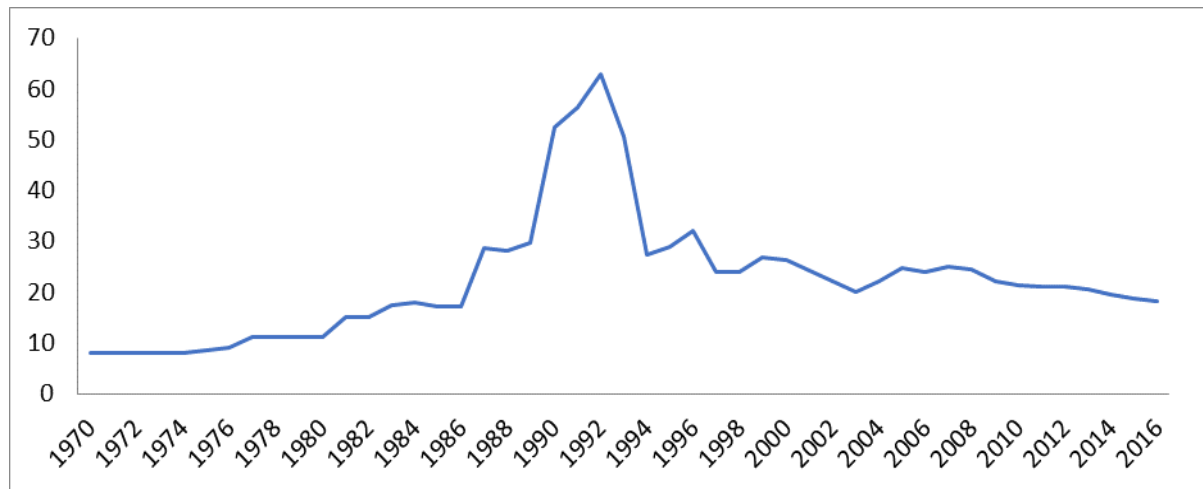

Figure 2. Interest rate in Sierra Leone 1970 – 2016

In applying stabilization policies to find remedies on inflation, interest rate plays a significant role in both monetary and fiscal policies with different nature of effect on inflation as mentioned earlier. This research intends to investigate the impact of interest rate on inflation in Sierra Leone. The rest of the research is as follows: Section two reviews the related literature on the nature of the effect of interest rate on inflation whereas section three presents the methodology used in the study. Section four presents the research's findings and discussions while section five concludes the study.

2. Literature review

There are numbers of empirical studies on the effects of interest rates on inflation rates, but their findings are inconclusive. Some studies reported positive or direct influence such as Bayo (2011), Adu and Marbuah (2011), Jalil *et al.*, (2013), Hossain and Islam (2013) and Nguyen (2014) while some reported inverse or negative influence such as Anari and Kolari (2016) and Sola and Peter (2013) and a lot of studies reported insignificant of interest rates influence on inflation rates dynamics Shamsul-Alam and Kamath (1986), Al-Khazali (1999), Odusanya and Atanda (2010), Adebiyi (2009), Aliyu and Englama (2009), Hossain and Islam (2013), Kumapayi *et al.* (2012), Maku and Adelowokan (2013) and Ndidi (2013).

Bayo (2011) (applied OLS on log-linear model) on Nigerian data and stressed that interest rates positively influence inflation rates. Adu and Marbuah (2011) (using ARDL, FMOLS, and DOLS) on Ghanaian data affirmed the existence of positive effects of interest rates on inflation rates both in the short run and long run. Jalil *et al.* (2013) (using ARDL) signified the positive effects of interest rates on inflation rate in both the short-run and long-run in Pakistan. Nguyen (2014) studied Asian economies (using PMG and GMM) and confirmed that interest rate is positively influencing the inflation rate in both the short run and the long run. Hossain and Islam (2013) studied Bangladesh economy (using OLS) affirmed that one year lagged value of interest rate positively influences inflation rate. Among the studies that discovered inverse effects of interest rates on inflation rates include: Anari and Kolari (2016) (using VAR) on United States data and tested dynamic relationships between interest rates inflation rates using Fisher and Wicksell process. The Fisher process is a positive relationship between the variables with inflation causing interest rates while Wicksell process is a negative relationship with causality going from interest rates to inflation and from their findings the two theories hold. Also, Sola and Peter (2013) (using VAR and GC) on data from Nigeria affirmed that interest rates Granger Causes inflation rates and affects it inversely.

Shamsul-Alam and Kamath (1986) studied developing economies (using a log-linear model derived from money demand and supply equations) affirmed that interest rate is insignificant in explaining inflation rate dynamics. Al-Khazali (1999) (using VAR and GC) maintained that interest rates are insignificant in explaining inflation rates and there are no causalities among them in the Pacific-Basin countries. Adebiyi (2009) (using VAR) and Odusanya and Atanda (2010) (using VECM) both studies discovered that interest rate is insignificant in explaining inflation rates dynamics and in the latter both in the short run and long run. Aliyu and Englama (2009) (using Bayesian VAR, GC and IRF) on data from Nigeria, showed that interest rate is insignificant in explaining inflation rates dynamics, no causality between them and the response of inflation rate to interest rate shocks is weak.

Hosssain and Islam (2013) studied Bangladesh economy (using OLS) affirmed that current interest rate is insignificant in explaining inflation rate dynamics. Kumapayi *et al.* (2012) and Maku and Adelewokan (2013) (using OLS) affirmed that interest rate is insignificant in explaining inflation rate dynamics in Nigeria. Iyaji *et al.* (2012) (using classical least squares) on Nigerian data confirmed that interest rate is insignificant in explaining inflation rate dynamics. Finally, Ndidi (2013) (using VECM) on Nigerian data stated that interest rate is insignificant in explaining inflation rate dynamics. The review of the related studies disclosed that there are inconsistencies regarding findings the various researchers in different areas on the nature of the effect of interest rate on inflation. Therefore, a study in one area cannot be used or generalized to all areas or countries. This stressed the need for more empirical studies on the effect of interest rate on inflation to be conducted in areas or countries where such studies are inadequate. As knowing the nature of the effect of interest rate on inflation will guide policymakers on which of the stabilization policies (monetary or fiscal policy) is more appropriate to their country.

3. Methodology of research

Source of Data: Data used in this research, were sourced from world development indicators (WDI) of the World Bank (WB) for the entire periods of study 1970 – 2016. Consumer price index (CPI) in this study is a proxy for inflation for Sierra Leone. While Broad Money is a proxy for money supply in the economy, and Gross Domestic Products (GDP) is a measure of economic growth whereas the lending interest rate is the interest rate of the country. All data are in logarithm form for uniformity of interpretations and easy measurements.

Econometric Techniques: The study makes use of the Autoregressive Distributed Lag Model (ARDL) as the econometric techniques for thoroughly analyzing both the short-run and long-run effects of the interest rate on inflation.

Theoretical Framework: This study will best be understood using the Keynesian theory of inflation. The study utilized liquidity preference Equation to derive the inflation function with inflation as the dependent variable and interest rate as one of the independent variables among others.

$$\frac{M_t}{P} = aY^{\beta_1} r^{\beta_2}$$

(1)

Where: M_t is money demand, *P* is price level, *Y* is the national income and *r* is the rate of interest while β are just coefficients. The equation is just showing that the total real money demand is being influenced by the level of income in the economy and the interest rate.

Equation 1 is transformed by taking the log of both sides, and substituting M_t with M_2 and making *P* the subject of the formula to derive Equation 2 which is as follows:

$$logP = logM_2 - loga - \beta_1 logY - \beta_2 logr$$

(2)

Note that 'loga' is constant. Therefore the final inflation function is presented in Equation 3.

$$INF = f(M_2, Y, r)$$

(3)

Where: all variables as defined in the previous Equations.

Model Specification: Equation 3 can be presented in an econometric form/function as follows:

$$lINF_t = \beta_0 + \beta_1 lM_{2,t} + \beta_2 lGDP_t + \beta_3 lr + \delta t + \varepsilon_t$$

(4)

where *lINF* is a log of inflation, *lM₂* is a log of the money supply, *lGDP* is a log of *GDP* representing the level of economic growth '*Y*,' *lr* is a log of lending interest rate, *βᵢ* and δ are parameters/coefficients of the variables and time trend, t is time signifies time series data to check the effect of time on inflation (time trend) and ε is the error term.

The ARDL function is presented in Equation (*v*) as follows:

$$\Delta lINF_t = \beta_0 + \sum_{k=0}^{n} \beta_1 \Delta lM_{2,t-k} + \sum_{k=0}^{n} \beta_2 \Delta lGDP_{t-k} + \sum_{k=0}^{n} \beta_3 \Delta lr_{t-k} + \sum_{k=1}^{n} \beta_4 \Delta lINF_{t-k} + a_1 lM_{2,t-1}$$
$$+ a_2 lY_{t-1} + a_3 lr_{t-1} + a_4 lINF_{t-1} + \delta t + \varepsilon_t$$

(5)

Where αᵢ are long-run coefficients and βᵢ short-run coefficients, the rest as defined in the previous Equations.

The short run and long run equations are presented in Equation (*vi*) and (*vii*) as follows:

$$\Delta lINF_t = \beta_0 + \sum_{k=0}^{n} \beta_1 \Delta lM_{2,t-k} + \sum_{k=0}^{n} \beta_2 \Delta lGDP_{t-k} + \sum_{k=0}^{n} \beta_3 \Delta lr_{t-k} + \sum_{k=1}^{n} \beta_4 \Delta lINF_{t-k} + \delta t + \vartheta_0 ECT_{t-1} + \varepsilon_t$$

(6)

Where *ECT* is the error correction term, v_0 is the speed of adjustment, the rest of the variables as defined in the previous Equations.

$$lINF_t = a_0 + \sum_{k=0}^{n} a_1 lM_{2,t} + \sum_{k=0}^{n} a_2 lGDP_t + \sum_{k=0}^{n} a_3 lr + \sum_{k=0}^{n} \delta t + \sum_{k=1}^{n} a_4 lINF_t + \varepsilon_t$$

(7)

All as defined in the previous Equations.

4. Results and Discussions of Findings

This section presents the results of the estimation and discusses the findings of the study. The descriptive statistics are presented in table 1 while Table 2 presents the correlation analysis of the variables used in the study. It is observed from table 1 that the average inflation rate is approximately 2.92 while that of interest rate is 2.97. The average money supply is approximately 23.67, and that of GDP is 20.86. All variables are in logarithm form.

Table 1. Descriptive Statistics of the variables

	LINF	LR	LM$_2$	LGDP
Mean	2.915139	2.974680	23.65633	20.85845
Median	2.811522	3.044522	24.45696	20.68320
Maximum	5.185710	4.140486	29.43868	22.33573
Minimum	0.737277	2.079442	17.58251	19.88950
Std. Dev.	1.004508	0.529194	3.940773	0.659230
Skewness	0.304762	0.051043	-0.090117	0.834893
Kurtosis	2.483666	2.764080	1.573480	2.737683
Jarque-Bera	1.143299	0.118393	3.704167	5.118780
Probability	0.564593	0.942521	0.156910	0.077352
Sum	125.3510	127.9112	1017.222	896.9134
Sum Sq. Dev.	42.37952	11.76196	652.2472	18.25253
Observations	43	43	43	43

While the correlation analysis presented in table 2 shows that the highest absolute value of the correlation is between money supply and GDP which is 0.75, the lowest absolute value of the correlation is between inflation and money supply which is 0.25.

Table 2. Correlation analysis

Correlation Probability	LINF	LR	LM$_2$	LGDP
LINF	1.000000			

LR	0.435404	1.000000		
	0.0035	-----		
LM$_2$	-0.250161	0.593367	1.000000	
	0.1057	0.0000	-----	
LGDP	-0.443527	0.139075	0.752330	1.000000
	0.0029	0.3738	0.0000	-----

Unit root test

Unit root test result is presented in table 3, which shows that all variable are stationary at first difference using both Augmented Dickey-Fuller test (ADF) and Philips-Peron test (PP).

Table 3. Unit Root test results

-	ADF	ADF	PP	PP
Variables	Level	1st Difference	Level	1st Difference
lINF	-2.245215 (0.1945)	-7.231565* (0.0000)	-2.161227 (0.2232)	-7.367264* (0.0000)
IM₂	-1.13798 (0.9107)	-3.567428* (0.0442)	-1.204623 (0.8977)	-3.437983* (0.0146)
IY	-1.692213 (0.7387)	-5.539304* (0.0002)	-1.762758 (0.7064)	-5.738194* (0.0001)
Ir	-1.788302 (0.3815)	-5.858674* (0.0000)	-1.826855 (0.3632)	-5.860870* (0.0000)

Source: Authors' 2018; Notes: * represents statistically significant at 5 percent level.

Bound Test

Bound test conducted shows the existence of long-run relationships between the dependent variable in one hand and the independent variables on the other hand. Having obtained the result of F-Statistics to be 6.340110 which is above the critical values of I(0) as 4.01 and I(1) as 5.07 at five percent level of significance. This result is from ARDL estimation presented in Table 4, which is also used for the Wald test.

Table 4. ARDL (1, 2, 2, 0) Estimation using HQ Criteria

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LINF(-1)	0.120676	0.168947	0.714285	0.4810
LR	1.174209*	0.435581	2.695727	0.0117
LR(-1)	-0.729829	0.609845	-1.196745	0.2414
LR(-2)	0.864655	0.434254	1.991129	0.0563
LM2	0.106969	0.669269	0.159830	0.8742
LM2(-1)	0.112671	0.947563	0.118906	0.9062
LM2(-2)	-1.312759*	0.591212	-2.220453	0.0347
LGDP	-0.967599*	0.363763	-2.659968	0.0128
C	37.15222*	11.56143	3.213462	0.0033
@TREND	0.307144*	0.093767	3.275620	0.0028
R-squared	0.881346			
Adjusted R-squared	0.843208			

Notes: ** represents statistically significant at 5 percent level.*

Wald test

The result of the Wald test conducted is presented in table 5. The result has indicated that all coefficients of the independent variable combined have a significant effect on inflation. Also, from the result, the coefficients of the variables individually, only that of the previous inflation rate has no effect on the current inflation whereas other variables such as money supply, GDP interest rate, constant and even time trend have a significant individual effect on inflation in Sierra Leone.

Table 5. Wald test results

Null Hypothesis	F-statistics	Prob	Result
All coefficients are zero	278.8184**	0.0000	Reject the null
lINF coefficients are zero	0.714285	0.4810	They are Zero
IM₂ coefficients are zero	7.704222**	0.0007	Reject the null
IGDP coefficients are zero	7.075431*	0.0128	Reject the null
Ir coefficients are zero	5.571773**	0.0040	Reject the null
Constant is zero	10.32634**	0.0033	Reject the null
Time Trend	10.72968**	0.0028	Reject the null

Notes: *'**' represent a statistically significant coefficient at one percent, while '*' represents statistically significant at 5 percent level.*

The results of the short-run and long-run of the ARDL estimation

In this section, table 6 presents the results of the short-run and long-run ARDL estimations. During the short-run, the current value of interest rate is inflationary as it significantly and positively influences inflation in Sierra Leone. For instant, a

one percent increase in interest rate will lead to an increase in the rate of inflation by approximately 1.2 percent. This is in conformity with the arguments of fiscal policy supporters. The lag value of interest rate and the current value of money supply are insignificant in explaining the fluctuation of inflation rate in Sierra Leone during the short-run whereas the first-year lag value of money supply is inflationary and significantly influences inflation during the short-run in the country. The coefficient of GDP is also significant and its' inversely influences inflation in the country during the short-run. The speed of adjustment toward long-run equilibrium is about 87.93 percent, and it is highly significant at one percent level.

During the long-run, the interest rate is significant and positively influencing inflation in Sierra Leone as it is in the short-run. Specifically, a one percent increase in the rate of interest will lead to an increase in the rate of inflation by approximately 1.49 percent. All other variables are also significant in explaining inflation in Sierra Leone during the long-run though with money supply having an inverse influence on inflation. The negativity nature of the influence of money supply on inflation could be due to the argument of Keynesian inflation theory whose implies that in an economy, where resources are not fully utilized and where involuntary unemployment exist increase in money supply will not generate inflation but rather expand the level of output and the level of employment.

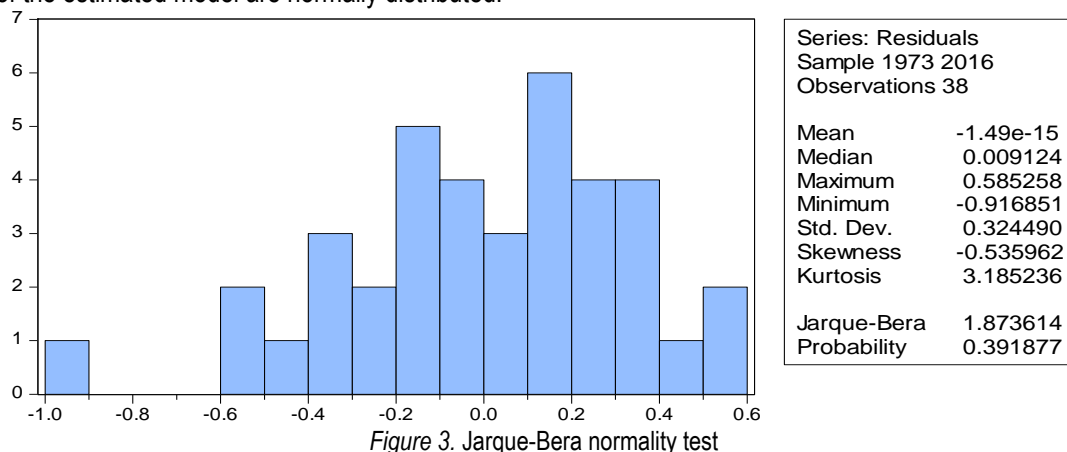*Table 6.* The results of short-run and long-run ARDL (1, 2, 2, 0) estimation

Variable	Coefficient	Std. Error	t-Statistic	Prob.
Short-run Results				
D(LR)	1.174209*	0.435581	2.695727	0.0117
D(LR(-1))	-0.864655	0.434254	-1.991129	0.0563
D(LM2)	0.106969	0.669269	0.159830	0.8742
D(LM2(-1))	1.312759*	0.591212	2.220453	0.0347
D(LGDP)	-0.967599*	0.363763	-2.659968	0.0128
D(@TREND())	0.307144*	0.093767	3.275620	0.0028
CointEq(-1)	-0.879324*	0.168947	-5.204725	0.0000
Long-run Results				
LR	1.488683*	0.311022	4.786422	0.0000
LM2	-1.243136*	0.289634	-4.292090	0.0002
LGDP	-1.100390*	0.360845	-3.049482	0.0050
C	42.250904*	11.003911	3.839626	0.0006
@TREND	0.349295*	0.090527	3.858470	0.0006

Notes: *represents statistically significant at 5 percent level.*

Post-estimation diagnostic checks

To check the reliability and stability of the estimated model, various tests were conducted which are post-estimation diagnostic checks, and their respective results are as follows:

• Serial Correlation test: the result of Breusch-Godfrey Serial Correlation LM indicated that the model is free from serial correlation, having the result of F-Statistics 0.991977 with a probability of 0.3281.
• Heteroskedasticity test: the result of Breusch Pagan-Godfrey heteroskedasticity test conducted shows that the variance of the error term of the estimated model is constant and desired homoskedastic with an F-Statistic value of 0.893345 and probability of 0.5435.
• Normality test: the estimated Jarque-Bera statistics with a value of 1.873614 and probability value 0.3919 signifies that the errors of the estimated model are normally distributed.

Series: Residuals	
Sample 1973 2016	
Observations 38	
Mean	-1.49e-15
Median	0.009124
Maximum	0.585258
Minimum	-0.916851
Std. Dev.	0.324490
Skewness	-0.535962
Kurtosis	3.185236
Jarque-Bera	1.873614
Probability	0.391877

Figure 3. Jarque-Bera normality test

- Stability of the model: Figure 4 and Figure 5 presents the stability sketch of the estimated model, and they show that the model is dynamically stable as indicated by the upper and lower ridge lines of Cusum and Cusum of squares
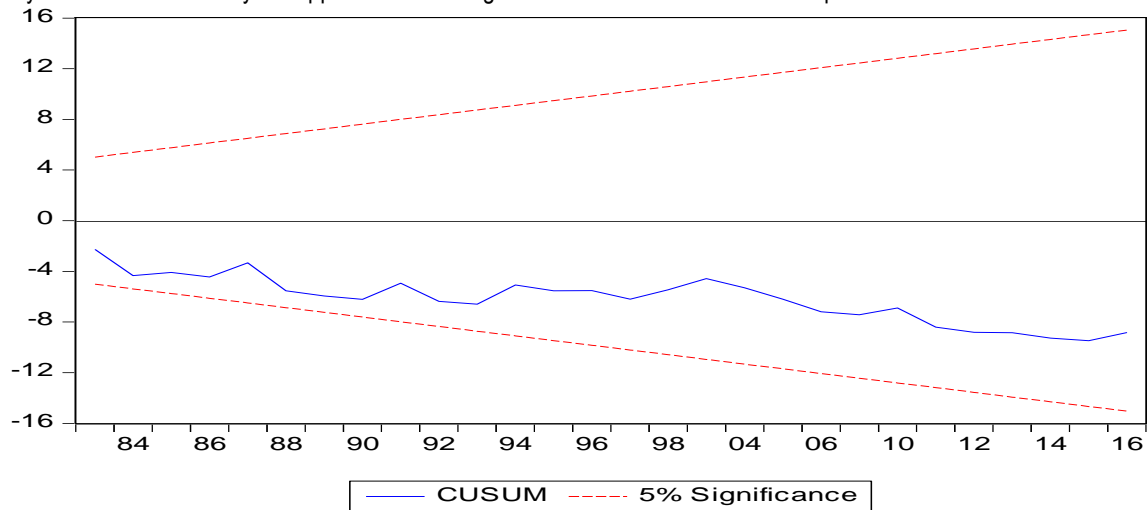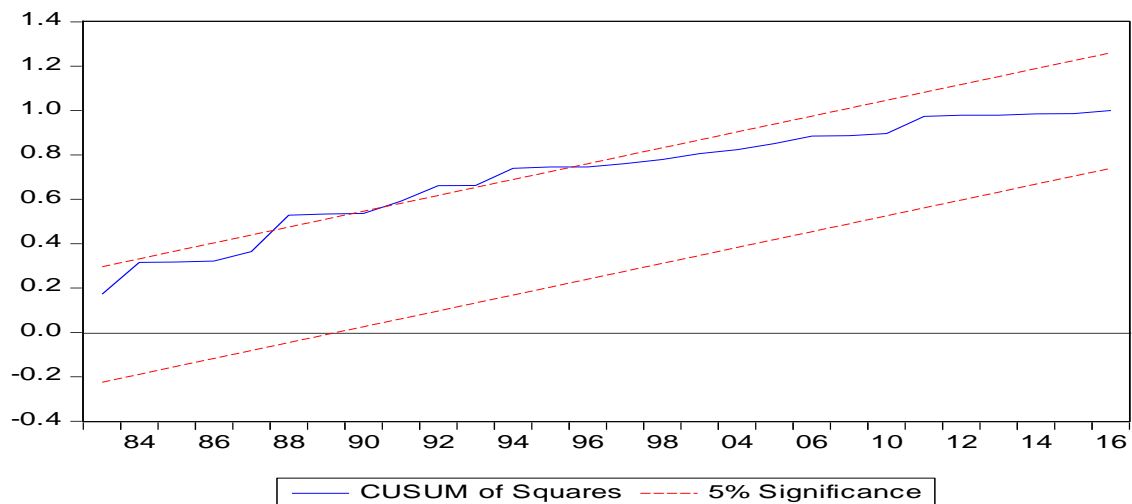

Figure 4. CUSUM stability indicator

Figure 5. CUSUM of squares stability indicator

5. Conclusions

Having estimated the model and conducted post-estimation diagnostics checks which the results reveal that the estimated model is highly dynamically stable and is free from serial correlation as well as free from heteroskedasticity problem and also having the errors normally distributed. Therefore, the model fits with the analysis. The results of the estimated model reveal that interest rate is inflationary both in the short-run and long-run with significant positive influence on inflation, though the lag value of interest rate, during the short-run, has no significant influence on inflation. Also, in the same short-run, the previous inflation rate is insignificant in explaining the changes in the current rate of inflation. In the same period, the current money supply is insignificant in explaining the changes of inflation in Sierra Leone whereas the lag value of money supply is inflationary with significant positive effects on inflation, though the long-run money supply is significant but with an inverse effect on inflation. GDP is significantly disinflationary in both the short-run and long-run. The short-run speed of adjustment towards long-run equilibrium is around 87.93 percent, and it is highly significant. Therefore, the research concludes that the interest rate effect on inflation during the short-run and long-run in Sierra Leone is positive.

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