MODELLING THE INFLATION-INVESTMENT NEXUS IN GHANA

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Abstract

The paper examines the nature of the link among inflation, investment, and economic growth in Ghana for 1970-2012 period using autoregressive distributed lag model (ARDL). The results show that there is significant negative effect of inflation on investment in both long run and short run. The findings support the view that inflation hampers investment and hence economic growth. The findings do not raise doubts on argument for low inflation targeting policy view for Ghana. There is the need to implement monetary and fiscal policies to stabilise prices and control inflation to single digits. This will make the financial sector vibrant to boost investment and ensure economic growth. Future studies should take into consideration the issue of causal analysis since the current study did not consider. Structural breaks should be considered in examining unit roots in future studies since that has not been accounted for in the current paper.

Keywords: Economic growth, ARDL, inflation, investment
Jel Classification:E22, E31, E62, R53, R42, G11, H54

1. Introduction

The importance of investment as a key determinant of economic growth has attracted much recent work on the theoretical link between inflation and investment. Inflation theoretically is believed to negatively affect economic growth and investment and that inflation affect economic growth rate through investment (Nasir & Saima, 2010). The negative effect of inflation on growth and investment is considered significant at higher levels of inflation rate and less significant at lower rates of inflation (Munir & Mansur, 2009; Sergii, 2009; Chaha & Sarno, 2002; Khan & Senhadji, 2001; Bruno & Easterly, 1998; Sarel, 1996; Fischer, 1993).

The findings on the effect of inflation on economic growth and investment have been contradictory empirically without consensus in the literature and Ghana is no exception (Byrne & Davis, 2004). In addition, studies investigation inflation-investment nexus are rare in the literature and on Ghana (Nasir & Saima, 2010). It is important to empirically investigate whether there is a significant effect of inflation on investment, because of policy implications in designing and implementing economic growth policies.

Anti-inflationary policy measures adopted by Ghana have not been successful over the years in achieving sustainable growth. According to the Ghana Statistical Service (GSS, 2015) report, inflation has become intractable over the years and the quest to attain sustainable single level inflation rate has been elusive. For example, the inflation rate in 2011 was 8.5% whereas it was 9.4% per annum in 2012. The inflation rate in 2014 was 17.0% whereas the rate was 19.5% as at April 2015.

The aim of the paper is to contribute to the body of knowledge existing in literature on investment, inflation and economic growth by investigating the linear relationship between

inflation and investment in Ghana by using autoregressive distributed lag model (ARDL) approach to cointegration over the period 1970 to 2012.

There are three testable assumptions related to inflation-investment nexus, which are as follows in the current paper: (1) there is significant cointegration link between inflation as explanatory variable and investment as dependent variable. (2) There is significant long-run nexus between inflation and investment. (3) There is significant short-run link between inflation and investment.

The findings provide answers to research questions, which are, what is the nature of the link between inflation and, investment and investment and economic growth in the long run and short-run?

The paper is limited to the use of secondary data, and as such, the findings might suffer from errors in variable. The estimated model is trivariate and as such might suffer from omitted variable bias. The study does not consider causality and structural break issues, as such predictive conclusions based on causal modelling could not be made. The rest of the paper looks at the literature review, methodology, empirical results, discussions, and conclusions.

2. Literature Review

According to researchers (Taylor, 2001; Hellerstein, 1997; Boyd et al., 1996; Barro, 1995; Gultekin, 1983; Dixit & Pindyck, 1994), theoretically, inflation is related to investment and economic growth negatively. Higher rates of inflation are detrimental to long run economicgrowth, since investment, which is a key engine of growth, is hampered by higher inflation rates.Higher inflation rates lead to lower investment and hence low economic growth

since higher rates of inflation creates macroeconomic instability, which does not attract investors to invest their capital in the economy.

The finding on empirical studies on the effect of inflation on investmentare found in the works of researchers (Nasir & Saima, 2010; Atesoglu, 2005; Hussain, 2005; Mubarik, 2005; Byre & Davis, 2004; Chadha & Sarno, 2002; Ericsson et al., 2001; Khan et al., 2001; Mallik & Chowdhury, 2001; Crosby & Otto, 2000). For example, Nasir and Saima (2010) investigated and reported of significant negative inflation-investment nexus for Pakistan using both linear and nonlinear models though the effect was small in magnitude (-0.07 and -0.08). Their findings support the theoretical assumption of negative inflation-investment nexus.

Atesoglu (2005) reported of significant but small and positive effect of inflation on investment using the Ordinary Least Square method of regression and Johansen Cointegration method for United State of America. The findings are inconsistent with that of the theoretical preposition that inflation negatively affects investment.

Byrne and Davis (2004) examined the inflation-investment nexus for United States using permanent and temporary inflation uncertainty and reported of significant negative effect of both permanent and temporary component of inflation uncertainty on investment in both levels and first differences of the variables.

Chadha and Sarno (2002) established significant negative effect of both transitory component and permanent component of inflation on investment for the United States, supporting the detrimental effect of inflation on investment.

Crosby and Otto (2000) investigated the link between inflation and investment for 34 countries including United States and reported of significant positive effect of inflation on

investment in some countries and insignificant effect in some other countries, indicating neutral effect of inflation on investment.

In United States and most of the other G7 countries, Ericsson, Iron, and Tryon (2001) reported of significant positive link between inflation and real gross domestic product indicating that inflation is not detrimental to growth.

The review indicates that the results are inconclusive. Some studies have produced negative link among inflation, investment, and growth (Nasir & Saima, 2010; Li, 2006; Faria & Carneiro, 2001; Bruno & Easterly, 1998) whereas others (Gillman & Nakov, 2004; Mallik & Chowdhury, 2001) have reported of significant positive link among inflation, investment, and growth. This inconstant results call for further empirical research to complement the existing literature to complement these studies.

3. Methodology

3.1 Unit Root and Cointegration Test

The study is based on cross-sectional, quantitative, and time series econometric approach. The quantitative design allows the link among the variables to be quantified in the analysis. The inflation-investment nexus is examined in two steps. In the first step the unit root properties are examined using the Augmented Dickey-Fuller (1981) (ADF) unit root test method and the Kwiatkowski et al. (1992, KPSS) without structural breaks. The long-run relationship among the variables is estimated using the autoregressive distributed Lag (ARDL) cointegration in the second step.The ARDL approach was developed by Pesaran and Shin (1999) and Pesaran et al. (2001) and is used in the current study because of its many advantages. It is efficient estimator in small sample studies and allows for the use of different lags and been appropriate when the unit root properties are not known. The ARDL model is as specified in equation (1).

$$\Delta inv_t = \alpha_1 + \sum_{i=1}^{a1} \phi_{1i} \Delta inv_{t-i} + \sum_{p=0}^{b1} \beta_{1p} \Delta \inf_{t-p} + \sum_{q=0}^{c1} \varphi_{1q} \Delta gdp_{t-q}$$
$$+ \delta_1 inv_{t-1} + \delta_2 \inf_{t-1} + \delta_3 gdp_{t-1} + \varepsilon_{1t} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (1)$$

Where inv=investment; inf=inflation; gdp=gross domestic product.

The ARDL/bounds approach is based on the null assumption (H_o) of no significant cointegration, $H_0 : \delta_r = 0$ against the alternative assumption (H_1) of $H_1 : \delta_r \neq 0$, r=1, 2, 3. The assumptions are tested using the Joint F-statistics/Wald statistics and the critical values provided by Pesaran et al. (2001) which classifies the independent variables into purely I(1), purely I(0) or mutually cointegrated. The assumption of cointegration is supported if the calculated F-value is larger than the upper level values of the band. If the calculated F-value falls between upper and lower bands, the results are inconclusive. If the F-value calculated is smaller than the lower level values, the assumption of cointegration is not supported. When the assumption of cointegration is supported, the long run, short run, and the error correction model are specified as in equations (2), (3), and (4).

$$inv_t = \alpha_2 + \sum_{i=1}^{a2} \phi_{2i} inv_{t-i} + \sum_{p=0}^{b2} \beta_{2p} \inf_{t-p} + \sum_{q=0}^{c2} \varphi_{2q} gdp_{t-q} + \varepsilon_{2t} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots(2)$$

$$\Delta inv_t = \alpha_3 + \sum_{i=1}^{a3} \phi_{2i} inv_{t-i} + \sum_{p=0}^{b3} \beta_{2p} \inf_{t-p} + \sum_{q=0}^{c3} \varphi_{2q} gdp_{t-q} + \gamma ecm_{t-1} + \varepsilon_{3t} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots(3)$$

Where γ is the coefficient of error correction term (ecm). The ecm is specified in equation (4). The sign of the coefficient of the error correction term is expected to be negative.

$$ecm_t = inv_t - \alpha_2 - \sum_{i=1}^{a2} \phi_{2i} inv_{t-i} - \sum_{p=0}^{b2} \beta_{2p} \inf_{t-p} - \sum_{q=0}^{c2} \varphi_{2q} gdp_{t-q} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots(4)$$

3.2 The Model

The study based on a trivariate model as specified in equation (5). The dependent variable is investment whereas the explanatory variables are inflation and economic growth. Economic growth is added as a control variable in the model.

$$inv_t = \alpha \inf_t + \beta gdp_t + \varepsilon_t \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots(5)$$

4. Empirical Results

4.1 Time Series Plot

The time series plot results are shown in figure 1 to figure 6. The figures indicate that the series are unitroot in levels (figure 1 to figure 3) but attained stationarity after first differenced (figure 4 to figure 6). The unit root properties are further examined scientifically using the ADF and the KPSS tests. The results are reported in Tables 1 to Table 4.

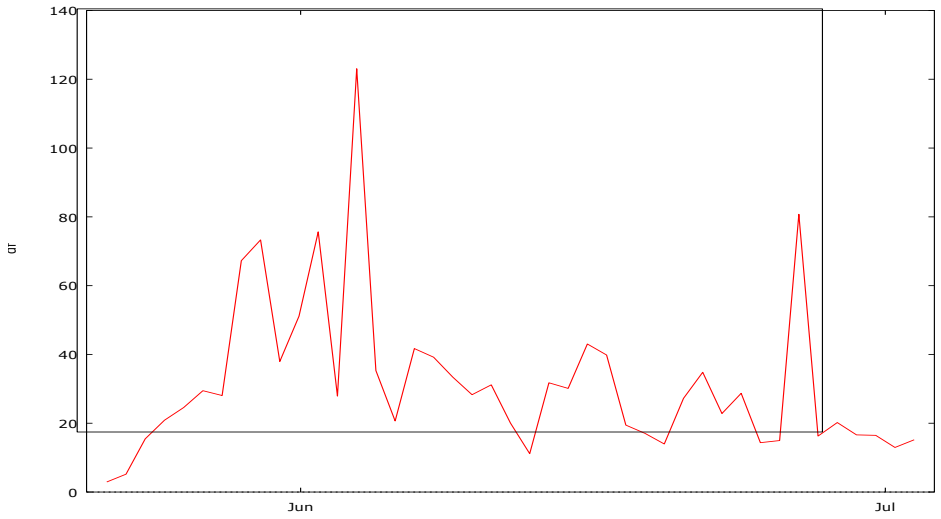

Figure 1. Time series Plot of inf in levels

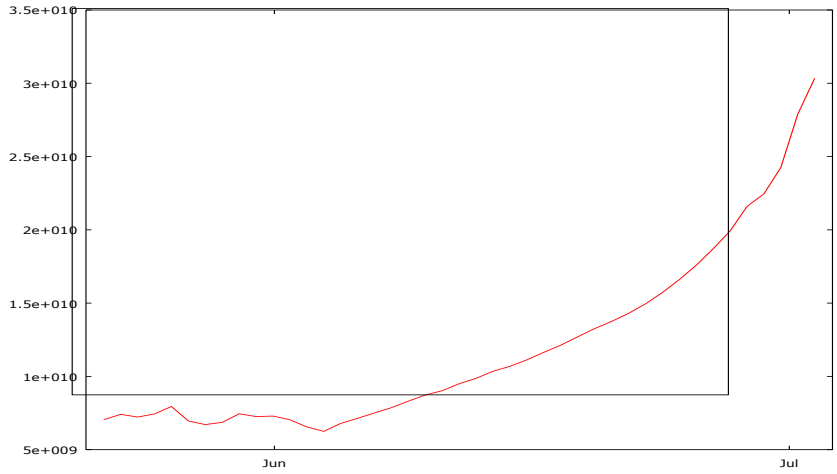

Figure 2. Time series Plot of gdp in levels

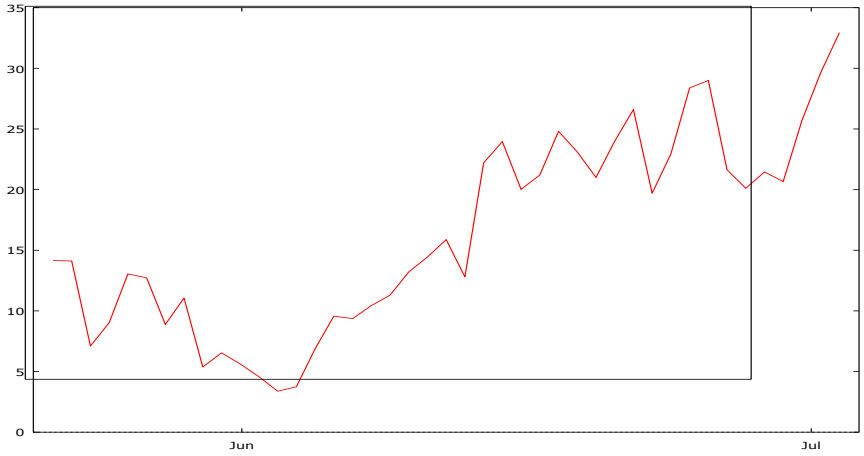

Figure 3. Time series Plot of gdp in levels

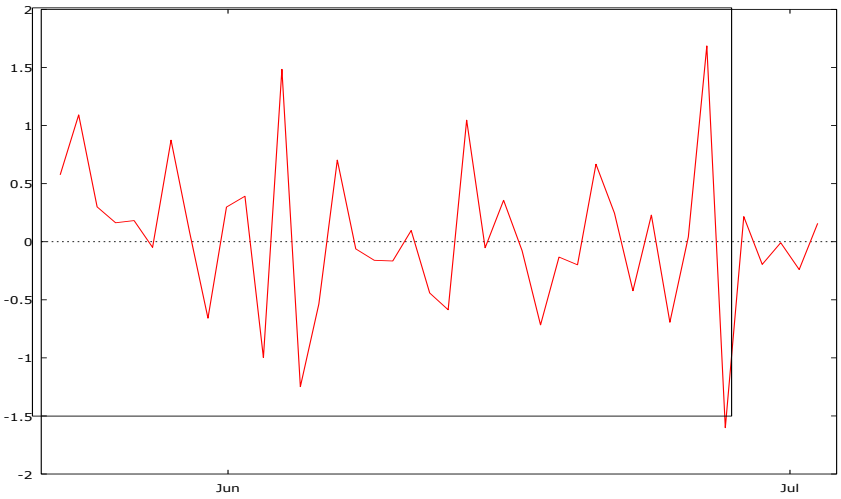

Figure 4. Time series Plot of inf in first difference

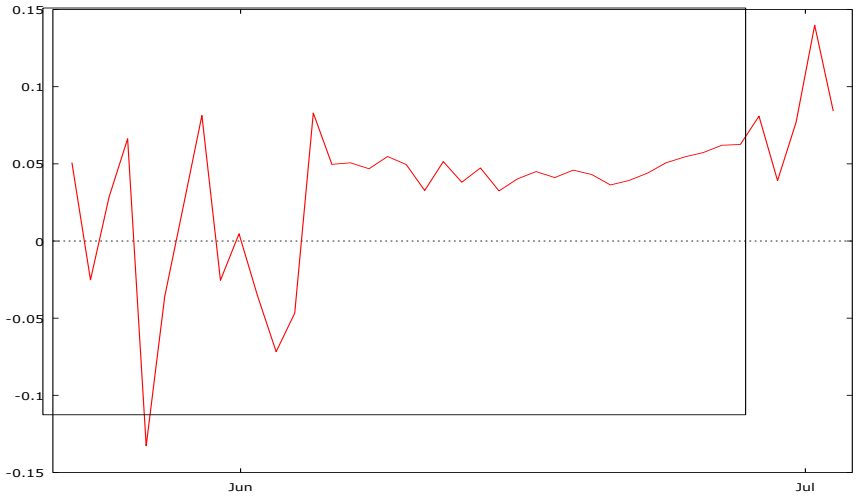

Figure 5. Time series Plot of gdp in first difference

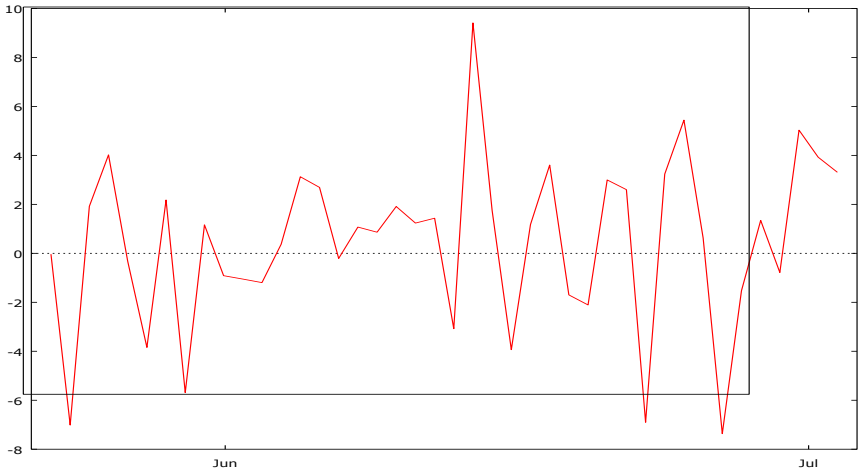

Figure 6. Time series Plot of inv in first difference

4.2 Unit Root Results

The ADF test results are reported in Table 1 and Table 2. The results indicate that the series are unit root in levels (Table 1) but attained stationarity after first differencing (Table 2). The KPSS test is used as a confirmatory test to the ADF test.The KPSS test results are shown in Table 3 and Table 4. The results indicate that the series are unit root in levels (Table 3) but attained stationarity after first difference (Table 4).

Table 1 ADF stationarity test results with a constant and trend

Variables	coefficients	t-statistics	ADF/P-Value	Results	Lag length
inv	-0.251	-1.853	0.679	Fail to reject Ho	9
lninv	-0.261	-2.722	0.233	Fail to reject Ho	9
inf	-0.396	-2.727	0.226	Fail to reject Ho	9
lninf	-0.082	-1.112	0.926	Fail to reject Ho	9
gdp	0.120	4.571	1.000	Fail to reject Ho	9
lngdp	-0.114	-1.819	0.695	Fail to reject Ho	9

Source: Author's computation, 2015

Table 2 ADF stationarity test results with a constant and a time trend

Variables(1^{st} dif.)	Coefficients	t-statistics	ADF/P-Value	Results	Lag length
Δinv	-1.506	-6.819	8.148e-009***	Reject Ho	9
Δlninv	-1.106	-6.859	4.209e-006***	Reject Ho	9
Δinf	-0.345	-1.657	0.770	Reject Ho	9
Δlninf	-2.606	-4.426	0.002***	Reject Ho	9
Δgdp	-0.302	-0.931	0.951	Reject Ho	9
Δlngdp	-1.126	-2.729	0.225	Reject Ho	9

Source: Author's computation, 2015: Note: *** denotes significance at 1% level

Table 3 KPSS stationarity test results with a constant and a time trend

Variables (levels)	t-statistics/P-value	Results	Lag length
inv	0.143	Reject Ho	3
linv	0.128	Reject Ho	3
inf	0.279	Reject Ho	3
lninf	0.272	Reject Ho	3
gdp	0.281	Reject Ho	3
lngdp	0.275	Reject Ho	3

(Author's computation, 2015): Critical values at 10% (0.122), 5% (0.149) and 1% (0.212) significant levels

Table 4 KPSS stationarity test results with a constant and a time trend

Variable (first diff.)	**t-statistics**	**Results**	**Lag Length**
Δinv	0.086	Fail to reject the null hypothesis	3
Δlninv	0.102	Fail to reject the null hypothesis	3
Δinf	0.262	Reject Ho	3
Δlninf	0.089	Fail to reject the null hypothesis	3
Δgdp	0.184	Reject Ho	3
Δlngdp	0.055	Fail to reject the null hypothesis	3

(Author's computation, 2015): Critical values at 10% (0.122), 5% (0.149) and 1% (0.212) significant levels

Since the series are stationary after first differencing the ARDL model is used to examine the cointegration nexus among investment, inflation, and growth.

4.3 ARDL/Bound Test Results

The results of the ARDL cointegration test are reported in Table 5. The results show evidence of cointegration among the variables in all the three models, since the calculated F-values are larger than the upper values at 1%, 5%, and 10% significant levels. Model 1 with investment as the dependent variable is estimated for the long run and short run parameters.

Table 5 Test for cointegration relationship

Critical bounds of the F -statistic: intercept and trend			
	90% level	95% level	99% level
	$I(0)$ $I(1)$	$I(0)$ $I(1)$	$I(0)$ $I(1)$
	2.915 3.695	3.538 4.428	5.155 6.265
Models	**Computed F -Stats**	**Decision**	
1. F_{inv}(inv/inf, gdp)	7.4404[0.006***]	Cointegrated	
2. F_{inf}(inf/inv, gdp)	8.9688[0.003***]	Cointegrated	
3. F_{gdp}(gdp/inv, inf)	9.4514[0.002***]	Cointegrated	

Source: Author's computation, 2015:
Critical values are obtained from Pesaran et al., (2001) and Narayan, (2004):
Note *** denotes significance at 1% level

4.4 Long run Parameter Estimates and Short run Parameter Estimates/Error Correction Test Results

The results of the long run parameters are reported in Table 6. The results show that inflation and economic growth are significant explanatory variables for investment in the long run. The coefficients of inflation and growth have the expected a priori theoretical signs of negative and positive respectively. The results show that 1% increase in inflation leads to about 50.5% decrease in investment. Economic growth affects investment positively. The results indicate a unit increase in growth leads to about 0.3562E-8 increase in investment. The effect of growth on investment is small but significant. Inflation is detrimental to investment in the long run.

The results of the short run parameters are reported in Table 7. The results are not different from that of the long run results. The results indicate that inflation influence investment negatively whereas growth affects investment positively. The results show that 1% increase in inflation leads to about 31.8% decrease in investment. A unit increase in growth leads to about 0.2239E-8% increase in investment. Inflation worsens investment in the short run.

The results are consistent with theoretical preposition of negative effect of inflation on investment and growth, as indicated by researchers such as Taylor (2001), Dixit and Pindyck (1994). The findings are in support of the findings of previous researchers such as Nasir and Saima (2010), Byrne and Davis (2004), Chadha and Sarno (2002), Ericsson et al. (2001), who reported of significant negative effect of inflation on investment and growth. The negative effect of inflation on investment reduces investment in an economy and hence economic growth. The findings are contrary to previous findings (Gillman & Nakov, 2004, Mallik & Chowdhury, 2001) that reported of positive effect of inflation on investment and economic growth.

Table 6 Estimated long-run coefficients. Dependent variable is lnv

Variable	Coefficient	Std. Error	T-ratio	P-value
Constant	-19.0078	5.7171	-3.3247	0.002***
Trend	0.15992	0.15992	0.98745	0.330
Inf	-0.50531	-0.50531	-3.8165	0.001***
Gdp	0.3562E-8	0.8994E-8	3.9602	0.000***

Author's computation, 2015:
Note: *** denotes statistical significance at the 1%.
ARDL (1) selected based on Akaike Information Criterion

Table 7 Short-run representation of ARDL model. ARDL (1) selected based on Akaike Information Criterion. Dependent variable: Δlnv

Variable	Coefficient	Standard error	T-statistic	P-value
ΔTREND	0.10052	0.10270	0.97870	0.334
ΔINF	-0.31761	0.10606	-2.9948	0.005***
ΔGDP	0.2239E-8	0.7282E-9	3.0743	0.004***
ecm(-1)	-0.62855	0.13617	-4.6158	0.000***

ecm = INV + 19.0078INPT -0.15992TREND + 0 .50531INF -0.3562E-8GDP

R-Squared	0.88960	R-Bar-Squared	0.87733
S.E. of Regression	2.8946	F-Stat. F(4,36)	72.5190[0.000]
Mean of Dependent Variable	16.4393	S.D. of Dependent Variable	8.2645
Residual Sum of Squares	301.6305	Equation Log-likelihood	-99.0869
Akaike Info. Criterion	-104.0869	Schwarz Bayesian Criterion	-108.3708
DW-statistic	1.8444	Durbin's h-statistic	1.0177[0.309]

Source: Author's computation, 2015. Note: *** denotes statistical significance at the 1% level respectively

4.5 Diagnostic and Stability Test Results

The results of the diagnostic test are reported in Table 8. The results show that the estimated model passed all the diagnostic tests since the null assumptions underlying the tests are accepted, since the calculated values are insignificant. The results of stability test as shown in figure 7 and figure 8, indicate that,the cumulative sum of recursive residuals (CUSUM) test of stability (figure 7) which determines the methodological arrangements of the estimates with

the null hypothesis which states that, the coefficients are stable, is rejected when the CUSUM surpasses the given critical boundaries. The cumulative sum of squares of recursive residuals (CUSUMSQ) (figure 8), on the other hand, determines the stability of the variance. The results of both tests revealed that the estimates and variance are stable as the residuals and squared residuals fall within the various 5% boundaries. The value of the R-square (R^2) of 0.8896 indicate that about 88.96% of the changes in investment is explained by the model. This is an indication of a well behaved model.

Table 8 Short-Run Diagnostic Tests of ARDL Model

Test Statistics	LM Version	F Version
A:Serial Correlation	0.35689[0.550]	F(1,35) = 0 .30734[0.583]
B:Functional Form	1.1115[0.292]	F(1,35) = 0.97530[0.330]
C:Normality	1.1416[0.565]	Not applicable
D:Heteroscedasticity	1.1348[0.287]	F(1,39) = 1.1102[0.299]
A:Lagrange multiplier test of residual serial correlation B:Ramsey's RESET test using the square of the fitted values C:Based on a test of skewness and kurtosis of residuals D:Based on the regression of squared residuals on squared fitted values		

Source: Author's computation, 2015

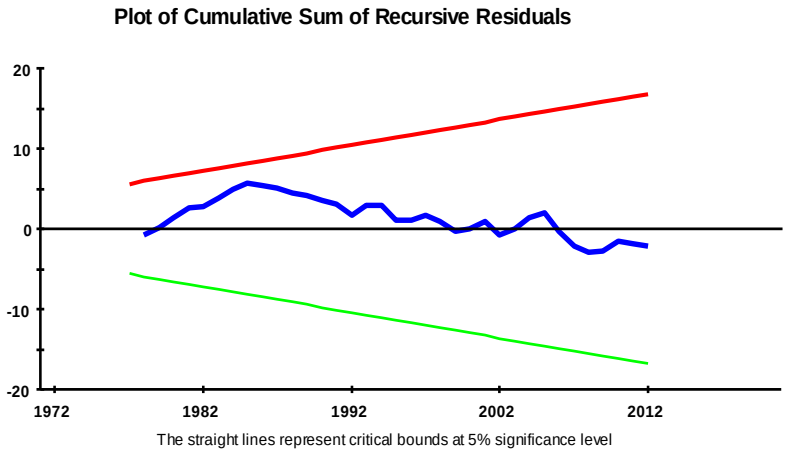

Figure 7 Plot of CUSUM

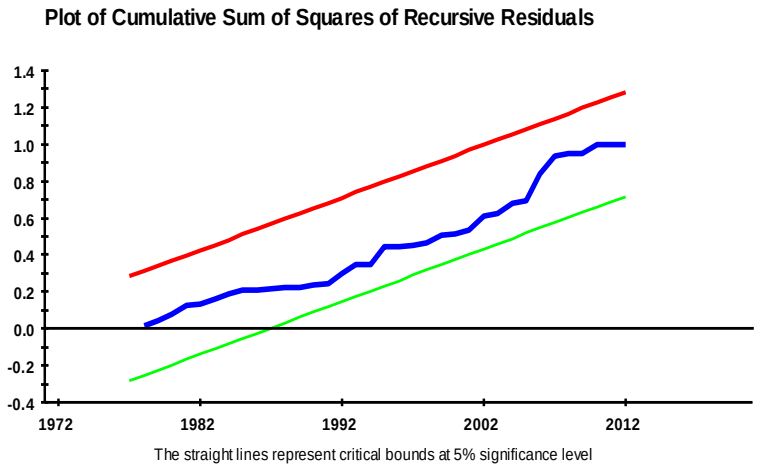

Figure 8 Plot of CUSUMSQ

5 Conclusion

There is a growing literature that examines the causality relationship between inflation and investment. However, the empirical findings have been inconsistent in terms of the nature of the relationship between inflation and investment. The current study may be considered as a complementary empirical study to previous works.

The paper examines the nature of the link among inflation, investment, and economic growth in Ghana for 1970-2012 period using ARDL model. The results show that there is negative effect of inflation on investment in both long run and short run. The findings discussed support the view that inflation hampers investment and hence economic growth. The findings do not raise doubts on argument for low inflation targeting policy view for Ghana. There is the need to implement monetary and fiscal policies to stabilise the prices and control inflation to single digits. This will make in the financial sector vibrant to boost investment and ensure economic growth.

Future studies should take into consideration the issue of causal analysis since the current study did not consider. Structural breaks should be considered in examining unit roots in future studies since the presence of structural breaks the robustness of the findings.

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