Interest Rate and its Threshold Effect on Private Investment: Evidence from Ghana

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Abstract
This paper investigates the effect of interest rate on private investment and determine the threshold level beyond which interest rate becomes detrimental to private investment in Ghana. The paper employed annual time series data from 1986-2016. To investigate the effect of interest rate on private investment, the paper employed the autoregressive distributed lag (ARDL) model, while the quadratic function and conditional least square procedures were employed to estimate the interest rate threshold. Results from the ARDL model revealed positive long and short run effect of interest rate on private investment, thus confirming the McKinnon-Shaw hypothesis in Ghana. However, results from the quadratic function and conditional least square model found the threshold of 23.59% and 24% respectively, beyond which interest rate impacts negatively on private investment in Ghana. Thus, the paper recommends the deepening of the financial sector reforms, improving competition in the financial sector as well as maintaining macroeconomic stability.

Keywords: Interest rate, Private Investment, Conditional Least Square, Quadratic function, ARDL, Ghana

JEL classification: E22, E43, E52

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1. Introduction

In developing countries where there is much dependence on foreign aid, grants and external borrowing, enhancement of the investment environment is necessary for promoting private investment and stimulating economic growth. The private sector helps in creating fiscal space for governments and thus recognized as a critical stakeholder in the progress of a country. This is mainly done through the creation of income-generating activities augmented by the allocation of requisite economic consumption for the enhancement of the standard of living (see Suryadarma and Suryahadi, 2007; Ayyagari et al., 2011).

Since independence in Ghana, the role of private investment in promoting sustainable economic growth and development has been highlighted by nearly all past governments. Thus, these governments focused their attention on programs and reforms aimed at providing vital ingredients for the development of the private sector (Eshun et al., 2014). Some of the reforms and policies include Economic Reform Program (ERP), 1983; Structural Adjustment Programme (SAP), 1986; Financial Sector Strategic Plan (FINSSP), 2003; Banking Amendment Act, 2007; Venture Capital Trust Fund, 2004, Borrowers and Lenders Act, 2008, among others (Bawumia, 2010). Despite these reforms and policies, private investment level in Ghana has not been enough to expand the capital stock and production capacity of the economy to generate the desired economic growth, as compared to other developed countries like the US, UK, and Canada. For instance, after increasing from a ten-year (1987 – 1996) average of 6.40% to 13.27% (10-year average for 1997 – 2006), private investment declined to 11.40% in 2007. There was however an improvement from 12.31% in 2008 to a high of 24.3% in 2012. However, it has seen a drop since then, having decreased to 21.1% in 2013 and even a further reduction to 19.62%, 17.16% and 15.6% for the years 2014, 2015 and 2016 respectively (WDI, 2018).

An important policy question is: what is the key determinant of private investment growth in Ghana? One key determinant that comes up is the interest rate. Theoretically, the interest rate is seen to have a strong relationship with domestic investment. Keynes (1936), asserted that, when interest rates decline, the financial viability of numerous projects cannot be overemphasized, whereas escalating interest rate causes the postponement or abrogation of some projects. This occurs as a result of higher cost of borrowing to finance investment. According to fundamental economic theory, when interest rates are low, investment is stimulated, which explains the rationale behind some countries keeping their interest rates as low as possible (see Tule et al., 2015). McKinnon (1973) and Shaw (1973), on the other hand, emphasized that low real interest rate discourages savings, hence causing a reduction in the number of funds available to carry out investments. According to McKinnon and Shaw (1973), the banking sector ought to be liberalized for interest rates to be fixed by the interaction between demand and supply. In this case, both nominal and real interest rates will cause a rise in savings mobilization, deepen financial intermediation process and thereby make loanable funds available to spur investment.

Thus, while Keynes proposition predicts an inverse relationship between private investment and rate of interest (see empirical evidence in Ababio et al., 2018); Suhendra and Anwar, 2017; Eshun et al., 2014; Erden and Holcombe, 2005; Akpalu, 2002). McKinnon and Shaw, however, posits that there exist a positive relationship between interest rate and private investment (see empirical evidence in Frimpong and Marbuah, 2010; Jamil, 2015; Agu, 2015). These opposing theories imply the possibility for the existence of a threshold effect of interest rate on private investment. Though studies have been undertaken on private investment in Ghana (see for instance, Ababio et al., 2018; Obeng et al., 2017; Eshun et al., 2014; Akpalu, 2002; Frimpong

and Marbuah, 2010; Asante, 2000), these were limited to the symmetric interrelation between the rate of interest and private investment, which produced inconclusive outcomes. This paper contributes to this growing literature from two specific angles. By employing the cointegration technique of the ARDL model, this paper will firstly investigate the impact of the interest rate on private sector investment in Ghana so as to ascertain whether the relationship points to that of Keynes' user cost of capital or the McKinnon-Shaw hypothesis. This is crucial given that the identification of the exact relationship can influence policymaking in enhancing private investment in Ghana. Second and most importantly, after identifying the exact relationship between interest rate and private investment, this paper will go a step further to estimate the threshold below or above which interest rate becomes detrimental to private investment in Ghana. This threshold if identified will go a long way to influence policy, which will make it possible to reap the benefits of private sector growth to GDP through investment.

The remainder of the paper is arranged in the following order. Section 2 reviews brief theoretical and empirical literature of the paper. Section 3 provides the model specification and empirical strategy. Section 4 presents discussion and results while the final section 5 concludes the paper with policy implications.

2. Literature Review

2.1 Theoretical Review

Keynes (1936) stressed the significant role of investment in promoting overall output, employment, and changes in economic activity. That is, he asserted that, when interest rates decline, the financial viability of numerous projects cannot be overemphasized, whereas escalating interest rate causes the postponement or abrogation of some projects. This occurs as a result of higher interest rate on loans to finance investment. Thus, according to Keynes, since investment changes and depends on firms' outlook or the prospect of the profitability of the investment, in as much as the anticipated return on their investment outperform the interest rate, fresh investment will occur. He, therefore, refused to accept the idea that investment was based entirely on technological status of output per unit of fixed production assets (fixed capital) but rather stressed that monetary factors, finance, and uncertainty are the fundamental factors that influence the level investment (Fazzari, 1989).

The rigid accelerator theory of investment formulated by Clark (1917), on the other hand, suggested that investment is directly related to changes in output. This means that the rigid accelerator model connects investment to the volatility in demand and suggests that, a rise in a firm's quantity of goods and services produced will call for an equal rise in capital stock. In short, the theory proposes that, the output level or variations in overall demand influences investment or the variations in stock of capital.

However, according to McKinnon (1973) and Shaw (1973), most economies especially less developed economies experience financial crises which if thoroughly resolved, would culminate the improved savings, investment and consequently stimulation of growth for these economies. Implicitly, saving is sensitive to interest rates; hence, an increase in rate of saving would imply an increase in the level of investment, resulting in higher growth.

Finally, Pindyck (1991) indicated that the nature of investment projects is considered irreversible. In view of this, contemporary literatures have enclosed component of uncertainty in the investigation of investment decisions. Dixit and Pindyck (1994) on the other hand, identified three main elements that characterize investment decisions: (1) the initial cost of investment, (2) evaluation of the probabilities of the consequences associated with profits or

loss by the investor, and (3) the timing of the investment decision. These three features underlying the decision to undertake investment projects, therefore, help to determine the optimal investment decision-making.

2.2 Empirical Review

Suhendra and Anwar (2017) examined the factors affecting private investment in Indonesia over the period 1990 to 2011. They employed multiple regression method using panel data and used variables such as interest rate, public investment, growth rate of gross domestic product, funds to the private sector, inflation, and exchange rate. Results from the study showed that public investment, growth rate of gross domestic product, funds to the private sector, and exchange rate have positive effect on private investment. However, interest rate and inflation were found to affect private investment negatively.

Erden and Holcombe (2005) on their part examined the effect of public investment on private investment in developing economies. Having used a panel of 19 Less-Developed Countries from 1980 to 1997, the results revealed that in both the long and short run, public investment and funds to the private sector have positive impact on private investment. Inflation-adjusted interest rate had a negatively substantial impact on the level of private investment. On his part, Agu (2015) investigated the factors that influence private investment in Nigeria spanning 1970-2012. By employing the Error Correction Model (ECM), the results indicated that infrastructure and interest rate affects private investment positively.

With respect to Ghana, Asante (2000) conducted an analysis on the causal factors of private investment using time series data from 1970 – 1992. Findings from the study revealed that funds to the private sector, inflation-adjusted exchange rate, and public investment have a positive effect on private investment, with public investment supporting possible complementary effect. In a similar study, Frimpong and Marbuah (2010) examined the factors influencing private investment in the country from 1970 to 2002. Employing the ARDL model, findings from the paper indicated that GDP, real interest rate, external debt as well as inflation have positive relationship with private investment. Moreover, Eshun et al. (2014) examined the financial determinants of private investment in Ghana. The paper used time-series data from 1970 to 2010 and employed the Autoregressive Distributed Lag (ARDL) estimation technique. Findings from the paper indicated that funds to the private sector, exchange rate, money supply as well as GDP growth, have a positive effect on private investment. However, interest irate and inflation rate have negative effect on private investment. Finally, Ababio et al. (2018) investigated the effect of financing cost on private investment from 1970 to 2010. The study employed the Error Correction Model and results revealed that interest rate, exchange rate, inflation rate, and external debt have negative impact on private investment.

It is noted that most of the empirical literatures reviewed focused on the causal linear impact or effect that interest rate has on private investment with inconclusive findings. However, the two opposing theories of the user cost of capital and McKinnon-Shaw means that there could threshold effect of interest rate on private investment. This paper seeks to contribute to policy formulation as well as add to the literature by assessing in addition to the causal relationship, the threshold effect of interest rate on private investment in Ghana.

3. Methodology

3.1 Model specification

Several approaches are generally considered in modelling investment. These consist of the accelerator model, the expected profits theory, the Tobin's-Q theory, the flexible accelerator

theory and the neoclassical accelerator theory. But, in the case of less-developed economies, because of inadequate data and structural restrictions, a modification of the flexible accelerator model has been adopted for the empirical research. Thus, the empirical model adopted here in this paper is a varied version of the flexible accelerator model designed to capture some of the key private investment behaviours in Ghana. This is given in equation (1) as:

$$PRI_t = \beta_0 + \beta_1 INTR_t + \beta_2 INF_t + \beta_3 PUI_t + \beta_4 EXD_t + \beta_5 EXR_t + \beta_6 GDPG_t + \varepsilon_t \qquad (1)$$

where, PRI is private investment as a percentage of GDP, INTR represents the interest rate, INF is the inflation rate, PUI is the public investment as a percentage of GDP, EXD is the external debt as a percentage of GDP, EXR is the exchange rate and GDPG represents growth rate of gross domestic product. β_1 , β_2, β_3, β_4, β_5, and β_6 are the coefficients of the predictors in the model, β_0 is the intercept, whilst ε_t is the error term.

3.2 Data and definition of variables

The paper used annual time series data from 1986-2016. The data used were sourced from WDI and Bank of Ghana database. Formal definitions of variables and their measurement are displayed in Table 1.

Table 1. Definition of variables and data sources

Variable	Description	Source
Private Investment (PRI)	Private investment covers gross outlays by the private sector (including private non-profit agencies) on additions to its fixed domestic assets.	World Development Indicators
Interest Rate (INTR)	It is calculated or measured as a percentage of the principal paid on a given number of times for a period over the entire duration of a loan.	Bank of Ghana
Inflation (INF)	Inflation as measured by the consumer price index reflects the annual percentage change in the cost to the average consumer of acquiring a basket of goods and services.	Bank of Ghana
Public Investment (PUI)	Public investment covers gross outlays by the public sector on additions to its fixed domestic assets	World Development Indicators
External Debt (EXD)	Total external debt is debt owed to non-residents repayable in currency, goods, or services.	World Development Indicators
Exchange Rate (EXR)	The exchange rate is measured as the Ghanaian Cedi per United State Dollar	Bank of Ghana
Growth Rate of Gross Domestic Product (GDPG)	Annual percentage growth rate of GDP at market prices based on constant local currency.	World Development Indicators

3.3 Estimation Strategy

3.3.1 The Autoregressive Distributed Lag (ARDL) Model

To investigate the effect of interest rate on private sector investment, the paper employed the ARDL cointegration technique developed by Pesaran, et al. (2001). The reason for choosing this method of estimation is due to the fact that it is comparatively more efficient in small sample size. Again, the ARDL technique to cointegration is most appropriate because the regressors are integrated of different orders (i.e., I (1) and I (0)). The general conditional ARDL modelling specifications for equation (1) is given by

$$\Delta PRI_t = \alpha_0 + \sum_{i=1}^{\rho} \alpha_{1i}\, \Delta PRI_{t-i} + \sum_{i=1}^{\rho} \alpha_{2i}\, \Delta INTR_{t-i} + \sum_{i=1}^{\rho} \alpha_{3i}\, \Delta INF_{t-i} + \sum_{i=1}^{\rho} \alpha_{4i} \Delta PUI_{t-i} + \sum_{i=1}^{\rho} \alpha_{5i}\, \Delta EXD_{t-i} + \sum_{i=1}^{\rho} \alpha_{6i}\, \Delta EXR_{t-i} + \sum_{i=1}^{\rho} \alpha_{7i}\, \Delta GDPG_{t-i} + \delta_1 PRI_{t-1} + \delta_2 INTR_{t-1} + \delta_3 INF_{t-1} + \delta_4 PUI_{t-1} + \delta_5 EXD_{t-1} + \delta_6 EXR_{t-1} + \delta_7 GDPG_{t-1} + V_t \quad (2)$$

where, Δirepresents the first-difference operator, ρxis the lag order selected by the AIC, α_0 is the drift component, and V_t is the error term which is normally distributed with zero mean and constant variance. The parameters α_i are short-run parameters and δ are the long run multipliers. The examination of long-run relationship between private investment and other variables used in the model begins with the bounds test using the OLS method, which is generally the first and foremost step in the ARDL model. The F-test, is thus employed to examine the existence of long-run relationship among the variables in equation (2) after which an error correction model is estimated to determine the short run dynamics in the model and the speed of adjustment towards equilibrium. The error correction version of the ARDL model pertaining to the long-run estimates is specified as follows:

$$\Delta PRI_t = \alpha_0 + \sum_{i=1}^{\rho} \alpha_{1i}\, \Delta PRI_{t-1} + \sum_{i=1}^{\rho} \alpha_{2i}\, \Delta INTR_{t-i} + \sum_{i=1}^{\rho} \alpha_{3i}\, \Delta INF_{t-i} + \sum_{i=1}^{\rho} \alpha_{4i}\, \Delta PUI_{t-i} + \sum_{i=1}^{\rho} \alpha_{5i}\, \Delta EXD_{t-i} + \sum_{i=1}^{\rho} \alpha_{6i}\, \Delta EXR_{t-i} + \sum_{i=1}^{\rho} \alpha_{7i}\, \Delta GDPG_{t-i} + \phi ECM_{t-1} + \mu_t \quad (3)$$

where, ϕ is the speed of adjustment of the parameter to long-run equilibrium following a shock to the system and ECM_{t-1} is the error correction model.

3.3.2 The quadratic function

Now in order to determine the interest rate threshold beyond which an increase in interest rate will retard private investment, the paper adopted two methodologies. The quadratic function as used by Younus (2012) and the conditional least square model developed by Khan and Senhadji (2001) and adopted by Mehrara and Karsalari (2011). The quadratic equation is given as:

$$PRI_t = \beta_0 + \beta_1 INTR_t + \beta_2 (INTR_t^{*})^2 + \beta_3 INF_t + \beta_4 PUI_t + \beta_5 EXD_t + \beta_6 EXR_t + \mu_t \quad (4)$$

where $INTR^*$ is the threshold interest rate and β_0 is the constant or the intercept. Equation (4) is then solved to obtain the threshold interest rate value by applying the optimization rule, where the first-order differentiation is set to zero.

3.3.3 The conditional least square approach

In the conditional least square approach, we find the level of interest rate, which minimizes the RSS or that increases the R^2 for various values of the threshold points assigned. The value of the threshold (k) is acquired by determining the highest point among the allotted values of k's

in the estimation process that increases the RSS from the various regressions. As outlined by Khan and Senhadji (2011), the spotting of the threshold point is given as:

$$k^* = Arg_k MaxR^2(\underline{k}, \dots, \overline{k}) \; or \; k^* = Arg_k MinRss \qquad (5)$$

where, k^* is the optimal or threshold interest rate, $\underline{k}$ and , $\overline{k}$ are the domain at which the upwards numbers are given. With conditional least square method (CLS), before undertaking the regression, it is important to allot dummy values for the threshold interest rate. Other plausible variables included in the model to estimate the threshold interest rate are inflation, public investment as a percentage of GDP and exchange rate. From equation (1), the interest rate model is modified to capture the threshold effect as:

$$PRI_t = \beta_0 + \beta_1 INTR_t + \beta_2 D_t(INTR_t - k^*) + \beta_3 INF_t + \beta_4 PUI_t + \beta_5 EXR_t + \varepsilon_t \qquad (6)$$

where, k^* is the threshold interest rate, D_t is a dummy variable that takes the value of one when interest rate exceeds the threshold level and zero otherwise. That is,

$$D_t = \begin{cases} 1, \dots\dots\dots if INTR_t > k \\ 0, \dots\dots\dots if INTR_t \leq k \end{cases} \qquad (7)$$

4. Results and Discussions

4.1 Preliminary results

Table 2 displays the descriptive statistics of the variables and the computed descriptive statistics reveals that each of the variables has a positive mean. The mean of private investment as a percentage of GDP is 12% while the mean rate of interest is 33%. The mean of public investment as a percentage of GDP is 21% and the mean rate of inflation over the study period is approximately 22%. Moreover, the mean of external debt as a percentage of overall external debt to gross national income is 69% and that of exchange rate is approximately 0.9. Finally, the mean of GDP growth rate is approximately 5.4%.

Table 2. Summary statistics of variables

Variable	PSI	INTR	PUI	INF	EXD	EXR	GDPG
Mean	11.92	33.13	21.44	21.68	69.06	0.89	5.39
Maximum	24.33	47.00	31.78	59.46	139.44	3.91	14.05
Minimum	2.01	23.00	9.36	8.73	18.23	0.01	3.30
Std. Dev.	5.79	6.60	5.77	11.98	34.02	1.05	2.22
Kurtosis	2.35	2.15	2.55	4.62	2.24	4.79	8.83
Sum	369.4	1026.9	664.8	672.2	2140.9	27.6	167.14
Sum Sq. Dev.	1004.2	1305.2	998.7	4303.0	34714.1	32.9	147.4
Observations	31	31	31	31	31	31	31

Also, results of the ADF and PP tests for unit root with intercept and trend are presented in Table 3. It reveals that all the variables with the exception of inflation, are not stationary at the levels, which means that they are not integrated of order zero (0) and thus poses unit root. However, at their first difference, all the variables become stationary. This means that inflation (INF) was the only variable which was integrated of order zero (0), while all others were integrated of order one (1). This finding makes the ARDL technique, the most appropriate for estimation.

Table 3. Results of Unit Root Test

	LEVEL			FIRST DIFFERENCE	
Variable	**ADF**	**PP**	**Variable**	**ADF**	**PP**
PRI	-3.0469	-2.8665	ΔPRI	-6.6063***	-16.6890***
INTR	-2.3825	-2.3825	ΔINTR	-5.5833***	-5.6267***
INF	-3.8232	-3.6440**	ΔINF	-6.3654***	-15.3238***
PUI	-2.8552	-2.6635	ΔPUI	-5.6400***	-13.9504***
EXD	-1.7421	-1.9331	ΔEXD	-4.3897***	-4.3831***
EXR	1.4989	1.4833	ΔEXR	-3.6895**	-3.6895**
GDPG	-3.1898	-3.1771	ΔGDPG	-7.2002***	-7.5081***

Note: ***,**,* indicates the rejection of the null hypothesis of non-stationary at 1%,5% and 10% level of significance respectively, Δ denotes the first difference.

Having established the stationarity status of the variables in the model, the study proceeded to test for co-integration or existence of long run equilibrium relationship among the variables using the Autoregressive Distributed Lag (ARDL) bounds test procedure. Result from the test as presented in Table 4 indicate that, there is long-run relationship between private investment and the independent variables. This is because the computed F-statistic for the model (9.2768) is greater than the critical upper bound values of 3.797 (10%), 4.499 (5%) as well as 6.211 (1%).

Table 4. Results of Bounds Test

Test Statistic	**Value**	**Significance**	**I(0)**	**I(1)**
F-statistic	9.2768	10%	2.457	3.797
k	6	5%	2.97	4.499
		1%	4.27	6.211
Actual sample size	30			

Note: k is the number of regressors used in the model.
I(0) represents lower bound I(1) represents upper bound

4.2 Main Results

4.2.1 Long Run Results

Following the establishment of cointegration between private investment and the independent variables, the ARDL co-integration model is used to estimate the long-run coefficients and short-run parameters of equation (3). Table 5 presents the long-run results. The coefficient of interest rate (INTR) is 0.3878 and statistically significant at 1%. This means that, a 1% rise in interest rate causes private investment to increase by nearly 0.39% in the long-run ceteris paribus. This positive and significant impact of interest irate on private investment is in accordance with the apriori expectation as well as McKinnon-Shaw hypothesis, which asserts that, high interest rate increases savings, domestic credit and hence increase in private investment. This result also conforms to the findings of Frimpong and Marbuah (2010), Ofori-Abebrese and Kamasa (2013) as well as Agu (2015).

Table 5. Long Run Results

ARDL (1, 0, 1, 1, 1, 0, 0) selected based on AIC
Dependent Variable: PRI

Variable	Coefficient	Std. Error	t-Statistic
INTR	0.387812***	0.140236	2.765420
INF	-0.178796***	0.052905	-3.379535
PUI	0.353426**	0.158205	2.233967
EXD	-0.023533**	0.010401	-2.262516
EXR	-1.884545***	0.558019	-3.377203
GDPG	0.566499**	0.211813	2.674528

Note: ***, **, * denote significance level at 1%, 5% and 10% respectively. Regression includes the constant term.

For the included covariates, a significant inflation (INF) coefficient of -0.1788 means that when the rate of inflation increases by 1%, private investment would decrease by approximately 0.18%. This negative impact of rate of inflation on private investment is because increasing prices reflects a fall in value of the currency, hence little motivation to stimulate people's desire to save in the banks leading to a fall in investment. Empirically, this finding is in accordance with the result of Ababio et al. (2018) and Eshun et al. (2014). Moreover, the coefficient of public investment (PUI) is 0.3534 and statistically significant at 5%**,** which means a 1% increase in public investment would result in approximately 0.35% rise in private investment. This positive relationship suggests complementarity between public investment and private investment and that the public sector investment is found to act as a crowding-in catalyst to private investment growth. The result conforms to the findings of Hailu and Debele (2015), as well as Ofori-Abebrese and Kamasa (2013).

Confirming a priori expectation, the effect of external debt on private investment is negative and statistically significant at 5%. This implies that, if external debt rises by 1%, private investment will decrease by 0.02% in the long-run. This is because as external debt rises, resources that could have be used to fund domestic enterprises or business will now be used to service or pay external debt. The finding is in harmony with the study outcomes of Ababio etial. (2018) and Mbanga (2002). In furtherance, the coefficient of exchange rate is negative and significant, with a 1% increase in exchange rate reducing private investment by 1.88% This negative effect is because a fall in the value of the local currency (cedi) in relation to a foreign currency raises the cost of goods imported and since majority of the goods used for businesses or investment in the country are imported, domestic private investment would fall. This finding confirms the results of Hailu and Debele (2015) and Naa-Idar et al. (2012).

Finally, the coefficient of GDP growth is 0.5665 and statistically significant at 5%. This indicates that, as GDP growth rises by 1%, private investment will also increase by 0.57% in the long run. This therefore implies that private investment increases during periods of boom and likely to fall during periods of recession. The result is in line with the findings of Molapo and Damane (2015) and also confirms the rigid accelerator theory by Clark (1917).

4.2.2 Short Run Results

Results of the short-run are shown in Table 6. Importantly, there is negative and highly significant error-correction term, which further confirms the presence of cointegration. A coefficient of -0.578 suggests a reasonably high speed of adjustment in long run equilibrium from short-run deviations.

Table 6. Estimated Short-Run Coefficients

ARDL (1, 0, 1, 1, 1, 0, 0) selected based on AIC
Dependent Variable: PRI

Variable	Coefficient	Std. Error	t-Statistic
D(INTR)	0.224179***	0.050855	4.408163
D(INF)	-0.011089	0.036792	-0.301411
D(PUI)	0.703710***	0.058424	12.04488
D(EXD)	-0.079555***	0.014610	-5.445269
D(EXR)	1.089382**	0.387959	2.807986
D(GDPG)	0.327471***	0.102275	3.201872
ECT(-1)	-0.578061***	0.091998	-6.283427
R-squared	0.936733	Adjusted R-squared	0. 926610
F-statistic	92.53707	Durbin-Watson stat	1.852079
Prob (F-statistic)	0.000000		

Note: ***, **, * denote significance level at 1%, 5% and 10% respectively. Regression includes the constant term.

Confirming long run result, the coefficient of interest rate (INTR) retained its positive sign and statistically significant at 1% significance level. This means that, a 1% rise in interest rate causes private investment to increase by almost 0.22% in the short-run. Also, the coefficient of inflation (INF) maintained its negative sign at the current period but statistically insignificant. Moreover, the short run estimate of public investment retained its positive sign and statistically significant at 1% significance level. This means that, a 1% rise in public investment results in 0.70% rise in private investment in the short-run.

Furthermore, external debt also retained its negative sign and statistically notable at 1% significant level. Thus, a 1% rise in external debt in the short-run causes private investment to reduce by approximately 0.08%. Again, the coefficient of growth rate of GDP maintained its positive sign and statistically significant at 1% significance level, where a 1% rise in growth rate of GDP leads to 0.33% increase in private investment. Finally, exchange rate had positive effect on private investment in the short run. This means that a 1% rise in exchange irate leads to 1.09% increase in private investment. This result is inconsistent with the long run result but consistent with the findings of Ababio et al (2018).

4.2.3 Diagnostic Checks

To ensure the robustness of the outcomes of the results as well as the significance of the variables, diagnostics tests such as autocorrelation, functional form, normality, heteroscedasticity, and structural stability of the model are considered as displayed in Table 7.

Table 7. Model Diagnostics (ARDL Model)

Test	F- statistic	P-Value
Serial Correlation	0.1166	0.7367
Heteroscedasticity	0.7092	0.7059
Functional Form	0.1261	0.7266
Normality	3.0897	0.2133

** denotes significance at 5%

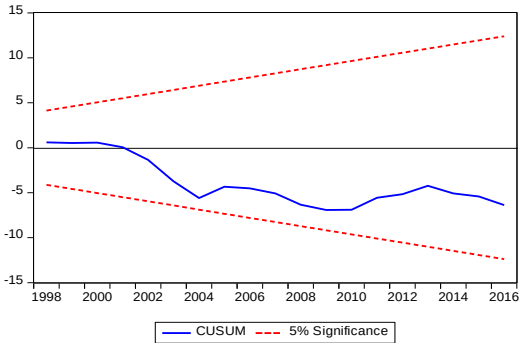

Figure 1: Plot of Cumulative Sum of Recursive Residuals

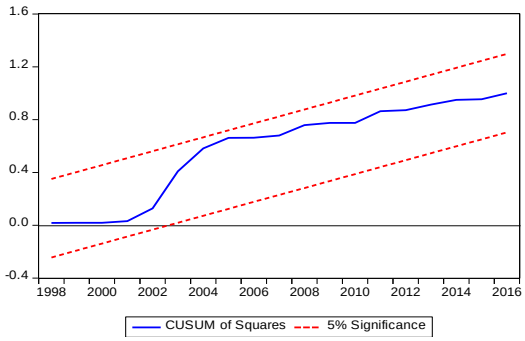

Figure 2: Plot of Cumulative Sum of Squares of Recursive Residuals

The model passes the test of misspecification, heteroscedasticity, normality and serial correlation. This is because, their probability values are all insignificant. Moreover, Figures 1 and 2 depict the plots of CUSUM and CUSUMQ for the estimated ARDL model. As shown in Figures 1 and 2both the CUSUM and CUSUMSQ tests confirm the stability of the coefficient of the private investment function.

4.2.4 Estimated results of interest rate threshold - the quadratic function method

Having established positive and linear effect of interest irate on private investment from the ARDL, the paper proceeds to determine the threshold interest rate beyond which an increase in interest rate will cause private investment to decline. Results of the estimated threshold interest rate applying the quadratic equation is displayed on Table 8.

Table 8. Estimated Threshold Interest Rate - Quadratic function

Dependent Variable: PRI			
Variable	**Coefficient**	**Std. Error**	**t-Statistic**
INTR	0.534193***	0.125432	4.258819
$(INTR)^2$	-0.011323***	0.003140	-3.606131
PUI	0.860561***	0.063951	13.45652
INF	0.059585*	0.033186	1.795514
EXD	-0.034170**	0.014432	-2.367653
EXR	0.072696***	0.014432	5.681379
R-squared	0.977975	Adjusted R-squared	0. 969503
Durbin-Watson stat	1.818733		

Note: ***, **, * denote significance level at 1%, 5% and 10% respectively. Regression includes the constant term.

From the results in Table 8, the marginal impact of interest rate on private investment, ceteris paribus is presented as follows:

$$\frac{\partial PRI}{\partial INTR} = \beta_1 + 2\beta_2 INTR^*$$

Now, solving for threshold interest rate:

$$\beta_1 + 2\beta_2 INTR^* = 0$$
$$0.534193 + 2(-0.011323)INTR^* = 0$$
$$0.534193 = 0.022646INTR^*$$
$$INTR^* = \frac{0.534193}{0.022646}$$
$$INTR^* = 23.59\%$$

Hence, the estimated quadratic function for the sample data from 1986 to 2016 gave a threshold interest rate of 23.59%. This means that when interest rate is up to 23.59%, there is the possibility of the realisation of positive or direct impact on private investment but any increase above this level has the tendency to retard private investment in Ghana.

4.2.5 Estimated results of interest rate threshold - conditional least square approach

The paper further adopted the conditional least square approach in examining the threshold level of interest rate on private investment. In view of this, we carried out sequence of regression equations and determined the impact of various interest rates together with other key explanatory variables on the private investment model. With the model, the expression $D_t(INTR_t - k^*)$ was repeated for a range of rates of interest between 23% and 47%. The reason for the choice of interest rates ranging between 23%-47% is because the lowest interest rate during the study period was 23% and the highest being 47%. The results are presented in Table 9. Results from Table 9 reveals that, the least RSS is at the interest rate threshold of 24%, which has a value of 29.1610. In addition, this threshold of 24% records the highest R^2 of 0.9472. Moreover, except for rate of inflation, the other explanatory variables incorporated in the model were significant when interest rate was at the threshold level. Specifically, at the optimal level of 24%, the p-values of the coefficient of both public investment and exchange rate were 0.0000 and 0.0252 indicating significant relationship between private investment and public investment as well as exchange irate. Also, from Table 9, if interest rate rises beyond the threshold level, private investment is anticipated to reduce approximately by the sum of the coefficients of INTR and D(INTR-k*), which is [0.155028 +(-1.832768) = -1.67774] in each year. This means that, when interest rate increases by 1 percent beyond 24%, private investment will decline by approximately 1.68%.

Table 9. Estimated Threshold Interest Rate - Conditional Least Square Method

k	Variable	Coefficient	Std. Error	t-Statistic	R^2	RSS
	INTR	0.015112	0.080722	0.187206		
23	D(INTR-23)	-0.525929	0.894907	-0.587691	0.9400	33.0201
	INF	-0.033119	0.027993	-1.183145		
	PUI	0.567349***	0.091535	6.198155		
	EXR	0.355784***	0.104749	3.396548		
	INTR	0.155028**	0.071307	2.174080		
24	D(INTR-24)	-1.832768**	0.873253	-2.098782	0.9472*	29.1610
	INF	-0.019204	0.026209	-0.732738		
	PUI	0.741508***	0.128175	5.785135		
	EXR	0.252031**	0.101401	2.485491		
	INTR	0.114726	0.097361	1.178352		
25	D(INTR-25)	-0.411995	1.325658	-0.310785	0.9286	35.0961
	INF	-0.021731	0.029494	-0.736817		
	PUI	0.686258***	0.098010	7.001945		
	EXR	0.227222***	0.072157	3.148996		
	INTR	0.132105	0.099049	1.333741		
26	D(INTR-26)	-0.563227	1.028088	-0.547839	0.9297	34.5232
	INF	-0.020817	0.031522	-0.660380		
	PUI	0.695400***	0.077390	8.985611		
	EXR	0.214043**	0.083056	2.577101		
	INTR	-0.082693	0.059374	-1.392742		
27	D(INTR-27)	-0.434204	0.751560	-0.577736	0.9294	34.685
	INF	-0.027994	0.034209	-0.818316		
	PUI	0.637655***	0.076282	8.359220		
	EXR	0.261537***	0.081119	3.224092		
	INTR	-0.153887**	0.058781	-2.617959		
28	D(INTR-28)	-0.579193	0.679787	-0.852021	0.9119	39.3143
	INFL	-0.029816	0.031062	-0.959865		
	PUI	0.708000***	0.090781	7.798976		
	EXR	0.112891*	0.058338	1.935107		
	INTR	-0.091520	0.067009	-1.365779		
29	D(INTR-29)	0.663049	0.686783	0.965442	0.9044	49.0107
	INF	-0.026770	0.027653	-0.968072		
	PUI	0.750046***	0.081831	9.165761		
	EXR	0.127483***	0.030983	4.114610		
	INTR	-0.114863	0.077059	-1.490590		
30	D(INTR-30)	-0.140274	0.694903	-0.201860	0.9001	51.1804
	INF	-0.022261	0.034386	-0.647389		
	PUI	0.756477***	0.088916	8.507751		
	EXR	0.114383***	0.031065	3.682070		

Note: ***, **, and * denote significance level at 1%, 5% and 10% respectively.

The conclusion of these outcomes is that interest rate between 23.59% - 24% is likely to be adequate for the stimulation of the development of private investment in Ghana. Thus, permitting interest rate beyond approximately 24% may probably retard private investment. A consideration of the quadratic model and conditional least square model revealed identical

limits for the rate of interest with two proximal values. While the quadratic function estimated threshold interest rate of 23.59%, the conditional least square approach suggested 24%.

5. Policy implications

In line with empirical evidence, the paper has shown that interest rate was found to have a positive impact on private investment. However, the paper established a threshold level of 24% beyond which an increase in interest rate could hamper or be detrimental to private sector investment in Ghana. As a policy implication, government must strengthen its collaboration with financial sector to deepen measures and policies so as to improve competition. Also, there must be the sustenance and improvement with regards to financial sector reforms. Finally, there must be macroeconomic stability so as to help private sector investment to thrive.

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