

Effects of Budget Deficit on the Private Sector Investment of Bangladesh

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ABSTRACT: *The study aims to discover the effects of budget deficit on private sector investment of Bangladesh and presence of crowding-in or crowding-out effects. The time period of the study is 1981 to 2018 and to test the effects of sustained budget deficit on the private sector investment of Bangladesh, ARDL bound testing approach was used for unveiling the long run and short run relationship among the variables based on three models. Before this, Perron's unit root test was conducted and except for real interest rate being integrated at level all other variables are integrated at first difference. Co-integration test was conducted using ECM bound testing to look for evidence of long run relationship and the results confirmed the existence of long run relationship among the variables. Based on the results of the ARDL bound testing approach, the overall results from all the equations show, there is crowding-out effect both on the longer term and in shorter-term. There significant positive relationship between GDP, trade liberalization and private investment and negative relationship between public investment, real interest rate, interaction term and private investment in long term. In short term, the effects are immediately show mirror effect but match with long term coefficients in lagged periods. The test variables and models show no signs of serial correlation, hetero skedasticity and the coefficients are stable at 5% significance level.*

Keywords: *Private sector investment, Public sector investment, Crowding-out, Aggregate Output, ARDL bound testing, Flexible accelerator model.*

1. INTRODUCTION

Bangladesh is one the fastest growing countries in South Asia with an average GDP growth rate of 6% in the last decade. Currently Bangladesh

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is in its seventh five year planning period dated from 2016-2020 with a target GDP growth rate of 8% and to achieve this optimistic growth rate and break the barrier of stagnant 6% GDP growth, Bangladesh has to implement monetary and fiscal policies that would accelerate both private and public investment growth and ultimately increase the potential GDP (Saidjada and Jahan, 2018). According to, planning commission (2015), to attain this desired GDP growth the Private and public investment growth on aggregate has to increase from 28.9% of GDP to 34.4% of GDP by 2020. Currently, in 2018, the composition of private sector and public sector investment is 23.26% and 7.97% of GDP respectively, thus the private sector having the loins share of total investment growth, private sector has to play a leading role attaining those targets. However, government has recently increased its emphasis on increasing public investment in increasing the GDP growth rate and because of that from 2011 there has been a boost in the public sector investment growth but at the same time the growth rate of private sector has faced a slight slowdown.

This slowdown suggests a probability of crowding-out effect of public investment on private investment in Bangladesh. Majority of previous macroeconomic theories have failed to give a general consensus about the relationship between private and public investment as various researchers in both developing and developed countries have found evidence of both crowding-out and crowding-in effects (Reil-Held, 2006). Thus, the relationship between public sector investment and private sector investment requires an in-depth investigation which leads to this study being conducted. The objective of this study therefore is to empirically quantify the effect of interaction of budget deficits and the resulting impact on private investment in Bangladesh.

2. LITERATURE REVIEW

Budget deficits received much of the blame for economic ills that beset developing countries in the 1980's and 1990s over indebtedness and the debt crisis, high inflation, and poor investment growth performance. Attempts to regain macroeconomic stability through fiscal adjustment achieved uneven success, raising questions about the macroeconomic consequences of public deficits and fiscal stabilization or fiscal deterioration. Research and empirical studies conducted by, Eberts (1986), Munnell (1990) and Aschauer (1989a, 1989b), stimulated a vast interest in unveiling the relationship among public investment and economic growth at national and state levels. According to those studies, there was a positive and significant relationship between public investment and aggregate economic growth which further motivated researchers to unveil and decompose the relationship further and find out whether public investment,

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private investment and economic growth are correlated altogether. Majority of the studies followed, single equation analysis (Aschauer, 1989a) or cross-sectional analysis (Easterly and Rebelo, 1993) and found positive relationship among public investment and economic growth. Mustafa et al. (2002), in their study found negligible evidence of crowding-out effects of public expenditure on private investment and those results were not statistically significant in the long- run. However, in the short and medium term there was evidence of complementary relationship between private and public investment. Their findings suggested that, the relationship among private and public investment was affected by chronic macroeconomic stability that which reversed the long run relationship in the short and medium term.

Miguel (1994) conducted a study on whether public investment caused a crowding-in or crowding-out effect on private investment in Mexico and the results suggested that there was rather a crowding-in effect rather than a crowding-out effect. Bazaumana (2004), conducted a similar study using the Johansen Co-integration test and bound test approach to estimate the long run private investment function. Rahman et al. (2005), conducted research on the relationship among public investment and private investment and aggregate output on Bangladesh in both short and long run. The results suggest that there is the marginal productivity of private and public investment are different thus have a different effect on aggregate output on longer term and emphasized the role private investment more than public investment in the long run aggregate output growth of Bangladesh.

Various studies conducted from 2002 to 2010 show mixed results for the crowding-in and crowding-out effects on various economies. Among those researches, Voss (2002), conducted research for USA and Canada, Narayan (2004a) conducted research in Fiji, Mitra (2006) conducted research for India and Cavallo and Daude (2011) for 116 developing countries and found existence of crowding out effects whereas Aschauer (1989) in USA, Ramirez (1994) in Mexico, Martinez-lopez (2006) in Spain, Ang (2010) and Hatano (2010) in Japan found crowding-in effects. In Bangladesh, Majumder (2007) and Hassan and Salim (2011), conducted research regarding the investigation of crowding-in or crowding-out effects on Private investment. The studies however, showed different results as according to Majumder (2007) who conducted the test using Johansen Co-integration test method found evidence of Crowding-out effect in long term in Bangladesh, whereas, Hassan and Salim (2011), found crowding-out effects on private investment in both short and long terms. Thus, the effects of public investment on private investment is still in dispute and unclear. investment more than public investment in the long

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The study of Hassan and Salim (2011), considered a smaller sample size than it should as the number of observations were limited to 23 and didn't consider interest as one of the variables in their model and according to theory, crowding-out channels through increase in interest rates due to increased borrowing from public sector. The review of the various literatures widely suggests that, there is still no concrete theories or empirical evidence that support either the crowding-in or crowding out effect of public investment in both various developing countries and in Bangladesh. The relationship between public expenditure and private expenditure is widely affected by various other variables which in turn determine whether there is a crowding-out effect or crowding in effect and based on the results in Bangladesh, it can be said that the crowding-out or crowding-in relationship could change with the passage of time as various other variables affect the relationship, a prime example being the findings of Majumder (2007) supporting crowding-in effect whereas Hassan and Salim (2011) supporting crowding-out effects.

3. DATA AND METHODOLOGY

Data and variables

The data selected for this study is yearly in nature and the study considers a time period of 37 years spanning from 1981 to 2018. The reason behind conducting this study based on yearly data rather than quarterly data is the unavailability of quarterly interest rate, public sector investment and private sector investment data for this time period in reliable local and international sources. All the yearly data used in this study has been collected from the world Development Indicator (WDI) database of World bank for maintaining consistency of data in this extensive time horizon.

The study could have been made more comprehensive if the time period of data was longer, however, the categorical data of private sector and public sector gross fixed investment is not available before 1981, thus due to limitations of data availability the study has been conducted from 1981 to 2018. The variables mainly used in this study are Gross fixed capital private sector expenditure, Gross fixed capital public sector expenditure, Gross domestic product, trade liberalization (dummy variable) and lastly real interest rate. To remove the effects of inflation from affecting the long run relationship among the aforementioned variables, all the variables have been transformed in to real terms (Menon and Ng, 2013).

For transforming the nominal data into real terms all the variables were deflated inflation or percent change in GDP deflator. For the interest rate data, weighted average lending rates were collected from the WDI database and subsequently inflation was subtracted from the lending rates to arrive at real interest rates. The dummy variable used in the study, trade liberalization, was introduced to further decompose the relationship among the variables. According to Bangladesh Bank, Trade liberalization was introduced extensively in 1992 and therefore the dummy variable takes a value of 1 starting from 1992 until 2018 and a value of zero for time periods before 1992 to mark the inception of trade liberalization upon the aforementioned variables.

Table 1: Variable Definition.

Panel A: Independent Variables	
Variables	Details
Y	Nominal Gross domestic product deflated by yearly percent change in GDP deflator.

GI	Nominal Public sector gross fixed capital formation deflated by percent change in GDP deflator.
Rt	Weighted average nominal lending rates of commercial banks adjust by subtracting yearly percent change in GDP deflator.
Lib	Trade liberalization dummy variable taking values of 1 from 1992 and onwards and value of 0 otherwise.
(GI*Lib)	Interaction term between
Panel B: dependent Variable	
Variables	Details
PI	Nominal Private sector gross fixed capital formation deflated by percent change in GDP deflator.

Model Specification

The basic of this study is based on various literature and previous advancement made on this topic. One of the earlier studies that made a remarkable breakthrough in this regard and introduced a new concept of investment is the flexible accelerator model. According to this model, Investment can be defined as the rate of adjustment of the gap between the desired capital stock and the current or existing capital stock (Reil-Held, 2006). The flexible accelerator model is stated below-

$$I_t = \lambda(K^* - K_{t-1})$$

Here, I_t = Investment in current period, K^* = Desired capital stock and K_{t-1} = Capital stock at the end of the previous period. The term λ denotes the rate of adjustment between the desired capital stock and the capital stock at the end of the previous period. In the flexible accelerator model, the capital stock at the end of the previous period is known, however, the desired capital stock is not known and this variable is affected by the same variables that affect or induce investment. The level of desired capital stock for a country mainly depends on the level of output or GDP and rental cost of capital where the prior has a positive effect on capital stock and the latter has a negative effect.

Interest rates in the economy mainly work as a proxy for the rental cost of capital however, to adjust for effects of inflation; real interest rates can be used as a direct proxy for the actual rental cost of capital in an economy (Saidjada and Jahan, 2018). Thus, the flexible accelerator model considers GDP and real interest rates as the two key factors that mostly affect investment in 1993, however, Chirinko (1993), found the previously popular models of investment to be unsuccessful in real life empirical applications and thus it implied that the key factors affecting the investment were not complete. Voss (2002), also pointed out the lack of

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clarity of what actually determined the investment spending the in the theoretical models and found very little to no empirical evidence which could support the literature of the previous theoretical models (Singh, 2017). To bring more acceptability of the Flexible accelerator model a modified version of the model is used where a new independent or explanatory variable public investment is introduced in the model as in many of the literatures it has been suggested that public investment can have a big impact on the private sector investment of a country. Thus, the modified version of the Flexible accelerator model used in this study is presented below-

$$PI_t = \alpha_0 + \alpha_1 Y_t + \alpha_2 R_t + \alpha_3 GI_t + \varepsilon_t \dots \dots \dots (1)$$

Here, PI_t = Private Investment, Y_t = Real GDP, R_t = Real interest rate and GI_t = Public investment. The operators' α_0 , α_1 , α_2 , α_3 and ε_t are used to denote intercept, elasticity of private investment to GDP, elasticity of private investment to GDP, elasticity of private investment to government investment and error term. The elasticity of private investment to GDP is expected to be positive whereas the elasticity of private investment to real interest rate is expected to be negative. The elasticity of private investment to public investment has an extended explanation. A positive coefficient of α_3 means there is crowding in effect and the negative coefficient means there is a crowding out effect (Tan, Huang and Woo, 2016).

To have an extended idea about the determinants of private investment, further modifications have also been made to equation (1). In various literatures, it has been observed that the trade liberalization or liberalization of financial sector of a country has a big effect on all the major economic indicators. From the beginning period of 1990s liberalization of trade and financial sector of Bangladesh started to speed up rapidly. This positive effect of trade and financial sector liberalization is brought upon private investment through establishment of international financial and trade relationship and increased foreign direct investment and portfolio investment in the country. It also increases domestic savings that further stimulates domestic investment in private sector and increases flow of capital in the economy. Thus, the effects of trade liberalization can a significant explanatory factor in the determinants of private investment. Thus, to replicate the trade liberalization a dummy variable Lib is introduced in the equation (1). The modified version of equation is presented below-

$$PI_t = \alpha_0 + \alpha_1 Y_t + \alpha_2 R_t + \alpha_3 GI_t + \alpha_4 lib_t + \varepsilon_t \dots \dots \dots (2)$$

In the modified equation above, all the variables are same as described earlier, however, the dummy variable Lib is expected to have a positive coefficient which indicates a there is a positive impact of trade

liberalization on private investment. Besides the direct effects of trade liberalization on private investment, according to various literature, trade liberalization also affects the public investment elasticity of private investment. Thus, due to effects of liberalization on public investment, public investment may affect private investment in a different way in a liberalized environment compared to a non-liberalized environment. Thus, to measure the effects of liberalization on public investment a further modification is done to equation (2) by introducing a new variable named (Lib*GI) which is an interaction term between trade liberalization and public investment. Various researchers including, Rajan and Zingales (2003), Castro, Clementi and McDonald (2004), Caprio, Laeven and Levine (2007) and Giuliano and Ruiz-Arranz (2009) have used this term in their studies. After the modification the final form of the equation is presented below-

$$PI_t = \alpha_0 + \alpha_1 Y_t + \alpha_2 R_t + \alpha_3 GI_t + \alpha_4 lib_t + \alpha_5 (Lib * GI)_t + \varepsilon_t \dots \dots \dots (3)$$

In the above equation, all the variables mentioned are same as previously explained in equation(2) except the interaction Term α_5 which is elasticity of private investment to interaction of trade liberalization and public investment. If the term $\alpha_5 > 0$ then there is evidence of increasing crowding-in effect or decreasing crowding-out effect. However, if $\alpha_5 < 0$ then this indicates liberalization strengthens the crowding-out effect or mitigates the crowding-in effect.

Test Methodology

As the study mainly focuses to describe the effects of sustained budget deficit or government borrowing on private sector investment, before going deep in the study, the characteristics of the dataset needed to be analyzed and appropriate model needed to be selected based on the characteristics of the dataset. Being time-series data in nature, at first the dataset needs to be tested for whether the data is non-stationary or the mean, variance and important characteristics of the dataset is not constant over time or rather dynamic in nature and show spurious autocorrelation among the variables which indicate false relationship among the variables predicted by the variable (Alam and Rashed, 2011). As most of the models for analyzing time series assume that the data series used is stationary at first.

Unit root tests - Phillips-Perron Unit root test

For unit root test, the most popular test is the Augmented Dickey fuller test. However, the augmented dickey fuller (ADF) test has some limitations and the major limitations pertaining to the nature to the nature of the data used in this study is the inability to consider structural breaks

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in time series data while measuring unit roots. Traditional unit root tests like ADF tests have a tendency to not rejecting the null hypothesis of unit roots while dealing with datasets with structural breaks. As a major variable in the study, Trade liberalization addresses the issue of structural break in the data, it is necessary to perform a unit root test that overcome this limitation and, in this case, the Phillips – Perron unit root test developed by Peter C. B. Phillips and Pierre Perron in 1989 comes into consideration. The Phillips-Perron test is not free from criticism and as a number of researchers pointed out that the original study considered the breakpoint in the dataset to be exogenous where in many case the break date or period of break date is actually known by the researcher and thus in this case the critical values generated by the original model are based on the asymptotic theory that break dates are rather exogenous and not correlated with the data. Later in 1997, a new a modified version of the model is was published which considered for endogenous breaks in the dataset (Biplob, 2019).

As in trade liberalization, mostly accelerated in 1992 and the whole Bangladesh economy went through reform in the 1990's it is quite realistic to assume that there is a structural break in our dataset and this structural break is endogenous. This in this study, the modified version of Phillips-Perron test in 1997 is used to test the unit root. According to this model there are two types of structural breaks that can remain in the data set. One is Innovative Outlier (IO) and Additive outlier (AO). These two structural breaks mainly explain the speed of the break that occurs after a series of shocks. According to the IO model, the structural break occurs slowly over time while according to AO model, the structural break occurs instantly. As discussed earlier that there was a reform from 1991 through 2000 in the Bangladesh economy, the model used for the unit root test is the Innovative outlier model of Phillips-Perron test (Hebous and Zimmermann, 2010).

Short run and long run relationship tests – Autoregressive Distributed Lag (ARDL) and Error Correction model(ECM)

Based on the results of Unit root tests, appropriate models are selected to analyze the short run and long run relationship among the variables and the aforementioned equations. While conducting, regression analysis using ordinary least square method or other co integration tests like Engle and Granger (1987) test or Johansen and Julius (1990) test, there are a number of limitations that contradict with this nature of study and its dataset. The first, limitation is that, in case of traditional co-integration tests, all the variables need to be co integrated in the same level or order. That is all the variables need to be at level or all the variables need be at

the 1st difference or 1st order. If there is an exception, in that case these tests cannot produce valid results (Islam, 2011). The second limitation is that all the variables should have the same number of lags or in other words different variables cannot take different lags and because of that the relationship among the variables may not be explained properly as different variables maybe stationary at different lags by nature. The third limitation related to the study is that, the study includes various endogenous regressors and in the presence of various endogenous regressors, other models can output contradictory long-term coefficients as those models consider the presence of exogenous regressors rather than endogenous regressors. In this case the long-term coefficients produced by the models can seem biased (MOHANTY, 2016). The fourth and a major limitation of traditional regression and co-integration is the inability to consider dummy variables in the study and generating invalid values in presence of dummy variables in the study and this study includes a dummy variable named “Trade liberalization”.

All the aforementioned limitations can be overcome with the use of “Autoregressive distributed lag (ARDL)” model. ARDL model not only is able to consider variables with different integration orders, different number of lags for variables, can generate valid t-statistic in presence of endogenous variables and can generate valid critical values in presence of dummy variables, this model can generate estimates of long term and short term coefficients that help explain the nature of the relationship among the variables in an expansive manner compared to other traditional models and also removes autocorrelation and issues related to omitted variables. In this study, the first step related to ARDL bound testing approach is to estimating conditional unrestricted error correction model using ordinary least square method. The error correction model equation can be expressed for all the equations in the following form-

$$\Delta PI_t = \beta_0 + \sum_{i=0}^p \phi_i \Delta PI_{t-i} + \sum_{i=0}^p \theta_i \Delta Y_{t-i} + \sum_{i=0}^p \lambda_i \Delta GI_{t-i} + \sum_{i=0}^p \gamma_i \Delta R_{t-i} + \delta_1 PI_{t-1} + \delta_2 Y_{t-1} + \delta_3 GI_{t-1} + \delta_4 R_{t-1} + \varepsilon_t \dots \dots \dots (4)$$

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Here, in these three above equations, PI, Y, GI are natural logarithm of private sector investment, Gross domestic product, Public sector investment and R is real interest rate and Lib is Trade liberalization which is a dummy variable and (Lib*GI) is an interaction term between trade liberalization and public sector investment. The operator Δ denotes the first difference of the variables and p denotes the maximum number of lags for the variables (Mwigeka, 2016). While conducting the ARDL bound testing approach, the first step is to measure the joint significance of the variables based on upper and lower bound critical values. For this process, Equation (4), (5), (6) is estimated using OLS method then F-test is conducted to measure the joint significance of the coefficients of the lagged level of the variables in the equations.

Before going to the OLS estimation and F-test for joint significance, the optimum number of lags for each of the variables needs to be determined. To determine the optimum of lags for all the variables for each equation, the standard vector auto regression model (VAR) is used where the variable for which the lag is being determined is selected as the endogenous variable and all other variables in the equation are selected as exogenous variables (Njiforti and Muhammad, 2011). Afterwards the lag structure for the vector auto regression model is analyzed to select the maximum number of lags for each variable in the equation. The maximum lags are selected based on Schwarz Bayesian Criterion (SBC) as according to Pesaran and Shin, 1999, SBC gives 1 slightly better results in majority of the tests. After determining the maximum number of lags for all the variables, the OLS estimation and F-test is conducted where the null hypothesis is that there is no co-integration or long run relationship among the variables or $\delta_1 = \delta_2 = \delta_3 = \delta_4 = \delta_5 = \delta_6 = 0$ and alternative hypothesis of co-integration among the variables or $\delta_1 \neq \delta_2 \neq \delta_3 \neq \delta_4 \neq \delta_5 \neq \delta_6 \neq 0$.

The test is conducted using E-views statistical software. According to Pesaran et. al. (2001), the test results show two sets of critical values for the co-integration F-test. The first set of critical values show the lower critical value bounds assuming all the independent variables are integrated at level or I(0) and the other set of critical values the upper bound of critical values that assume all the independent variables are integrated at the first level or I(1). When, the results of the F-test are lower than the lower critical value bounds or I (0), then the null hypothesis of no co-integration or long term relationship cannot be rejected and on the other hand, if the F-test value is higher than the higher critical value bounds then the null hypothesis of no co-integration among the variables can be rejected and there is evidence that there is indication of long term relationship among the variables (Rahman, 2017). However, If the F-test value is in between the lower and upper critical value bounds, then additional diagnosis is

required for the integration level of the variables to come upon a conclusion. If there is evidence of co-integration in the previous test conducted, the next step is to estimate the ARDL long run model for the long run relationship among the variables. The ARDL long run equation for equation (1), (2) and (3) is given below-

$$PI_t = \beta_1 + \sum_{i=0}^l \phi_{1i} PI_{t-i} + \sum_{i=0}^m \theta_{1i} Y_{t-i} + \sum_{i=0}^n \lambda_{1i} GI_{t-i} + \sum_{i=0}^q \gamma_{1i} R_{t-i} + \varepsilon_{1t} \dots \dots \dots (7)$$

$$PI_t = \beta_1 + \sum_{i=0}^l \phi_{1i} PI_{t-i} + \sum_{i=0}^m \theta_{1i} Y_{t-i} + \sum_{i=0}^n \lambda_{1i} GI_{t-i} + \sum_{i=0}^q \gamma_{1i} R_{t-i} + \sum_{i=0}^s \zeta_{1i} Lib_{t-i} + \varepsilon_{1t} \dots \dots \dots (8)$$

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Here, l, m, n, q, s, and u are used to denote the number of lags for each variable. The third and final stage of the ARDL bound testing approach is to estimate the short run relationship among the variables using the error correction model (ECM) approach. The error correction form shows the lagged levels of the variables and shows the short run relationship among the variables in each equation. The error correction model form for each of the equations is presented below-

$$\Delta PI_t = \beta_2 + \sum_{i=0}^p \phi_{2i} \Delta PI_{t-i} + \sum_{i=0}^p \theta_{2i} \Delta Y_{t-i} + \sum_{i=0}^p \lambda_{2i} \Delta GI_{t-i} + \sum_{i=0}^p \gamma_{2i} \Delta R_{t-i} + \Psi ECM_{t-1} + \varepsilon_{2t} \dots \dots \dots (10)$$

$$\Delta PI_t = \beta_2 + \sum_{i=0}^p \phi_{2i} \Delta PI_{t-i} + \sum_{i=0}^p \theta_{2i} \Delta Y_{t-i} + \sum_{i=0}^p \lambda_{2i} \Delta GI_{t-i} + \sum_{i=0}^p \gamma_{2i} \Delta R_{t-i} + \sum_{i=0}^p \zeta_{2i} \Delta Lib_{t-i} + \Psi ECM_{t-1} + \varepsilon_{2t} \dots \dots \dots (11)$$

$$\Delta PI_t = \beta_2 + \sum_{i=0}^p \phi_{2i} \Delta PI_{t-i} + \sum_{i=0}^p \theta_{2i} \Delta Y_{t-i} + \sum_{i=0}^p \lambda_{2i} \Delta GI_{t-i} + \sum_{i=0}^p \gamma_{2i} \Delta R_{t-i} + \sum_{i=0}^p \zeta_{2i} \Delta Lib_{t-i} + \sum_{i=0}^p \eta_{2i} \Delta (Lib * GI)_{t-i} + \Psi ECM_{t-1} + \varepsilon_{2t} \dots \dots \dots (12)$$

In the equations above, the coefficients of the short run model show the short run dynamics of the variables while converging to equilibrium in the short run and the term Ψ is used to denote the speed of adjustment to short run equilibrium. All the tests mentioned above have been performed using E Views statistical software (Saidjada and Jahan, 2018).

4. EMPIRICAL ANALYSIS AND RESULTS

Results of unit root test – Phillips-Perron Test

The unit root tests are conducted to know the appropriate level of integration of the variables to perform the appropriate co-integration tests. Thus, the main purpose of the unit root tests is to identify whether all the variables are at I(0) or all the variables at I(1) and if the variables meet these criteria then the Johansen or Engle-Granger co-integration tests can be used. If some of the variables are at I(0) and some of the variables are at I(1) then, ARDL bound testing approach to co-integration has to be used. If any of the variables are at I(2) then neither of the above mentioned tests can be used and a different methodology have to be followed. The variable private investment is integrated at I (1). According to the innovative outlier model, at level, the variable private investment has a test statistic of -3.078 whereas the critical value at the 10% significance level is -4.193 and the P-value is 0.6. Thus, even at the 10% significance level the null hypothesis of the variable PI has a unit root could not be rejected at I(0) (Alam and Rashed, 2011).

However, the variable PI has a test statistic of -10.35 and the critical value at the 1% significance level is -4.94 and the P-value is less than 0.01 thus, the null hypothesis of the variable PI has a null hypothesis at I(1) can be rejected with high degree of confidence. The variable total output or GDP is integrated at I (1). According to the innovative outlier model, at level, the variable GDP has a test statistic of -3.440 whereas the critical value at the 10% significance level is -4.193 and the P-value is 0.41 (Biplob, 2019). Thus, even at the 10% significance level the null hypothesis of the variable Y has a unit root could not be rejected at I (0). However, the variable Y has a test statistic of -10.20 and the critical value at the 1% significance level is -4.94 and the P-value is less than 0.01 thus, the null hypothesis of the variable Y has a null hypothesis at I(1) can be rejected with high degree of confidence.

The variable government investment is integrated at I (1). According to the innovative outlier model, at level, the variable government investment has a test statistic of -3.06 whereas the critical value at the 10% significance level is -4.193 and the P-value is 0.64. Thus, even at the 10% significance level the null hypothesis of the variable GI has a unit root could not be rejected at I (0). However, the variable GI has a test statistic of -8.76 and the critical value at the 1% significance level is -4.94 and the P-value is less than 0.01 thus, the null hypothesis of the variable GI has a null hypothesis at I (1) can be rejected with high degree of confidence. The variable Real interest rate is integrated at I (0). According to the

innovative outlier model, at level, the variable R has a test statistic of -5.21 and the critical value at the 1% significance level is -4.94 and the P-value is less than 0.01 thus, the null hypothesis of the variable R has a null hypothesis at I (0) can be rejected with high degree of confidence (Hebous and Zimmermann, 2010).

Table 2: Results of Phillips-Perron Unit root test.

Variable	Number of lags	Break date	T-statistic	Result
PI	0	1990	-3.07	
Δ PI	7	1993	-10.35 ^{***}	I (1)
Y	0	1990	-3.44	
Δ Y	9	1993	-10.20 ^{***}	I (1)
GI	0	1990	-3.06	
Δ GI	0	1996	-8.76 ^{***}	I (1)
R	0	1985	-5.21 ^{***}	I (0)
(***), (**), (*) coefficients are significant at 1%, 5%, 10% significant level.				

Test for existence of long run relationship and Lag length selection for variables

Test for existence of long run relationship

For equation 1, the maximum number of lags was restricted to 2 and the results suggest that, even at the 1% significance level, the F-statistic value of 5.95 is greater than the upper bound critical value, thus it can asserted with significance that for model 1, the null hypothesis of no co-integration can be rejected and there is existence of long run relationship among the private investment and other regressors of the equation 1 or model 1 (MOHANTY, 2016). For equation 2, the maximum number of lags was restricted to 2 and the results suggest that, even at the 1% significance level, the F-statistic value of 19.02 is greater than the upper bound critical value, thus it can asserted with significance that for model 2, the null hypothesis of no co-integration can be rejected and there is existence of long run relationship among the private investment and other regressors of the equation 2 or model 2. For equation 3, the maximum number of lags was restricted to 2 and the results suggest that, even at the 1% significance level, the F-statistic value of 21.69 is greater than the upper bound critical

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value, thus it can be asserted with significance that for model 3, the null hypothesis of no co-integration can be rejected and there is existence of long run relationship among the private investment and other regressors of the equation 3 or model 3.

Lag structure of the models

For the selection of the lags in each of the models for both the independent and dependent variable, either Schwarz Bayesian Criterion (SBC) or Akaike Information Criteria (AIC) (Mwigeka, 2016). However, as discussed earlier in majority of the models SBC gives a better estimate of F-statistic compared to AIC thus, for selection of lag structure The SBC criteria has been used, however, the maximum number of lags for the models have been limited to 2 because of the integration level of the models and as majority of the studies conducted previously also limited the number of lags for yearly data to 2.

ARDL bound testing – Long-run model

Based on the results of the long run coefficients of Equation 1, it can be said that, GDP and Government investment has a positive but insignificant impact on the Private sector investment in Bangladesh. However, there is a negative relationship among the private investment and real interest rate (Njiforti and Muhammad, 2011). Thus, according to the flexible accelerator model, there is presence of slight crowding-in effects in the absence of trade liberalization. Based on the results of the ARDL long-run estimates of equation 2, there is a positive relationship among aggregate output and trade liberalization with private investment and negative relationship with Government investment and real interest rate. The P values of all the coefficients are significant at the 1% significance level, meaning all the results of the coefficients are highly reliable.

Based on the results, it can be said that aggregate output exerts a significant positive effect on the private investment growth and 1% increase in Aggregate output leads to 1.45% increase in private investment and real interest rate and Government investment has a negative impact on private investment thus, 1% increase in real interest rate leads to a 1.58% decrease in private investment and a 1% increase in government investment leads to a 0.41% decrease in Private investment. The negative coefficient of Public investment also indicates that public investment crowds out private investment (Rahman, 2017). The positive coefficient of trade liberalization indicates that the approximate impact of presence of trade liberalization is 0.442% higher private investment compared to trade liberalization not being present. Based on the results of the ARDL long-

run estimates of equation 3, there is a positive relationship among aggregate output and trade liberalization with private investment and negative relationship with Government investment and real interest rate and the trade interaction term between liberalization and public investment. Based on the results, It can be said that Aggregate output exerts a significant positive effect on the private investment growth and 1% increase in Aggregate output leads to 1.38% increase in private investment and real interest rate and Government investment has a negative impact on private investment thus, 1% increase in real interest rate leads to a 2.43% decrease in private investment and a 1% increase in government investment leads to a 0.23% decrease in Private investment. The negative coefficient of Public investment also indicates that public investment crowds out private investment (Saidjada and Jahan, 2018).

The positive coefficient of trade liberalization indicates that the approximate impact of presence of trade liberalization is 2.4% higher private investment compared to trade liberalization not being present. The interaction term between public investment and trade liberalization is also negative indicating that, the interaction further reinforces the crowding-out effects exerted by public investment. Thus, Trade liberalization affects Private investment both directly and indirectly and the indirect effect reinforces the direct effect of crowding out.

ARDL bound testing – Short-run model

This part of the Testing discusses the ARDL short-run model coefficients. The relationship among the variables in various equations can differ in short-run compared to long-run estimates thus, diagnosis of the short-run coefficients of the equations is necessary to unveil the complete nature of the relationship among the variables in all three equations (Alam and Rashed, 2011). The short-run coefficients of equation (1), (2) and (3) are discussed in detail in the following section. Based on the results above, in short run private investment is positively affected by aggregate output and negatively affected by public investment.

The effects of real interest rate are same at level and at lag1 and negatively affects private investment. The effects of real interest rate become stronger and significant compared to weaker and insignificant effect at level (Biplob, 2019). This is due that, the effects of real interest rate take some time reflect on the economy and another intuition is that real interest rate has the ability to significantly affect private investment in long run if the increase is persistent. Thus, the short-run coefficients are almost same as the long run coefficients of equation 1 with the exception

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of public investment coefficient being positive but insignificant in the long run. Based on the results, in presence of trade liberalization, aggregate output has a positive significant and large immediate impact on Private investment; however, this large impact is partially mitigated in the lagged variable of aggregate output (Hebous and Zimmermann, 2010). This is because, after the initial large impact of GDP on private investment the investors overreact and tries to cross the potential private investment, however, at lag one the economy slightly slows down to meet the equilibrium long run estimates of private investment. The overall effect of aggregate output is positive in the long run.

The short run impact of Public is significantly negative, however the effect of public investment infrastructure come with a lag thus the lagged variable of public investment is positive and mitigates initial crowding out effect in the long run. The overall public investments are negative in the long run. The effects of trade liberalization are same as aggregated output with slightly positive effect immediately and negative effect on the lagged variable (Islam 2011). Based on the results, Aggregate output has an immediate and big positive impact on private investment however, the initial overreaction is mitigated with the lagged variable and smooth out the initial effect, and however, the overall effect of aggregate output on private investment is positive. The immediate and long run effects of real interest rate on private investment are negative and significant.

The effects of public investment on private investment immediately is negative, however due to lagged positive effects bearing from public infrastructure on private investment the initial effect of crowding-out slightly mitigated, however, the overall effects show crowding-out effects in the long run. The initial effect of trade liberalization is positive and the interaction term between public investment and trade liberalization show immediate and long-term negative impact on private investment which is also similar to the long run coefficients (MOHANTY, 2016). The overall short-run effects resemble the long run coefficients of the ARDL study further supporting the findings in previous section.

Summary and analysis of Results

Table 3: Summary results of ARDL bounding testing.

Dependent Variable:	Regression Coefficients		
Private Investment	Model 1	Model 2	Model 3
Long-Run Relationship			
Constant	-9.83 (-2.24) **	-7.54 (-8.28) ***	-7.26 (-3.71) ***
Y	0.58 (0.40)	1.54 (12.54) ***	1.38 (6.69) ***
GI	0.76 (0.51)	-0.41 (-3.70) ***	-0.24 (-1.05)

R	-0.43 (-0.08)	-1.58 (-2.96) ***	-2.43 (-2.37) ***
Lib	-	0.43 (5.64) ***	2.4 (0.78)
(GI*Lib)	-	-	-0.06 (-0.59)
Short-Run Relationship			
ΔY	1.39 (21.06) ***	1.44 (37.63) ***	1.31 (38.25) ***
$\Delta Y (-1)$	-	-0.18 (-4.46) ***	-0.10 (-2.71) ***
ΔGI	-0.38 (-5.61) ***	-0.37 (-9.80) ***	-0.21 (-4.75) ***
$\Delta GI (-1)$	-	0.19 (4.87) ***	0.13 (3.30) ***
ΔR	-0.13 (-0.67)	-0.67 (-5.45) ***	-0.92 (-7.45) ***
$\Delta R (-1)$	-0.44 (-3.52) ***	-0.57 (-5.25) ***	-0.47 (-4.86) ***
Δlib	-	0.03 (1.66)	1.98 (5.84) ***
$\Delta lib (-1)$	-	-0.26 (-7.36) ***	-
$\Delta (GI*Lib)$	-	-	-0.07 (-5.68) ***
$\Delta (GI*Lib) (-1)$	-	-	-0.01 (-5.99) ***
CointEq (-1)	-0.06***	-0.32***	-0.22***
Values in the parenthesis indicates the t statistic, values in the brackets [] are p values of F statistics, (***),(**),(*) coefficients are significant at 1%, 5%, 10% significant level.			

The overall results from all the equations show that, there is crowding-out effect on the longer term and in shorter-term. Initially, the concept of crowding out is connected with decreases in private investment due increases in the real interest rate in the economy caused by increased public borrowing. Here, in model 3 in presence of trade liberalization and interaction between public investment and trade liberalization, the result suggests that in long run, 1% increase in public investment decreases private investment by almost 0.24%-0.41%, whereas, 1% increase in real interest rate leads to a 1.58% to 2.43% decrease in private spending. As, Private spending is highly sensitive to real interest rate, it could be a significant determinant of private spending, but could not be the only deciding factor or channel of crowding-out effect persistent in the economy (Mwigeka, 2016).

In majority of the developing economies a major constraint in private spending is the availability of credit in the financial system rather than the real interest rate due to the robust growth of GDP which Bangladesh is currently experiencing. The mechanism through which the real interest rate is determined is also a key factor affecting private investment in an economy. If the there is any kind of intervention on interest rate determination rather than pure market forces then the availability of credit becomes an even more crucial factor in investment rather than the real interest rate. However, due to some distortions present in the capital market and financial market in distribution of credit and funds stemming

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from government intervention in many cases such as credit disbursements to selected sectors, Bangladesh Bank's intervention in interest rate determination of various selective sectors, information asymmetry, existence of large informal credit market alongside formal credit market and high interest rates of government savings certificates compared to formal lending rates in market (Njiforti and Muhammad, 2011). The current liquidity crisis in banks also reinforces the crowding out-effects in the economy alongside the constraints imposed by the availability of credit rather than the real cost of borrowing persistent in the market and thus is expected to have a much larger explanatory power in explaining the crowding-out effect rather than the real interest rates. In, Bangladesh, the government is capable of meeting increased government expenditure through circulation of savings certificate and more borrowing ability from the banking system which may have a negative impact in availability of credit to private sector and lead to crowding-out of private investment (Rahman, 2017).

Another significant phenomenon in recent years is that, government is focusing on increased public sector investment to sustain the Higher GDP growth which may have a long-term effect on both fiscal and monetary policies. As the results of the study suggest that there is presence of crowding-out effects in Bangladesh, a major portion of the public investment has been spent towards unproductive and consumption rather than capital investment of productive nature. Thus, rather than lowering the real interest rates to stimulate private sector investment it is suggested to focus on strengthening the credit availability rather than cost of credit. Government should also focus on selective public investment that maximizes the social spillover effects and productivity and implementation of the current projects and as trade liberalization has an extensive impact stimulating private investment, government should work towards easing the impediments of international trade and financial deregulation to reap the beneficial effects of trade liberalization (Saidjada and Jahan, 2018).

5. CONCLUSION

Currently Government is focusing on increased public sector investment to sustain the Higher GDP growth which may have a long-term effect on both fiscal and monetary policies. As the results of the study suggest that there is presence of crowding-out effects in Bangladesh, a major portion of the public investment has been spent towards unproductive and consumption rather than capital investment of productive nature. Thus, rather than lowering the real interest rates to stimulate private sector

investment it is suggested to focus on strengthening the credit availability rather than cost of credit. Government should also focus on selective public investment that maximizes the social spillover effects and productivity and implementation of the current projects and as trade liberalization has an extensive impact stimulating private investment, government should work towards easing the impediments of international trade and financial deregulation to reap the beneficial effects of trade liberalization. From policy perspective, there is need for intensified efforts to strengthen government revenue mobilization and government savings so as to finance the needed expansion in economic and social infrastructure, while at the same time ensuring reduction in the budget deficits. There is need also for more effort from the government to improve on the budgeting process and financial planning as well as management practices to bring about a significant reduction in the level of budget deficits.

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