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Impulse Response of External Debt Stock and Gross Capital Formationon Economic Growth in Bangladesh: Var Model, Granger Causality and Variance Decomposition Analysis

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ABSTRACT

Purpose: This study employs an annual time series data set from 1987 to 2018 gathered from the World Development Indicators (WDI), 2021 to analyze the properties of external debt stock on financial progress (proxied by economic growth) in Bangladesh.

Methodology: The objectives are determined using a variety of econometric techniques, including the Phillips-Perron (PP) unit root test, Var model, Johansen co integration test, Impulse Response Function (IRF), Variance decomposition function, and Granger causality test. The get the result of the Phillips-Perron (PP) unit root test which indicates the stationarity of all the variables at the initial difference.

Findings: There is an expectant impact on financial progress (proxied by Gross Domestic Product Per capita) in Bangladesh, according to the short run Var model with the two independent variables External Debt Stock (proxied by public debt) and second lag of Gross Fixed Capital. Block Exogeneity/ Wald Tests and Johansen Co-integration test show that both lnEDS and lnGCF have a strong constructive impact on Bangladesh's financial progress in the short as well as long run. Pairwise, Granger Causality also indulgence the Bi-directional causality between lnGDPPC and lnEDS and Uni-directional causality from lnGCF to lnGDPPC. The influences of lnEDS and lnGCF on lnGDPPC are rising in the long term, showing that both variables are significantly exogenous on the dependent variable.

Practical Implication: Bangladesh is now a fast-growing economy with several megaprojects for infrastructural, human, and technological advancements such as roads, train, power, education, health, information technology, gas, and energy. External debt service and gross capital formation are crucial for Bangladeshi economic growth. The government should establish a priority aim for long-term economic growth by implementing suitable measures to control, maintain, regulate, and stabilize inflation at a reasonable level.

Originality/Value: In a developing country, Savings within the country are insufficient to support investment for financial progress, according to the dual-gap theory and the Keynesian theory of public debt. As a result, bridging this gap for the required level of investment and achieving targeted economic growth will necessitate a bigger inflow of foreign aid or external borrowings. That's why this study is very important.

Limitations: Some limitations of this study include the absence of recent data with the factors. Also numerous factors can influence Bangladesh economic growth for instances, remittances, exchange rates and foreign direct investment all have acrucial impact on GDP growth.

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1. Introduction

Bangladesh's economy is categorized as a developing country, with eleven emerging market economies of medium income and an edge market. Along with the growing economic countries, Bangladesh remained the world's sixth fastest-growing economy in the first quarter of 2019, rising at yearly rate of 8.3 percent real GDP. Unfortunately, in consequence of the detrimental impact of the Covid-19 pandemic, the country's monetary growth has halted. According to BBS's tentative estimate, per capita GDP and per capita national income in FY 2020-2021 were US$2097 and US$2227, respectively. The inflation rate in FY 2019-20 was 5.65 percent. Domestic savings accounted for 24.17 percent of GDP, national savings accounted for 30.39 percent of GDP, and gross investment accounted for 29.92 percent of GDP. (Bangladesh Economic Review, 2021).

Every nation's economy needs a certain amount of funding to invest in a range of development projects, including constructing government buildings, water and sanitation systems, water and rail networks, ports, and energy-generating plants. It also needs funding to fund pensions that benefit not only retirees but also the society as a whole with benefits that can last a lifetime (Origin et al., 2021). A government has a budget deficit when its spending exceeds its tax receipts. To close this gap, it can raise taxes, print money, borrow domestically or abroad, or use prior budget surpluses. To make up for its budget shortfall, a government may choose to borrow instead of implementing new taxes, but doing so results in an obligation known as a debt. (Origin et al., 2021)

Many empirical researchers have discovered that, in many nations, public debt and government investment have a favourable or negative stimulus on financial progress that is true both in the short as well as long run. When it comes to the affiliation among the economic growth and external debt, an appropriate level of deriving is expected to facilitate financial growth through productivity growth and capital accumulation (Chowdhury, 2001). The rate of investment is another crucial factor for a nation. While countries with low investment rates suffer gradual growth, those with high investment rates experience rapid growth (Tawiri, 2010). According to Ajayi, developing nations frequently take on debt because they are at a point in their growth where they need more help. As a result, public debt is a way by which the savings-investment gap is related and delivering additional investment required to achieve the desired economic growth. Siddiqui and Malik claim that resource availability increased by the foreign borrowing and supported South Asia's economic expansion.What is known as the debt cycle analyses the purpose of governmental debt. Countries borrow in the first stage to provide more resources for expansion. They are now able to place on their particular. Preliminarily they get to the second stage, they are still borrowing since there is a chance that the surplus won't be enough to pay the interest. They would have accumulated enough extra funds in the third stage to pay off their debts. As a result, to assist beneficiary countries in developing, maintaining, and accelerating their economic growth is the goal of public debt while also repaying the loans using the proceeds. Debt have to be properly managed if it is to be eliminated and the resources must be allocated so that they will be used sensibly and effectively. (Origin et al., 2021)

According to Cecchetti, a two-edged sword is debt. By way of, when utilized properly, it can promote well being, but when used poorly, it can be disastrous. This avowal suggests that borrowing is only appropriate in specific conditions during recessions, and that governments should be cautious when designing debt policies. Ogunjimi (2019) believes that if the government takes on realistic public debts, economic activity and growth will most certainly improve. However, whether or not public debt leads to economic growth will be determined to a considerable measure by the direction of government spending. If the public debt is not suitably handled, there could have an adverse impact. It can result in a public debt ceiling or debt overhang, which might raise interest rates, increase inflation as well as stifle private investment, (Boccia, 2013). Taking higher interest rates because of skepticism about the country's ability to repay its obligations.

2. Theoretical Background

2.1 The Dual Gap Theory

This theory advocates for the use of external borrowing to fund capital expansion, particularly in developing and impoverished countries. Because of a lack of savings and capital accumulation, developing countries face two constraints: the savings-investment gap and the foreign exchange gap, which is the theory's central notion. The modification between domestic savings and the required level of investment represents the savings investment gap. When net export profits fall short then the foreign exchange necessities, foreign exchange gap occurs. (Jhingan, 2017).

In the terms of national income secretarial characters, the two gaps are explained as follows:

$$\mathbf{E - Y \equiv I - S \equiv M - X \equiv F} \qquad (1)$$

Where, E = national expenditure, Y = national output and income, I = Investment. S = Savings, M = Imports, X = Exports, and F = Net capital inflow.

Savings within the country are insufficient to support investment for financial progress, according to the dual-gap theory. As a result, bridging this gap for the required level of investment and achieving targeted economic growth will necessitate a bigger inflow of foreign aid or external borrowings.

2.2 Keynesian Theory of Public Debt

In 1935, John Maynard Keynes proposed the public debt theory, arguing that debt does not stifle an economy's growth and development, but rather adds more value to it provided it is channeled toward capital development, which yields profit and improves financial development. (Kur et al., 2021).

2.3 Empirical literature Survey

Saifuddin (2016) worked with the Two States list square regression method to inspect the relationship of public debt growth in Bangladesh. The results showed that the government borrowing heighten investment and also financial progress. The experimental discoveries advised that these advances are blessing to financial progress completed their optimistic outcome on investment.

Odubuasi, Uzoka and Anichebe (2018) scrutinized the affiliation involving Nigerian financial progress as well as external turn on debt. While the cost of servicing debt has no bearing on the rate of economic growth, capital investment and debt stock were once thought to be positively significant to growth.

Owusu-Nantwi and Erickson (2016) scrutinized the affiliation amongst debt profile and financial progress of Ghana. They used Johansen co-integration and VECM and used data spanning from 1970 to 2012 to demonstrate the long-term as well as causal relationship among the studied variable. The outcome of their investigation revealed a bi-directional causality between public debt and financial progress in the short run as well as in the long run they investigated a long run positive also robot affiliation linking financial progress.

Rahman (2015) examined the affiliation between investment and economic development in Bangladesh. He employed some econometrics approach like the ADF test, Granger Causality test and co-integration using time-series from 1987 to 2011. The experimental outcomes ascertain that public debt has anoptimistic and noteworthy impact on GDP.

Uddin, Chowdhury, and Uddin (2015) used yearly data for the years 1972 to 2011 and performed analyses using Ordinary Least Squares, Jarque- Bera Test, ADF co-integration, and Pagan Godfrey test. Their empirical results showed that economic prosperity in Bangladesh results from governmental investments.

Norman and Sabahat (2017) had inspected the investment -growth association and conveyed that the investment pointedly boosted the economic growth.

Sánchez-Juárez and Garca-Almada (2016) used different econometric models to scrutinize the connection between debt, investment, and financial progress in the economy of Mexico. The goal of the study was to see if state governments had a high debt profile when it came to public investment. If this occurs, would the 32 states of Mexico see an increase in growth along with an increase in public investment? Their research indicates that public debt has a favourable and substantial connection with public investment, which fosters economic expansion. They recommended that, because growing public debt fascinates greater public investment, there should be conscious and strong intensive care of the multiplier effects to a given age effectiveness.

In Pakistan, Khan, Rauf, Mirajul and Anwar (2016) developed the ARDL model to investigate the overtone between fastening financial progress as well as public debt between 1970 to 2013. The answers concluded with a low optimistic affiliation among economic growth as well as public debt. Selimaj, statovci, lokaj, and beqiri (2020) pointed out that cautious use of public debt can promote financial progress as well as financial solidity in relation to debt-growth leakage in Kosovo. The misuse of it, however, will have an adverse impression on the economy of the nation by causing inflationary pressure.

Nacnywa and Masog (2018) studied how public investment as well as economic growth are affected by public debt between the period of 1995 and 2016. Among other econometric methods, they applied a structural analysis *(Granger causality, variance decomposition, and impulse response function)* autoregressive distributive lag model. A long-time inverse bond between public debt and investment was found via the co-integration test. The empirical data demonstrate an undesirable link between the public debt-economic growth nexus due to the direct relationship between investment and financial progress. This process can achieve equilibrium at a rate of 17% thanks to the verification of the error correcting mechanism. There was a bidirectional casual association of public debt as well as economic growth. According to the Impulse Response Function (IRF), a one standard deviation shock wave to the public debt would have a optimistic influence on economic evolution. According to the consequences of the variance decomposition, changing economic growth are responsible for the 16.39% stake in the public debt.

Akomolafe, et. al. (2015) used data from 1980 to 2010 and employed the Johansen co-integration test and VECM model to examine the impression of state borrowings on private investment in Nigeria. The results showed that domestic investment both in the short as well as long terms crowds out by domestic debt. They also demonstrated that domestic debt crowds out domestic investment over the long term.

Ma'ale (2016), in his examination of the influence of public debt as well as investment on Jordan's financial progress. The time frame was from 1998 to 2017. Multiple linear regression analysis was done to obtain the results. The investigation discovered that in Jordan, public investment has a statistically substantial beneficial impact on financial progress although public debt has a statistically substantial negative influence.

From 1996 to 2018, Doan Van Dinh (2019) researched the stimulus of inflation on financial progress in Vietnam. He employed the VAR (Vector Autoregressive), Johansen cointegration test, and impulse response function as well as variance decomposition to identify the goal. In the near run, the inflation rate is completely associated with financial progress, consistent with the verdicts of the study. This study points up issues that the government should investigate in order to manage inflation, maintain growth, set a top priority for long-term economic growth, and take the necessary actions to keep inflation at the best-fit VAR model level.

The following are the paper's main contributions: (a) The identification of both short as well as long run affairs, Granger causal links between financial progress (as measured by GDP per capita), External Debt Stock (EDS), and Gross Fixed Capital Formulation (GCF) (b)The impulse response function (IRF) charts the impact of a shock with a one standard deviation on the endogenous variable's

existing and future values. (c) this study makes use of up-to-date and comprehensive data (from 1987 to 2018); (d) the study's anticipated strong results would assist policymakers in Bangladesh, as well as other developing nations, in making successful policies. As a result, our current research is a thorough endeavor to close the existing literacy gap and propose appropriate policy recommendations for supporting economic growth.

2.4 Objectives of this Study

The research bears the respective objectives:

(a) The identification of both short run as well as long run relationship and Granger causal linkages among financial progress (proxied by Gross Domestic Product Per Capita), External Debt Stock (EDS) and Gross Fixed Capital Formulation.

(b) The influence of a one standard deviation shock to one of the inventions among the examined variables is tracked by the impulse response function (IRF) on the endogenous variable's current and future values.

(c) The variance decomposition demonstrations the percentage of the forecasting error caused by a specific shock across time among the variables under investigation.

3. Research Methodology

3.1 Data

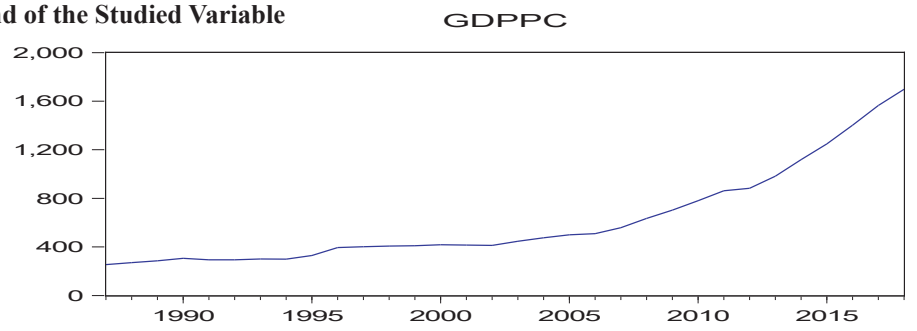
The prime goal of this analysis is to evaluate the impulse retort of total peripheral debt service and gross capital construction on financial progress in Bangladesh by taking the secondary annual time series data covers a period of 31 years spanning from 1987 to 2018 for the three variables Gross Domestic Product per capita (GDPPC), Total External Debt Service (EDS) and Gross Fixed Capital Formation (GCF) from the database of World Development Indicator (WDI) 2021. The regress and GDPPC is proxied by financial progress in Bangladesh. On the contrary, EDS (proxied by public Debt) and GCF (proxied by public investment) are the independent variable.

3.1.1 Gross Domestic Product per Capita (GDPPC): The gross domestic output divided by the midyear population determined the GDP per capita. By adding up all of the gross value contributed by all of the economy's resident producers, subtracting any product taxes, and adding back any subsidies that are not part of the product value GDP is determined. (Current U.S. dollars.)

3.1.2 Gross Fixed Capital Formation (GCF): All land improvements (fences, ditches, drains, etc.), purchases of plants, machinery and equipment and the building of roads, railways and other structures like schools, offices, hospitals, private residences, commercial and industrial buildings are included in GCF. (Current US$)

3.1.3 Debt Service on External Debt (EDS): The aggregate of the principle and interest charges on the long-term debt made in currency, products, or services, the interest expenditures made on the short-term debt made in cash, products, or amenities, and the IMF returns (repurchases and assessments) equals the entire amount of debt service. (Current US$).

3.2 Trend of the Studied Variable



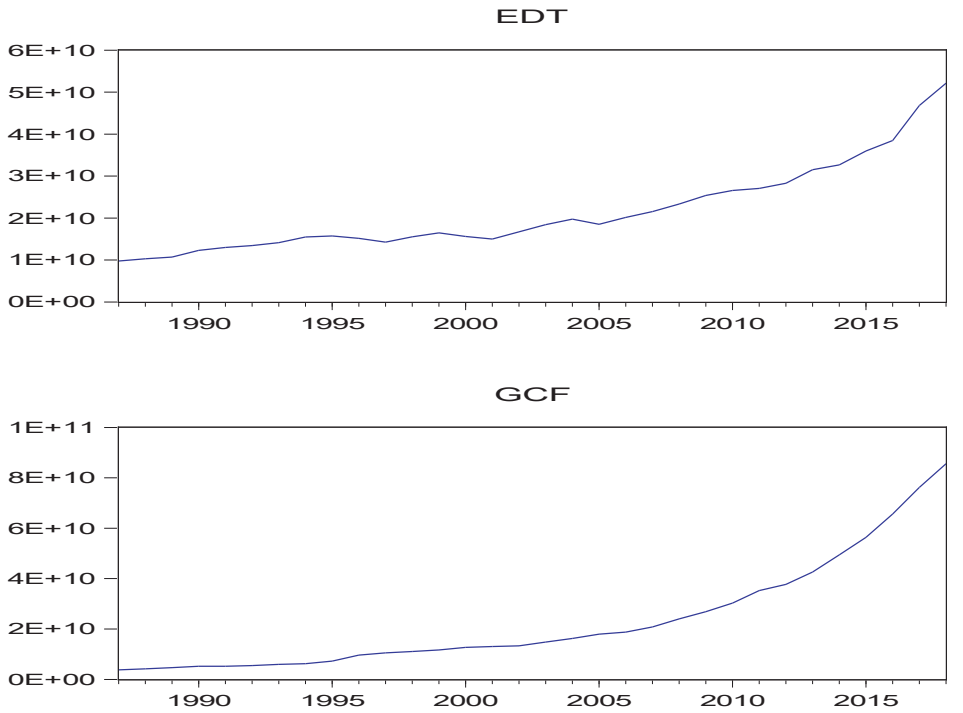


Figure 1.

Present Trend of Our Selected Variable

Source: World Development Indicators (2021)

From this figure we conclude that all the studied variable are increasing.

3.3 Econometric Model Specification

For this theory we have selected Gross Domestic Product per capita (GDPPC) proxied by financial progress in Bangladesh, External Debt Service (EDS) proxied by public debt and Gross fixed capital formations (GCF) proxied by Government investment. So, the efficient form of our study is scripted as:

$$GDPPC = f(EDS, GCF) \quad (2)$$

For the easy elasticity interpretations, we have converted all of our variable in to natural log form. So, the econometric form of the above functional form can be written as:

$$lnGDPPC_t = a + b_1 \ln EDS_t + b_2 \ln GCF_t + u_t \quad (3)$$

Where, a = intercept, b_1 = coefficients and u_t is error term.

3.4 Estimation Procedure

3.4.1 Unit root test

The majority of time series contain a unit root. We must first determine the unit root before making any estimations using time series data. The Augmented Dickey -Fuller (ADF), Phillips-perron (PP) and Kwiatkowski-Phillips-Schmidt-Shin (KPSS) tests are mostly used in testing stationarity. Here pp test is used since PP is non-parametric with consideration of the deterministic trend and the existence of residue auto correlations (Shrestha & Bhatta, 2018; Too, 2021). The PP is modeled is followed,

$$DY_t = pY_{t-1} + bD_{t-1} + e_t \quad (4)$$

e_t is I(o) with *zero* mean and D_{t-1} is deterministic trend component.

3.4.2 VAR Optimal Lag Selection Criteria

It is important to get optimal lag for estimating our VAR model. We have found the lag order by running unrestricted VAR lag selection criteria and choose optimal lag according to LR: consecutive improved LR test statistic (each test at 5% level), FPE: Final prediction error, AIC: Akaike information criterion, SC: Schwarz information criterion, HQ: Hannan-Quinn information criterion and choose that model that gives the lowest values of these criteria.

3.4.3 Estimation of VAR Model

Once we have established the ideal latency, we do our primary VAR model. We are handling with a vector of two (or more) variables when we use the term vector. The name autoregressive refers to the existence of the lagged value of the dependent variable on the right side of the equation. In a VAR model, we take into account a lot of endogenous factors. However, each endogenous variable is clarified by its lagged or past values as well as the lagged values of all other endogenous variables in the model; there are typically no external variables in the model. Due to the following factors, the Vector Autoregression (VAR) model was selected: The VAR model is particularly suited to dealing with such time series and autocorrelation difficulties because the variables in the model are time series and autocorrelated. Second, whereas conventional regression models are unable to account for the causal and dynamic relationships between economic variables, the VAR model does. Both macroeconomic planning and policy analysis can benefit from VAR (Van Dinh, 2020).

3.5 Model Specification

The var model for this study is shown as

$$lnGDPPC_t = \alpha + \sum_{i=1}^{k} \beta_i \, lnGDPPC_{t-i} + \sum_{j=1}^{k} \phi_j \, lnEDS_{t-j} + \sum_{m=1}^{k} \gamma_m \, lnGCF_{t-m} + u_{1t} \quad (5)$$

$$lnEDS_t = \sigma + \sum_{i=1}^{k} \beta_i \, lnGDPPC_{t-i} + \sum_{j=1}^{k} \phi_j \, lnEDS_{t-j} + \sum_{m=1}^{k} \gamma_m \, lnGCF_{t-m} + u_{2t} \quad (6)$$

$$lnGCF_t = \theta + \sum_{i=1}^{k} \beta_i \, lnGDPPC_{t-i} + \sum_{j=1}^{k} \phi_j \, lnEDS_{t-j} + \sum_{m=1}^{k} \gamma_m \, lnGCF_{t-m} + u_{3t} \quad (7)$$

Where, k = optimal lag, u_t's are stochastic error term often called impulse or innovations or shocks.

3.5.1 Cointegration

Engle Granger developed the concept of cointegration between two time series in 1987. It shows that the variables have a long-term relationship. The Engle and Granger cointegration test performs well for a single equation but poorly for a multivariate VAR model, hence the co integration test can be utilized if the integrated variables are in same order. The Johansen cointegration method is used in this work to examine cross-variable long-term equilibrium relationships.

3.5.2 Granger Causality

The consequence of the Granger representation statement is that if dual variables, such as X_t and Y_t, are cointegrated as well as each is individually I(1), then the relationship between them is I(1).i.e., integrated of order 1 (i.e., each is nonstationary individually), then either X_t must Granger cause Y_t or Y_t must Granger cause X_t. 2012's (Gujarati et al., 2012).

Our goal in this work is to determine whether each of the three variables-lnGDPPC, lnEDS, and lnGCF-is independently I(1) before using the Johansen cointegration test to see whether they are cointegrated. Accordingly, if lnGDPPC, lnEDS, and lnGCF are each individually I(1) and cointegrated, then either lnGDPpc or lnEDs must Granger Cause lnGDPPC. The same is valid for lnGCF and lnGDPPC.

3.6 Diagnostic Check

For further estimation of IRF (Impulse Response Function) as well as Variance Decomposition Variance, we need to do some diagnostic check such as VAR Residual Serial Correlation LM Tests, VAR Residual Normality Tests, VAR Residual Heteroskedasticity Tests. If the results of the diagnostic check is good then we further proceed IRF and Variance decomposition Variance.

3.7 Impulse Response Functions (IRF)

IRF clarifies in what way an endogenous variable counters to one of the improvements. It describes how the variable of interest has changed over a specific time period following a shock. It charts the impact of a shock of one standard deviation on the endogenous variable's recent as well as upcoming values for one of the inventions.

3.8 Variance Decomposition Variance

The fraction of anticipated fluctuations in each variable that is brought on by shock from other factors is computed by the variance-decomposition process of the predicted error. It shows the magnitude of the relative influence one variable has over another. the factor that calculates the percentage of a variable that is influenced by adjustments to other variables.

4. Result Analysis and Findings

4.1. Narrative Statistics

Table 1.
Descriptive Statistics

	GDPPC	EDS	GCF
Mean	620.5361	2.16E+10	2.34E+10
Median	432.1898	1.76E+10	1.41E+10
Maximu	1698.132	5.21E+10	8.56E+10
Minimum	253.9745	9.74E+09	3.76E+09
Std. Dev.	400.1265	1.05E+10	2.21E+10
Skewness	1.341651	1.315965	1.413694
Kurtosis	3.738276	4.133514	4.069877
Jarque-Bera	10.32689	10.94922	12.18501
Probability	0.005722	0.004192	0.002260
Sum	19857.16	6.90E+11	7.48E+11
Sum Sq. Dev.	4963138.	3.43E+21	1.51E+22
Observations	32	32	32

Source: Authors Calculations.

Table no 1 enunciate the various statistical information about the variables. The mean value are 620.5361, 2.16E+10, 2.34E+10 for GDPPC, EDS, and GCF with a greatest value 1698.132, 5.21E+10, 8.56E+10 and with a lowest value 253.9745, 9.74E+09, 3.76E+09. The estimated results confirm that all of the variables are positively skewed because the middling value is superior to the intermediate value. Here, also the positive value for the skewness supports this. The kurtosis values are 3.738276, 4.133514 and 4.069877 for GDPPC, EDS and GCF shows that GDPPC, EDS and GCF are leptokurtic because 3.738276 >3, 4.133514 >3 and 4.069877>3. The Jarque-Bera values are 10.32689, 10.94922,

and 12.18501 with the probability value 0.005722, 0.004192 and 0.002260 indicate that none of the variable are normally distributed.

4.2 Correlation Matrix

Table 2.
Correlation Matrix

Correlation and Probability			
Variables	**GDPPC**	**EDS**	**GCF**
GDPPC	1.000000		
EDS	0.989265	1.000000	
	(0.0000)		
GCF	0.998828	0.991313	1.000000
	(0.0000)	(0.0000)	
Variables	GDPPC	EDS	GCF
GDPPC	1.000000		

Source: Authors Calculations

Table 2 denotes the upshots of the correlation matrix. Correlation matrix shows the associations amid variables. Estimated consequences demonstrate that Gross Domestic product per capita is positively related with external Debt Stock and also a strong (0.989265) relationship exists which is statistically substantial at 1 % significance level. On the other hand, GDPPC and GCF also have a strong relationship exists (0.9988280, which is also statistically substantial at 1 % significance level.

4.3 Unit Root Test Results

To test the stationarity of the variables, we test PP test and the estimated results are shown outline 3 and 4 respectively.

Table 3.
Stationary Test (Phillips Perron test) at Level

Variables	**PP test-statistics (Intercept and trend)**	**1%**	**5%**	**10%**	**Prob***	**Order of integration**
lnGDPPC	-0.170511	-4.284580	-3.562882	-3.215267	0.9909	Non-stationary
lnEDS	-0.246663	-4.284580	-3.562882	-3.215267	0.9888	Non-stationary
lnGCF	-0.736597	-4.284580	-3.562882	-3.215267	0.9610	Non-stationary

Source: Authors Calculations

Table 4.
Stationary Test (Phillips Perron test) at First Difference

Variables	**PP test-statistics (Intercept and trend)**	**1%**	**5%**	**10%**	**Prob***	**Order of integration**
lnGDPPC	-3.940394	-3.940394	-3.568379	-3.218382	0.0225	Stationary
lnEDS	-4.615900	-4.615900	-3.568379	-3.218382	0.0047	Stationary
lnGCF	-3.987525	-3.987525	-3.568379	-3.218382	0.0203	Stationary

Source: Authors Calculations

For robustness of results we test the stationarity test by using the most popular method Phillps Perron test at level and first difference for both intercept and trend. Our null hypothesis is: Ho: Data is non stationary, Alt hypothesis H1: Data is Stationary. From table 3 we see that the pp test value is less than the 5% critical value for lnGDPPC, lnEDS, lnGCF, which is also statistically insignificant because the p- value is greater than 5% significance level. Thus, we cannot reject the null hypothesis and accept that data is non-stationary at level. But at first difference, we get that pp test -statistic value is greater than 5% critical value, which is statistically substantial at 5% significance level. So, from table 4 we confirm that our data becomes stationary after first difference. So, we further estimate the VAR model to get our expected results.

4.4 VAR Lag Order Selection Criteria

For estimating VAR model, we have to regulate the optimal lag. For determining optimal lag we used Standard VAR approach by using Eviews software. The estimated result are shown in table 5.We select optimal lag 2 according to LR, FPE, AIC and HQ criteria.

Table 5.
VAR Lag Order Selection Criteria

Lag	LogL	LR	FPE	AIC	SC	HQ
0	28.21484	NA	3.74e-05	-1.680989	-1.540869	-1.636164
1	187.9301	276.8398	1.63e-09	-11.72867	-11.16820*	-11.54937
2	199.9759	18.47014*	1.36e-09*	-11.93172*	-10.95089	-11.61795*

* indicates lag order selected by the criterion

Source: Authors Calculation

5. Results Analysis

Table 6.
Outcome of VAR model at optimal lag 2

Vector Autoregression Estimates **Standard errors in ( ) & t-statistics in [ ]**			
	LNGDPPC	LNEDS	LNGCF
LNGDPPC(-1)	2.533116	0.820402	1.230929
	(0.59881)	(0.79656)	(0.66937)
	[4.23026]	[1.02993]	[1.83892]
LNGDPPC(-2)	-1.620144	-0.447406	-1.323054
	(0.57348)	(0.76287)	(0.64106)
	[-2.82509]	[-0.58648]	[-2.06384]
LNEDS(-1)	0.067025	0.782086	0.132154
	(0.16907)	(0.22491)	(0.18900)
	[0.39642]	[3.47736]	[0.69924]
LNEDS(-2)	0.244913	-0.028354	0.285105
	(0.19721)	(0.26233)	(0.22045)
	[1.24190]	[-0.10808]	[1.29330]
LNGCF(-1)	-1.380428	-0.921682	-0.067779
	(0.56562)	(0.75240)	(0.63227)
	[-2.44058]	[-1.22498]	[-0.10720]
LNGCF(-2)	1.302189	0.832733	0.935701
	(0.53173)	(0.70733)	(0.59439)
	[2.44895]	[1.17729]	[1.57421]

C	-4.902197	5.698354	-6.078823
	(2.01925)	(2.68607)	(2.25720)
	[-2.42774]	[2.12144]	[-2.69308]
R-squared	0.995732	0.986752	0.997876
Adj. R-squared	0.994618	0.983296	0.997322
Sum sq. resids	0.036880	0.065259	0.046084
S.E. equation	0.040043	0.053267	0.044762
F-statistic	894.2385	285.5197	1800.779
Log likelihood	57.95129	49.39058	54.60926
Akaike AIC	-3.396753	-2.826038	-3.173951
Schwarz SC	-3.069807	-2.499092	-2.847005
Mean dependent	6.311950	23.74101	23.56909
S.D. dependent	0.545834	0.412143	0.864924

Source: Authors Calculation.

VAR Model Representations:

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LNGDPPC = 2.53311577073*LNGDPPC (-1) - 1.62014354563*LNGDPPC (-2) + 0.0670247382157*LNEDS (-1) + 0.244912744012*LNEDS (-2) - 1.38042840868*LNGCF (-1) + 1.30218864892*LNGCF (-2) - 4.90219746055 *(8)*

LNEDS = 0.820402342358*LNGDPPC (-1) - 0.447405868849*LNGDPPC (-2) + 0.782086071477*LNEDS (-1) - 0.0283536526857*LNEDS (-2) - 0.921681531865*LNGCF (-1) + 0.832733078217*LNGCF (-2) + 5.69835355331 *(9)*

LNGCF = 1.23092906378*LNGDPPC (-1) - 1.32305354326*LNGDPPC (-2) + 0.132154230475*LNEDS (-1) + 0.285105459311*LNEDS (-2) - 0.0677793691179*LNGCF (-1) + 0.935701047757*LNGCF (-2) - 6.078822575 *(10)*

Table no 6 represents the outcome of VAR model. From equation (8) we see that, the first lag and second of EDS has optimistic impact on GDPPC, on average, ceteris-paribus, but not statistically significant. That means, a 1% change in EDS leads to 0.2449% % increase in GDPPC on the short run, on average, ceteris paribus for the second lag. First lag of GCF has negative impact on GDPPC as usual, ceteris paribus, and also statistically substantial at 5% significant level. A 1% change in GCF leads to 1.3021% rise in GDPPC on average, ceteris paribus, for second lag of GCF, which is statistically noteworthy at 5% significant level. The first lag of GDPPC has positive impact on itself which is highly significant at 1% significant level on average, ceteris paribus. That means, a 1% rise in GDPPC leads to 2.5331% rise in GDPPC itself which is highly significant at 1% significant level on average, ceteris paribus. Second lag of GDPPC has adverse impact on itself, on average, ceteris paribus and statistically significant.

The impact of GDPPC and GCF on EDS shown in equation (9). Here the first lag of GDPPC has optimistic impact on EDS, on average, ceteris paribus and statistically insignificant. But at second lag, a 1% rise in GDPPC will decline in EDS by 0.44% % on average, ceteris paribus and statistically insignificant. First lag of GCF has negative impact on EDS that means, a 1% rise in GCF will decline in EDS by 0.9217%, on average, ceteris paribus. But second lag of GCF has positive impact on EDS, on average, ceteris paribus that means a 1% rise in GCF will rise in EDS by 0.8327%. On the other hand, a 1% rise in EDS will increase in EDS itself by 0.77820% typically, ceteris paribus and statistically substantial at 1% significant level at first lag of EDS.

From equation (10) lag of first of GDPPC has positive influence on GCF in the short run on average, ceteris-paribus, also statistically significant. But Second lag of GDPPC has negative impact on GCF, on average, ceteris paribus and statistically significant at 5% significance level. Both first and second lag of EDS has positive impact on GCF on average, ceteris-paribus, and statistically insignificant. At second lag of GCF, a 1% rise in GCF will rise GCF itself by 0.936% on average, ceteris paribus.

5.1 Johansen Co-integration Test

Table 7.
Johansen Co-integration Test

Unrestricted Cointegration (Trace)			**Rank Test**		**Unrestricted Cointegration (Maximum Eigenvalue)**			**Rank Test**	
Hypothesized		**Trace**	**0.05**		**Hypothesized**	**Max-Eigen**	**0.05**		
No. of CE(s)	**Eigen value**	**Statistic**	**Critical Value**	**Prob.** **	**No. of CE(s)**	**Eigen value**	**Statistic**	**Critical Value**	**Prob.****
None *	0.450	31.87	29.79	0.028	None	0.450	17.37	21.13	0.154
At most	0.296	14.49	15.49	0.070	At most 1	0.296	10.21	14.26	0.198
At most 2*	0.137	4.276	3.841	0.039	At most 2*	0.137	4.276	3.84	0.038

** Mackinnon -Hauq- Michelis (1999) p-values
Source: Authors Calculation.

The estimated results of both rests confirmed that, there also exists long run relationships among the variable.

Table 8.
Normalized Cointegrating Coefficients (standard error in parentheses)

lnGDPPC	**lnEDS**	**lnGCF**
1.000000	-0.400610	-0.450061
	(0.27313)	(0.12536)

Source: Authors Calculation.

In the long run, both lnEDS as well as lnGCF have an optimistic impact on lnGDPPC, on average, ceteris paribus, according to the projected results. The magnitude of the beneficial impact is large, implying that the external debt stock is a strong predictor of economic development. Our findings are in line with those of Egbetunde (2012), Ahlborn and Schweickert (2015), Sanchez-Juárez and Garca-Almada (2016), Owusu-Nantwi and Erickson (2016), Odubuasi, Uzoka, and Anichebe (2018) Thao and Truong (2019). On the other hand, we find that public investment is a strong driver of financial progress in Bangladesh, which is corroborates withthe result of (Saifuddin, 2016; Rahman, 2015; Uddin, Chowdhury, & Uddin, 2015; Norman, & Sabahat, 2017).

5.2 VAR Granger Causality/Block Exogeneity Wald Tests

Table 9.
VAR Granger Causality/Block Exogeneity Wald Tests

Dependent variable: lnGDPPC			
Excluded	Chi-sq	Df	Prob.
lnEDS	6.852560	2	0.0325
lnGCF	5.999753	2	0.0498
All	13.69817	4	0.0083

Dependent variable: lnEDS			
Excluded	Chi-sq	Df	Prob.
lnGDPPC	7.405413	2	0.0247
lnGCF	1.652799	2	0.4376
All	10.76311	4	0.029
Dependent variable: lnGCF			
Excluded	Chi-sq	Df	Prob.
lnEDS	5.571553	2	0.0617
lnGCF	9.940153	2	0.0069
All	14.60930	4	0.0056

Source: Authors Calculation.

From this above table we confirm that, each causality tests (checks) assist as strength or indication of validation for one another. Here the t-statistics of the explanatory variables and the F-statistics from Granger and Wald tests indicates the "short-run" causal effects exist.

Table 10.

Pairwise Granger Causality Tests

Lags: 2			
Null Hypothesis:	**Obs**	**F-Statistic**	**Prob.**
LNEDS does not Granger Cause LNGDPPC	30	3.31831	0.0527
LNGDPPC does not Granger Cause LNEDS		4.61931	0.0196
LNGCF does not Granger Cause LNGDPPC	30	2.86643	0.0757
LNGDPPC does not Granger Cause LNGCF		1.77183	0.1907
LNGCF does not Granger Cause LNEDS	30	1.38039	0.2700
LNEDS does not Granger Cause LNGCF		3.95400	0.0322

Source: Authors Calculation.

The pairwise Granger Causality test indoctrinate the path of the causality among the variables. From the table, we conclude that, there is Bi-directional causality between lnGDPPC and lnEDS and Uni-directional causality from lnGCF to lnGDPPC and lnEDS to inGCF.

Out of Granger Causality/Block Exogeneity Wald Tests and Johansen Co-integration test corroborate that both variables such as lnEDS and lnGCF plays a strong optimistic impact on Economic growth (proxied by GDPPC) in Bangladesh for the short and long run. Pairwise Granger Causality also indulgence the Bi-directional causality between lnGDPPC and lnEDS.

For further estimation of Impulse Response functions (IRF) and Variance decomposition of variance we need to redact diagnostic checks. If our model's residuals are free from serial correlation, constant variance and model is normally distributed then we further estimate it.

5.3 Diagnostic Checks

Table 11.

VAR Residual Serial Correlation LM Tests

Null hypothesis: No serial correlation at lag h						
Lag	**LRE* stat**	**df**	**Prob.**	**Rao F-stat**	**Rao F-stat**	**Prob.**
1	5.291534	9	0.8082	0.576108	0.576108	0.8092
2	9.094534	9	0.4286	1.031676	1.031676	0.4308

Source: Authors Calculation.

The estimated results confirm that, there is no serial correlation in the residuals because the p-value of Rao statistics is greater than 5% significance level on lag 1 and 2.

Table 12.

VAR Residual Normality Tests

Component	Jarque-Bera	df	Prob.
1	1.245648	2	0.5364
2	0.498392	2	0.7794
3	1.724415	2	0.4222
Joint	3.468455	6	0.7482

Source: Authors Calculation.

Here the p-value of Jarque-Bera test is 0.7482>5% significance level, so we cannot reject the null hypothesis, so we terminate that VAR residuals are normally distributed.

Table 13.

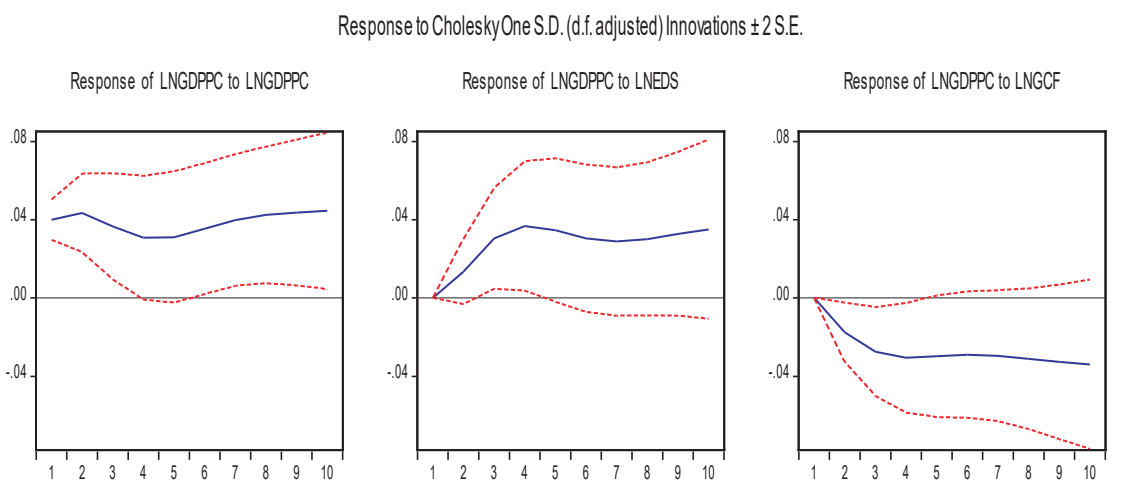
VAR Residual Heteroskedasticity Tests (Levels and Squares)

VAR Residual Heteroskedasticity Tests (Levels and Squares)		
Joint test:		
Chi-sq	df	Prob.
70.44617	72	0.5298

Source: Authors Calculations with Eviews

The p-value of chi-sq is 0.5298 which is greater than 5% significant level and conclude that our model has constant variance. By performing different diagnostic tests we confirm that our model is good fit for further estimation like impulse response functions and variance decomposition approach.

5.4 Impulse Response Functions



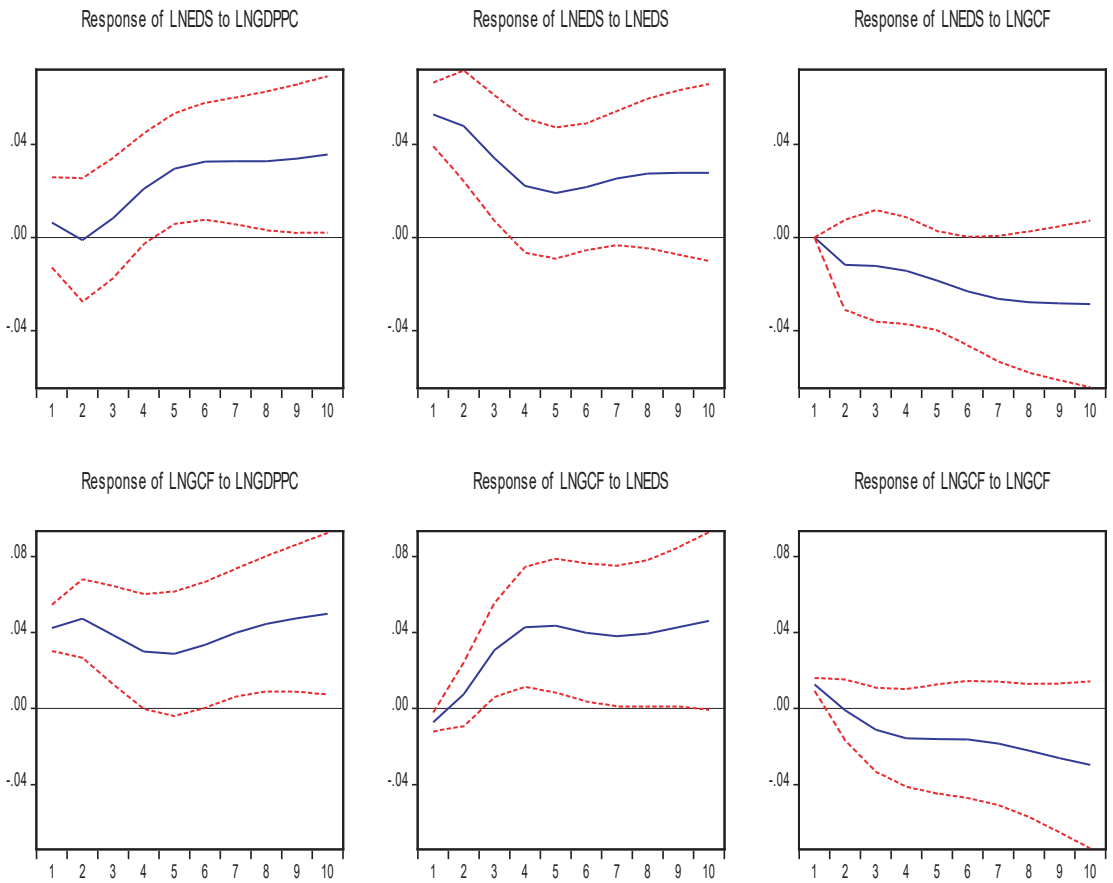


Figure 2.

Impulse Response Functions

Source: Author Computations

5.4.1 Interpretation of a Standard Deviation (SD) Shock to lnGDPPC

Response of lnEDS: A one SD shock (innovation) of lnEDS to lnGDPPC initially falling in periods 1 and 2. From period 2, the response progressively increases until the 8th period when it hits steady state value, beyond 8th period, lnEDS increase gradually above its steady state value, remains in the constructive section.

Response of lnGCF: In periods 1 and 2, a one SD shock (innovation) of lnGCF to lnGDPPC initially causes an increase. Up until the fifth period, when it reaches its steady state value, the positive response rapidly decreases. Beyond the fifth period, lnGCF increases above its steady state value and stays in the positive zone, indicating that shocks to lnGCF have a favourable effect on lnGDPPC in both the SR and the LR.

5.5 Variance Decomposition

Table 14.

Variance Decomposition

Variance Decomposition of lnGDPPC				
Period	S.E.	lnGDPPC	lnEDS	lnGCF
1	0.040043	100.0000	0.000000	0.000000
2	0.063057	87.78103	4.492141	7.726829
3	0.083614	69.01206	15.80638	15.18156
4	0.101118	56.42891	24.07325	19.49784
5	0.115235	50.73115	27.56530	21.70355
Variance Decomposition of lnEDS				
Period	S.E.	lnGDPPC	lnEDS	lnGCF
1	0.053267	1.495467	98.50453	0.000000
2	0.072597	0.826776	96.57448	2.598743
3	0.081564	1.708233	94.00822	4.283552
4	0.088253	7.068674	86.65423	6.277101
5	0.096794	15.19801	75.92490	8.877088
Variance Decomposition of lnGCF				
Period	S.E.	lnGDPPC	lnEDS	lnGCF
1	0.044762	89.42705	2.526299	8.046654
2	0.065542	93.75273	2.476896	3.770379
3	0.082785	80.51527	15.29667	4.188067
4	0.099143	65.24820	29.35424	5.397564
5	0.113174	56.52577	37.33059	6.143640
Cholesky Ordering: lnGDPPC lnEDS lmGCF				

Source: Author Computations

The estimated outcome of variance decomposition are represents in above table. Upper part of the table we can indicate period 1 and 2 are short run and from 3 to 5 represent long run. We can describe that, lnGDPPC have strong endogenous influences itself for short run, and indicating that 100% forecast error in lnGDPPC is explained by the variable itself. In the long run lnGDPPC has weakly endogenous implies weak influence from own variable. On the other hand, in the short run, lnEDS and lnGCF have weak influence on dependent variable on lnGDPPC. In the long run, the influences of lnEDS and lnGCF to lnGDPPC are increasing, indicating that both variables are strongly exogenous on dependent variable.

When lnEDS is dependent variable we see in the short run and long run, lnGDPand, lnGCF has strongly exogenous (implies weak influence on lnEDS variable). The variable itself clarified 98.50453% forecast error in lnEDS in the short run.

In period 1, 89.82% forecast error variance on lnGCF is clarified by the lnGDPPC variable when lnGCF is the dependent variable. That means, lnGDP has least exogenous (Implies strong influence) on lnGCF.37.24% forecast error variance on lnGCF is described by the variable lnEDS in the long run. lnGCF has weakly endogenous influence on itself for both short run as well as long run. We can say that in lnGCF model both lnGDPPc andlnEDs have more strong endogenous impact on lnGCF.

Become acquainted from table 6 and 10, there are the consistency between the VAR estimated result and Variance Decomposition result.

6. Conclusion and Policy Implication

External debt service and gross capital formation are crucial for Bangladeshi economic growth. Our major goals are to determine how gross fixed capital creation and the stock of external debt affect economic growth (as measured by GDPPC). We use a variety of econometric techniques named the Phillips-Perron unit root test, VAR optimal lag estimation, to determine the intended objectives. In order to establish a long-term relationship, one must estimate a VAR model and perform tests like the Impulse Response Function (IEF), Variance Decomposition, and VAR Granger Causality. Our variables are initially nonstationary, but after the first difference, they become stationary. In order to run any VAR model, we must first find the ideal lag using the conventional VAR system. We then choose two lag values for the VAR model based on the AIC, HQ, and LR ratios. Following the estimation of a VAR model, VAR Granger Causality/Block Exogeneity Wald Tests are run. The short run Var model shows that the two independent variables External Debt Stock (proxied by Public Debt) and Second Lag of Gross Fixed Capital Formation have an optimistic consequence on economic growth in Bangladesh (proxied by Gross Domestic Product Per Capita) which is similar with the result of Saifuddin (2016), Obubuasi, Uzoka and Anichebe (2018), Rahman (2015), Norman and Sabahat (2017), Uddin, Chowdhury and Uddin (2015) and Juárez and Almada (2016). That is, ceteris paribus for the second lag, a 1% change in EDS causes an average short-term increase in GDPPC of 0.2449 percent. According to ceteris paribus calculations, for the second lag of GCF, a 1% change in GCF causes an average rise in GDPPC of 1.3021 percent, which is statistically substantial at the 5% level of significance. Block Exogeneity/Wald Tests and Johansen Co-integration tests demonstrate that both lnEDS and lnGCF have both a short- and long-term, significant beneficial impact on Bangladesh's economic growth. Additionally, Pairwise Granger causation indulges in the unidirectional causation from lnGCF to lnGDPPC, the bi-directional causality between lnGDPPC and lnEDSwhich is similar with the result of Owusu-Nantwi and Erickson (2016). Long-term trends in the effects of lnEDS and lnGCF on lnGDPPC demonstrate that both variables are considerably exogenous to the dependent variable which is similar with the result of Nacnywa and Masog(2018).

After confirming the findings of our various diagnostic tests, we further estimate the impulse response function (IRF) and use the variance decomposition approach for robustness or to validate the results. Finally, we illation that the Granger Causality/Block Exogeneity Wald Tests and the VAR Granger Causality/Block Exogeneity Wald Tests results are compatible.

6.1 Policy Implication

External borrowing aids public investment in emerging countries, according to the dual gap theory and the Keynesian theory of public debt. Bangladesh is now a fast-growing economy with several megaprojects for infrastructural, human, and technological advancements such as roads, train, power, education, health, information technology, gas, and energy. The administration should prevent waste and dishonesty by ensuring that monies rented and assigned for investment are used clearly as well as wisely in the delivery of infrastructure and public belongings and facilities in order to promote financial growth, progress, as well as capital formation. If project identification, monitoring, evaluation, loan repayment is developed by a loan transparency cycle, public debt can be an effective way to finance public investment and drive economic growth. Debts should only be incurred when absolutely necessary, and they should be used to invest rather than pay salaries. The government should establish a priority aim for long-term economic growth by implementing suitable measures to control, maintain, regulate, and stabilize inflation at a reasonable level.

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