The Relationship between Budget Deficit and Public Debt in Bangladesh: A Vector Error Correction Model (VECM) Approach

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Abstract: *This study attempts to explore the relationship between budget deficit and public debt in Bangladesh over the period 1995 to 2015. After collecting all relevant data from different publications of Bangladesh Bank, the study employed Augmented Dickey-Fuller (ADF) and Phillips-Perron (PP) tests for testing the stationarity of the series, Johansen Cointegration techniques to visualise the long run relationship between the two variables and Vector Error Correction Model (VECM) to evaluate the short run properties of the cointegrated series. The results of the unit root test show that the series are non-stationary at levels form but after differentiating they become stationary. Cointegration test shows the presence of long run equilibrium relationships between the two variables. The Vector Error Correction Model (VECM) provides evidence that there is a unidirectional causality running from public debt to budget deficit but not the way round.*

Keywords- *budget deficit, public debt, unit root, co-integration, vector error correction model (VECM), Bangladesh.*

1. Introduction

Deficit budget is considered as a tool to stabilize the economy. But modern fiscal practices show that the success of deficit budgeting depends on the sagaciousness of the government in using this tool properly. If a government cannot handle it efficiently the dangerous effect would be an escalation of the debt stock of a country as the deficit is commonly financed by taking debt. Like the governments of other developing countries in the world, government of Bangladesh always try to use deficit budget as a potential instrument to stabilize the economy and forward to a sustainable economic growth. To finance the deficit in annual budget, government take loan from local sources as well as from external/ foreign sources largely. As the size of the budget is going to be large, the amount of deficit in budget

shows a growing trend which instigates an increase in public debt.

Actually Bangladeshi economy is primarily dependent on foreign aids and loans. But these aids and loans are not used in proper way because of some reasons including corruption. Government always try to carry out a structural change by taking some steps such as Public Private Partnership (PPP) to use the foreign aid and loans efficiently to stabilize the economy. As days go on the amount of public debt is increasing which demands an effective and efficient coordination of fiscal policy. It is a great challenge for Bangladeshi government to tackle the rising public debt created by past budget deficits.

This paper examines the relationship between budget deficit and public debt in Bangladesh to contribute in escalating the fiscal policies of the country and government's sector performance. The next section reviews both theoretical and empirical literature on the relationship between budget deficit and public debt, section 3 provides data and methodology of the study, section 4 shows the empirical analysis of the data and finally section 5 concludes the report with some recommendations on how effectively Bangladeshi government can coordinate fiscal policy in order to stabilize the economy.

2. Review of Literature

2.1. Theoretical Review

Budget Deficits occur when a government's expenditures exceed the revenue that it generates. The deficit can be measured with or without including the interest payments on the debt as expenditures. The *primary deficit* is defined as the difference between current government spending on goods and services and total current revenue from all types of taxes net of transfer payments. The *total deficit* (which is often called the fiscal deficit or just the 'deficit') is the primary deficit plus interest payments on the debt (Burda and Wyplosz, 1995)

[9]. Therefore, if **G** is government spending and **T** is tax revenue for the same timeframe, then Primary Deficit = **G** – **T**. If **D** is last year's debt, and **K** is the interest rate, then Total deficit = **K . D + G – T.**

Agarwal (2014) stated that fiscal deficit happen when government spending is higher than tax revenue. It represents a negative value in national saving, which will reduce the whole value of national saving and raise the real interest rate and encourage foreigners to invest in the domestic economy, leading to exchange rate appreciation. This makes domestic goods and services more expensive relative to foreign goods. So the country imports more and exports less, increasing the trade deficit [2].

Deficits can be financed through money printing, internal and/ or external borrowing and use of central bank's foreign reserves. Each financing mechanism would involve different macroeconomic repercussions such as inflation, balance of payments crises, and external debt crises (Osinubi and Olaleru, 2006) [16, 17]. Alam and Fauziah (2013) enunciated that public debt may be defined as the sovereign borrowing from its own population, from foreign governments or from international institution. Public borrowings are usually made on a national scale by central governments and at lower tiers of the government by provincial/ state, regional, district and municipal administrative authorities. Government takes loans to fill gap in budget when it appears a deficit in it [3, 4].

Economic trends can influence the growth or shrinkage of fiscal deficits in several ways. Increased levels of economic activity generally lead to higher tax revenues, while government expenditures often increase during economic downturns because of higher outlays for social insurance programs. Changes in tax rates, tax enforcement policies, levels of social benefits, and other government policy decisions can also have major effects on public debt.

2.2 Empirical Review

A number of studies have been conducted to investigate the relationship between budget deficit and foreign debt in different countries by using different data sets. This study is about the relationship between budget deficit and public debt in Bangladesh. So the empirical literatures regarding the relationship between budget deficit and foreign debt are closely related with it. In case of Jordan, Shahateet et al. (2014) showed that external debt is not caused by budget deficit but by other factors related to economic growth and, more likely, political factors. They also said that the budget constraints must rely on more important factors other

than external debt when drawing fiscal policies. These factors may include good governance, tax reforms and lowering government spending on certain economic activities that have little significance on total output [20].

Some researchers investigated the impact of budget deficit or certain economic variables recently. Agarwal (2014) [2] investigated an existence of the long-run equilibrium relationship between current account and fiscal deficit in India. Qayyum et al. (2014) presented a theoretical model for foreign aid, external debt and governance. They showed that external debt and foreign aid do not affect the growth rate of consumption but have level impact on consumption. They concluded that foreign aid encourages the economic growth but external debt creates a burden on the economy. Foreign aid does not affect investment directly but it has a direct positive impact on the savings in the economy. Foreign aid has a positive impact on economic growth and it is playing a constructive role in spurring the economic activity of an economy. External debt has a negative impact on economic growth and it is a burden that puts an economy into trouble. They recommended that developing countries should finance budget through foreign aid and do not depend on the external debt as it affects the economic activities adversely [18].

By conducting a study about budget deficit, external debt and economic growth in Nigeria, Osinubi and Olaleru (2006) confirmed an existence of the debt Laffer curve and the non linear effects of external debt on growth. They also suggested that if debt financed budget deficits are operated in order to stabilize the debt ratio at the optimum sustainable level, debt overhang problem would be avoided and the benefits of external borrowing would be maximized [16].

In his study in Jordan, Abdelhadi (2013) found that there is a positive and significant relationship between external debt and economic growth in Jordan. But with the increasing reliance on foreign funds and of loans foreign, in particular, led to rising debt service burdens, which has a negative impact on economic growth in Jordan, and there is an inverse and significant relationship between debt service and economic growth, because the country spend major portion of its Balance of Payment to serve its external debt [1].

A study of Jayaraman and Evan (2008) confirmed that the high flow of aid and foreign debt has contributed significantly to high rates of economic growth in the six countries of the Pacific during the period 1988 to 2004 [12]. Another study by Butts

(2009) shows the existence of a causal relationship between economic growth and the external public debt in 13 out of 27 countries of Latin America and the Caribbean during the period 1970-2003 [10].

The estimated results of the study conducted by Al-Refai (2015) revealed that the gross fixed capital formation and domestic debt have positive and significant relationship with economic growth in Jordan, but labor, external debt, and long-term external debt have a negative and insignificant impact on economic growth in Jordan [5].

3. Data and Model Specification

3.1. Data

This study uses yearly time series data expressed as percentage of GDP covering the period 1995 to 2015 which are represented in table 1. The two variables of the study are budget deficit and public debt. Data are obtained from different publications of Bangladesh Bank (BB), the central bank of Bangladesh.

Table 1. Budget deficit and public debt in Bangladesh

Fiscal Year	Budget Deficit as % of GDP	Public Debt as % of GDP	Fiscal Year	Budget Deficit as % of GDP	Public Debt as % of GDP
1995	4.6	4.6	2006	3.4	2.8
1996	4.7	4.7	2007	3.2	2.8
1997	3.7	4.2	2008	5.3	4.6
1998	3.4	3.9	2009	3.4	3.1
1999	4.6	4.6	2010	3.2	2.8
2000	6.1	5.4	2011	3.9	3.5
2001	5.1	4.8	2012	3.6	3.2
2002	4.7	4.8	2013	3.8	3.3
2003	4.2	3.6	2014	4.4	4.0
2004	4.2	4.6	2015	5.0	4.6
2005	4.5	4.5			

Source: Annual Reports of Bangladesh Bank (2004-2005, 2009-2010 and 2014-2015)

3.2. Model Specification

The analysis process of this study follows three steps. These are as follows:

3.2.1. Stationarity Test. A time series is called stationary if its mean and variance remain constant over time, otherwise the series is said to be non stationary. A non stationary time series is not used in econometric analysis because it generates spurious regression. To test the stationarity of the data the Augmented Dickey-Fuller (ADF) and the Phillips-Perron (PP) unit root tests are applied. We know that ADF test assumes that Y series follows an AR(p) process and adds a p lagged difference terms of the dependent variable on the right- hand side of the equation and is based on the following three regression forms.

Without constant and trend:

$$\Delta Y_t = \delta Y_{t-1} + \sum_{i=1}^{p} \gamma_i \Delta Y_{t-i} + u_t \qquad (1)$$

With constant:

$$\Delta Y_t = \alpha + \delta Y_{t-1} + \sum_{i=1}^{p} \gamma_i \Delta Y_{t-i} + u_t \qquad (2)$$

With constant and trend:

$$\Delta Y_t = \alpha + \beta T + \delta Y_{t-1} + \sum_{i=1}^{p} \gamma_i \Delta Y_{t-i} + u_t \qquad (3)$$

Where Y is budget deficit or public debt, Δ is the first difference operator, t is time, all Greek letters $(\alpha, \beta, \delta, \gamma)$ are parameter to be estimated and u_t is error term.

3.2.2 Cointegration Test. If the variables under study are non stationary at level and become stationary at same order (cointegrated in same order) then Johansen Cointegration test can be applied to examine if there is any long run relationship between the variables. Johansen Cointegration test uses two tests namely the Trace test and the Maximum Eigenvalue test [13, 14]. The Trace test tests the null hypothesis of **r** cointegrating vectors against the alternative hypothesis of **n** cointegrating vectors based on the following equation.

$$J_{trace} = -T \sum_{i=r+1}^{n} \ln(1 - \lambda_i) \qquad (4)$$

Where Maximum Eigenvalue test investigates the null hypothesis of **r** cointegrating vectors against the alternative hypothesis of **r+1** cointegrating vectors and follows the equation underneath.

$$J_{max} = -T \ln(1 - \lambda_{r+1}) \qquad (5)$$

In both equations, **T** is the sample size, **n** means number of variables, λ_i means the **i**[th] largest canonical correlations and **r** = 0, 1, 2, 3 .... (n-1).

3.2.3. Vector Error Correction Model (VECM). Engle and Granger (1987) showed that if the null hypothesis of no cointegration cannot be rejected, an

error correction model of the cointegrated series is appropriate [11]. That means if Johansen cointegration test reveals that there is long term relationship between Budget Deficit (BD) and Public Debt (PD), then Vector Error Correction Model (VECM) can be applied in order to evaluate the short run properties of the cointegrated series. The error correction model for BD (PD) could be expressed as a least-squares regression of changes in BD (PD) on past changes in BD and PD, and on lags of the residual from the cointegrating regression. The regression equations for VECM are given below.

$$i. \Delta BD_t = \sum_{i=1}^{p-1} \beta_i BD_{t-i} + \sum_{i=1}^{p-1} \gamma_i PD_{t-i} + \delta_1 c1_{t-1} + \epsilon_{1t} \tag{6}$$

$$ii. \Delta PD_t = \sum_{i=1}^{p-1} \beta_i BD_{t-i} + \sum_{i=1}^{p-1} \gamma_i PD_{t-i} + \delta_2 c2_{t-1} + \epsilon_{2t} \tag{7}$$

Where Δ is the difference operator, $c1$ and $c2$ are estimated residuals from the cointegrating equations, ϵ_1 and ϵ_2 are random disturbances and β, γ, δ are parameters.

4. Empirical Analysis, Results and Discussion

4.1. Unit Root Test Result

The variables under study are tested based on the above three forms of equations with the help of EViews (Econometric Views), a statistical software developed by Quantitative Micro Software (QMS). The critical values are taken from MacKinnon (1996) one-sided p-values. The maximum lag length is automatically selected by the method based on Schwarz Information Criterion (SIC) and Akaike Information Criterion (AIC) both gave similar results in ADF test. In Phillips- Perron (PP) test, the bandwidth is automatically selected by Newey-West using Bartlett kernel. The results of unit root tests in Table 2 representing that at level form there is a unit root, which means data are non-stationary. As the variables have a unit root in the level form so a unit root test for first difference should be employed. After the first difference both budget deficit and public debt became stationary.

Table 2. **Results of unit root tests- ADF and PP in levels and in first difference**

Variable	Equation Includes	ADF		PP	
		Level	First Difference	Level	First Difference

	None	-0.52	-5.38*	-0.31	-9.58*
Budget deficit as % of GDP	Constant	-3.17	-5.17*	-3.12	-9.76*
	Constant and trend	-3.38	-4.99*	-3.17	-9.73*
	None	-0.73	-6.35*	-0.57	-7.45*
Public debt as % of GDP	Constant	-2.71	-6.22*	-2.76	-7.81*
	Constant and trend	-3.53	-5.99*	-3.50	-7.58*

Source: Authors' compilation using EViews.
*means the rejection of null hypothesis at 5%.

4.2. Cointegration Test Result

As the variables under study are non-stationary at level but they become stationary at first difference so we can apply Johansen Cointegration test to find out whether any long term relationship exist between the variables or not. The test followed both the Trace and Maximum Eigenvalue estimators. The critical values are taken from MacKinnon et al. (1999) [15]. Tables 3 and 4 represent that both Trace and Maximum Eigenvalue indicate one cointegrating equation at 5% level. So there is a long run equilibrium relationship between the variables (budget deficit and public debt).

Table 3. **Results of Johansen unrestricted cointegration rank test (trace)**

Hypothesized No. of CE(s)	Trace Statistic	5% Critical Value	Prob.**
None*	32.30744	15.49471	0.0001
At most 1	2.141764	3.841466	0.1433

Table 4. Results of Johansen unrestricted cointegration rank test (maximum eigenvalue)

Hypothesized No. of CE(s)	Max-Eigen Statistic	5% Critical Value	Prob.**
None*	30.16568	14.26460	0.0001
At most 1	2.141764	3.841466	0.1433

Source: Authors' compilation using EViews.
*Represents rejection of null hypothesis. Both Trace and Max-eigenvalue indicate one cointegrating equation at the 0.05 level.

4.3. Vector Error Correction Model (VECM) Result

The presence of cointegration between variables suggests a long term relationship between the variables under consideration. Then, Vector Error

Correction Model (VECM) can be applied to evaluate the short run properties of the cointegrated series. The results of VECM follow the following regression equation form when budget deficit is dependent variable and public debt is independent variable. Here the value of coefficient is negative (-2.975153) and it is significant (p=0.0144). So it is proved that there is long run causality running from public debt to budget deficit.

$$\Delta BD = -2.98\ BD - 0.72\ PD - 1.34$$

Standard Error:	(0.96)	(0.06)
t-statistics:	[-3.11]	[-10.78]
Probability:	0.0144	

Source: Authors' compilation using EViews.

To test the short run causality Wald test is applied. The results are followings.

Wald Test:

Equation: Untitled

Test Statistic	Value	df	Prob.
F-statistic	4.019063	(3, 8)	0.0513
Chi-square	12.05719	3	0.0072

The Wald statistic showed that there is also a short run causality running from public debt to budget deficit.

The results of VECM follow the following regression equation form when public debt is dependent variable and budget deficit is independent variable.

$$\Delta PD = 1.03\ PD - 1.38\ BD - 1.86$$

Standard Error:	(0.79)	(0.12)
t-statistics:	[1.30]	[-11.93]
Probability:	0.2298	

Source: Authors' compilation using EViews.

This equation shows that the coefficient is positive (1.030896) and not significant (p=0.2298), so there is no long run casuality running from budget deficit to public debt. The Wald test provides the following result.

Wald Test:

Equation: Untitled

Test Statistic	Value	df	Prob.
F-statistic	1.476880	(3, 8)	0.2925
Chi-square	4.430641	3	0.2186

This statistic also confirms that there is no short run causality running from budget deficit to public debt**.**

5. Conclusion

After analysing the data for the period 1995 to 2015, it can be said that there is an existence of equilibrium relationship between budget deficit and public debt in Bangladesh. The vector error correction model (VECM) approach has enabled us to find out a causality running from public debt to budget deficit but not the way round. That means budget deficit is not responsible for public debt but public debt cause budget deficit. It is because of the payment of interest as well as principal of debt in every year. So the policy makers of Bangladesh must develop such a budget each year which should consider public debt and rely on more other important factors such as good governance and tax reforms.

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