Volume-5, Issue-2, July-December, 2016
PP. 40-49

Causality between Budget Deficit and Interest Rate: The Case of Bangladesh

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Abstract

The paper examines the dynamic linkage between the budget deficit and interest rate in Bangladesh over a long period of time (1974-2014) by applying standard techniques of time series analysis, i.e. cointegration, error correction models and Granger causality tests. It is evident that the data series are integrated of order one, i.e. they are non stationary at their levels and first difference makes them stationary. Then Johansen Juselius technique established that the considered variables are cointegrated, implying that there is a stable long run relationship between the two. However, to take care for the short run disequilibrating relationship, we have estimated the error correction model, which shows that the impact of budget deficit on interest rate is not instantaneous. The error correction model also shows bidirectional causality between the variables, which is also supported by the Granger causality test.

Key Words: Budget deficit, interest rate, cointegration, error correction model.

JEL Classification : H60, H62

1.0 Introduction

The causal relationship between budget deficit and interest rate dates back to Mundel-Flemming model (1962, 1963) which assumes that an increase in budget deficit causes an increase in nominal interest rate with exchange rate appreciation and capital inflows. This has attracted much theoretical and empirical debate in the 1970s, in the backdrop of large and sustained increase of budget deficit in many developing and underdeveloped countries. It has been observed that to meet the growing public expenditure government of these countries borrowed severely from the domestic banking system that lead to the increase of the interest rate and thus crowds out private investment causing adverse impact on domestic output. However, during the 1980s, the Ricardian Equivalence as advocated by Rober Barro (1989) received much attention. This theory strongly advocates that there is no relationship between the budget deficits and the interest rate.

Due to this two diverging viewpoints about the relationship between the budget deficit and the interest rate empirically it becomes a combative and lively issue in the literature. Some of the early studies by Hoelscher (1983), Evans (1985), Darrat (1989), Findlay (1990) and Kormendi & Protopapadakis (2004) have found no significant relationship between the budget deficit and the interest rate. While the other studies by Makin (1983), Tanzi (1985), Cebula (1988), Zahid (1988), Vamvoukas (1997), Baer (2003) and Dai & Philippon (2004) have found a significant positive relationship between the budget deficit and the interest rate.

Bangladesh, a small open economy has been facing huge budget deficit over the years to meet it growing public expenditure. For Bangladesh public borrowings mostly based on domestic banking system. The interest rate on the loanable funds is also double digit. It is thus imperative to examine empirically the dynamic causal relationship between the budget deficit and the interest rate.

The study is based on the annual data from 1974 to 2014. In order to analyze short-run dynamics and long-run relationships among budget deficits and interest rate, the study make use of Vector Autoregression (VAR) and Vector Error Correction (VEC) specifications. As unrestricted VARs do not impose co-integration on its variables, a VEC model needs to be set up if the variables are known to be non-stationary and cointegrated. The study will use both the ADF and PP test to see whether the considered variables are stationary or not. Then the Johansen Juselius test will be applied to examine the cointegration of the variables. Finally error correction models and Granger causality tests will be applied to examine the short run dynamics of long run relationship between trade deficits and the interest rate.

The rest of the paper is organized as follows. Section 2 throws a birds eye view on the existing theoretical and empirical literatures. Analytical framework is presented section 3. Section 4 describes the estimation and interpretation of results. Finally section 5 concludes the study.

2.0 A Brief Review of the Literature

There is a diversity of theoretical and empirical literature on the relationship between the budget deficit and macroeconomic fundamentals for the developed countries. However, there is a scarcity of literature regarding developing countries like Bangladesh.

A very early study by U.S. Treasury Department (1984) show that deficits do *not* impact either short-term rates or long-term rates, i.e. deficits have at most a negligible effect on raising real interest rates (Treasury, 1984: p.82).

Leanne J. Ussher (1998) found that models which take account of multi-asset markets, investment accelerators and consider the alternative causality - interest rates to budget deficits. And also suggests that such models provide a richer understanding to the interaction between deficits and interest rates in their institutional setting.

Gale and Orsza (2004) provided new evidence that sustained budget deficits reduce national saving and raise interest rates by economically and statistically significant quantities.

Mukhtar and Zakaria (2008) showed that budget deficits do not have significant effect on nominal interest rates. These result reveals that the existence of the Ricardian deficit neutrality in Pakistan.

Bayat, Kayhan, and Senturk (2012) demonstrated that there is no causal relation between budget deficits, budget deficit ratio to gross domestic product and nominal interest rate in the Turkish economy during years between 2006 and 2011. Results reveal the existence of Ricardian equivalence hypothesis.

Obi and Nurudeen (2008) conducted an empirical test on the effects of fiscal deficits and government debt on interest rate in Nigeria. The objective of the study was to investigate the effect of fiscal deficits and government debt on interest in Nigeria. They employed Vector Auto-regression approach (VAR). Their empirical conducted focused on interest rate as being captured by the lending rate earlier specified by Bhalla(1995) and Deepak Lal et al. (2002) and the major findings of their study show that the explanatory variables account for approximately 73.6 percent variation in interest rate in Nigeria. The estimation also shows that fiscal deficits and government debt (our variable of interest) are statistically and economically significant.

It is evident that the results of the early studies are inconclusive. For Bangladesh no such studies have conductive to examine the dynamic causal relationship between the budget deficit and the interest rate. The study applies standard times series techniques of cointegration and error correction models to examine the relationship between the budget deficits and interest rate for Bangladesh considering a long span of data (1980-2014).

3.0 Analytical Framework[1]

3.1 Data

This study is based on the annual data of 1974 to 2014 periods taken from the various issues of Bangladesh Economic Survey published by the Ministry of Finance. The paper considers the average lending rate by the commercial banks as the interest rate (R) and the difference between the government income and expenditure as the budget deficit (BD). Nominal values of both the figures are considered. The natural logarithmic scale BD has been used to view the percentage changes. The data has been processed and the results have been derived by using econometric software E-views.

3.2 Granger Causality Test

The direction of causal relationship between two variables can be examined by the widely applicable Granger Causality test. According to this test in a two variable framework a variable X causes another variable Y if Y can be explained better by the current and lagged values of X than by the past values of Y alone assuming that both X and Y are stationary variables. Considering time series data in a two variables system the test is based on the following set of equations (Gujrati 2003):

$$Y_t = \alpha + \sum_{i=1}^{m} \beta_i Y_{t-i} + \sum_{j=1}^{n} \varphi_j X_{t-j} + \varepsilon_t \quad \ldots\ldots\ldots\ldots\ldots (1)$$

$$X_t = \chi + \sum_{i=1}^{m} \phi_i X_{t-i} + \sum_{j=1}^{n} \mu_j Y_{t-j} + \nu_t \quad \ldots\ldots\ldots\ldots\ldots (2)$$

where, ε_t and ν_t are white noise error term and assumed to be stationary, and m and n are the number of lags determined by Akaike's information criterion (AIC). Equation (1) shows that current Y depends on the past values of itself as well as that of X and equation (2) postulates a similar relationship for X. Given the above specification the statistical significance of the coefficients implies the causal relationship between the variables. It can be tested whether there is unidirectional causality from X to Y or Y to X. The statistical test can also establish feedback or bilateral causality or independence between the variables.

[1]This section draws on Hossain, M.A. (2015)

The test statistic applied to conduct the Granger test is ususal F calculated as follows:

$$F = [(RSS_r - RSS_{ur})/m] / [RSS_{ur} / (n - k)]$$

which follows F distribution with m and (n – k) degrees of freedom (df). Here m is the number of lagged values of X included in equation (1) and k is the number of parameters estimated in the unrestricted equation. X is said to Granger causes Y if the computed F statistics is greater than the tabulated values at the specified degrees of freedom that is computed F is significant at the conventional level. The same procedure can be applied to test causality on the other way i.e. from Y to X (Gujrati: 2003).

3.3 Cointegration Test and Error Correction Models

The presence of cointegration between variables provides the basis for modeling both the short run and long run relationship simultaneously. If two variables Y_t and X_t are cointegrated, then according to Granger representation theorem (Engle and Granger, 1987) the relationship between them can be expressed as the error correction mechanism as follows:

$$\Delta Y_t = \lambda_1 Z_{t-1} + \sum_{i=1}^{k} \delta_i \Delta X_{t-i} + \sum_{j=1}^{k} \pi_j \Delta Y_{t-j} + u_{1t} \quad \ldots\ldots\ldots(3)$$

$$\Delta X_t = \lambda_2 Z_{t-1} + \sum_{i=1}^{k} \tau_i \Delta X_{t-i} + \sum_{j=1}^{k} \zeta_j \Delta Y_{t-j} + u_{2t} \quad \ldots\ldots\ldots(4)$$

where, $Z_t = Y_t - \gamma X_t$, and u_{1t} and u_{2t} are white noise error terms. In the above equations, the series Y_t and X_t are cointegrated when at least one of the coefficients λ_1 or λ_2 is not zero and thus calls for short run dynamics of the long run relationship between Y_t and X_t. X_t will lead Y_t in the long run if $\lambda_1 \neq 0$ and $\lambda_2 = 0$. If $\lambda_2 \neq 0$ and $\lambda_1 = 0$ then Y_t will lead to X_t. However, the feedback relationship exists between Y_t and X_t if both $\lambda_1 0$ and $\lambda 2 \neq 0$. Besides short run dynamics between Y_t and X_t are characterized by the coefficients δ_i's and ζ_j's. If δ_i's are not all zero, changes in X_t will lead to Y_t in the short run. If ζ_j's are not all zero, changes in Y_t will cause X_t in the short run (Woolridge: 2003).

3.4 Empirical Methodology

To apply the cointegration test and to estimate error correction models, we must first examine the time series properties of the investment and output variables by unit root tests. This is accomplished by applying augmented Dickey-Fuller (ADF) test, which is based on the following regression equation with a constant and a trend:

$$\Delta Y_t = a_1 + a_2 t + bY_{t-1} + \sum_{i=1}^{m} \rho_i \Delta Y_{t-i} + \upsilon_t \quad \ldots\ldots\ldots(5)$$

where, $\Delta Y_t = Y_t - Y_{t-1}$ and Y is the variable under consideration, m is the number of lags in the dependent variable, is chosen by Akaike information criterion and υ_t is the

stochastic error term. The null hypothesis is that the coefficient of Y_{t-1} is zero. The rejection of null hypothesis establishes the stationarity of the series and no differencing is required to induce stationary. Otherwise differencing of the series is necessary to make them stationary.

The next step is to search for cointegration between variables. This can be done either by Engle-Granger two steps cointegration procedure or by Johansen-Juselius cointegration technique. We relied on Johansen-Juselius cointegration techniques because our sample size is small and by this we can avoid the defects of the Engle-Granger test. This test relied on the relationship between the rank of matrix and its characteristic roots. This test involves checking two test statistics to identify the number of cointegrating vectors. These are the trace statistic and the maximum eigenvalue test statistic. The Trace test statistic for the null hypothesis that there are atmost *r* distinct cointegrating vectors is

$$\lambda_{trace} = T\sum_{i=r+1}^{N} \ln(1 - \lambda_i) \quad \text{.....(6)}$$

where, λ_i's are the N-*r* smallest squared canonical correlations between X_{t-k} and ΔX_t (where $X_t = (BD_t\ R_t)'$and where all variables in X_t are assumed I(1)), corrected for the effects of the lagged differences of the X_t process.

The maximum eigenvalue statistic tests the null that the number of cointegrating vectorsis *r* against the alternative of $r + 1$ cointegrating vectors is given by

$$\lambda_{\max} = -T\ln(1 - \lambda_{r+1}) \text{.....(7)}$$

Johansen (1988) shows that equations (6) and (7) have non-standard distributions under the null hypothesis and provide approximate critical values generated by Monte Carlo methods.

The third step is the estimation of error correction model as specified in equation (3) and (4). Finally, standard F test has been used to examine the causality and feed back relationship between the time series.

4. Discussion of the Results

Based on the methodology discussed above, the budget deficit and interest rate series have been tested for the unit root suggested by ADF test and is further checked by PP test. The test is used to check whether the considered series are stationarity or not. Here we have applied the test to both the original series and to the first differences. In addition, both the models with and without trend are tested. The exact lag length, which is crucial in time series analysis, is determined by Akaike's information criterion. The results are reported in table -1.

Table- 1: Unit Root Tests (ADF) for the period 1974-2014

Without Trend		
Variables	**Series in Levels**	**First Differences**
LBD	-2.03	-4.57***
R	-2.02	-6.70***
With Trend		
Variables	**Series in Levels**	**First Differences**
LBD	-2.00	-5.02**
R	-1.09	-6.70**

Note: i)*** and ** indicates significance at 1% and 5% respectively.

ii) The optimal lag length has been considered to be 4 according to the Akaike information criterion.

Source: Own calculations by using econometric software E-views.

The ADF test result indicates both the budget deficit and interest rate series non-stationary at their levels both in inclusion of trend or non inclusion of trend in the model. However, taking first difference makes them stationary implying that the variables LBD and R are integrated of order one, i.e. I(1). The integration of order one of the variables indicate that is necessary to apply cointegration tests to determine whether there exist a stable long run relationship among them in Bangladesh. We applied the Johansen and Juselius approach to establish the cointegrating vectors. The result is presented in the following table-2.

Table – 2: Johansen and Juselius Test of Cointegration

Data Vector	Lag	Hypothesis	λ Trace	λ Max
LBD, R	1	r <=0	16.08	15.42
		r <=1	1.05**	1.05**

Notes: i) we have experimented with a number of lags and found 4 to be the optimal lag length. The null hypothesis states that there doesn't exist at most *r* cointegrating relationship among the variables. ii) ** indicates significance at 5% level.

Source: Own calculations by using econometric software E-views.

Table-2, presents the maximum eigen-value and trace tests of Johansen and Juselius (1990). These are complementary versions of the same test to determine the cointegration

rank, *r*. Both the eigen value and trace statistic suggest that the budget deficit and interest rate are cointegrated in Bangladesh implying that the considered variables maintain a stable long run relationship meaning that budget deficit has long run impact on interest rate in Bangladesh. However, in the short run they may drift apart, i.e. they may be in disequilibrium. To take care of this disequilibrium, we need see the short run dynamics between the variables, which can be examined by error correction mechanism. The result is shown in table-3.

Table – 3: Estimation of Error Correction Model

Independent Variable	Dependent Variable	
	D(LY)	D(LI)
Zt-1	0.204727 [3.47826]	0.253187 [2.55549]
D(LY(-1))	-0.299867 [-2.51603]	0.316056 [1.57543]
D(LY(-2))	-0.501121 [-4.30434]	-0.053572 [-0.27337]
D(R(-1))	0.15771 [1.50455]	-0.030571 [-0.17326]
D(R(-2))	-0.151318 [-2.50040]	-0.080081 [-0.78613]
C	0.224607	0.143938

Note: i) Figures in the Parenthesis represents t statistic.

Source: Own calculations by using econometric software E-views.

Table–3 reveals that the coefficient of the error correction term is statistically significant in the two equations implying that the changes in the budget deficit causally affect interest rate in the short run. It is also seen from the table that the coefficients in the lag terms are also positive and statistically significant. The implication is that the budget deficit has positive impact on the interest rate and the impact is not instantaneous. It implies that current budget deficit may have positive impact on future interest rate as well, which is very likely and is theoretically and empirically supported by both the

endogenous and exogenous growth models. It is also interesting to see that there is both way causal relationship between budget deficit and the interest rate. This result is also supported by the Granger causality test as shown in the following table-4.

Table – 4: Direction of Causality (Granger Causality Test)

Null Hypothesis	Obs	F-Statistic	Probability
LBD does not Granger Cause R	40	4.041 03***	0.00308
R does not Granger Cause LBD		9.30314**	0.00140

Note: *** and ** indicate significance at 1% and 5% respectively.
Source: Own calculations by using econometric software E-views.

5. Conclusion and Policy Implications

The paper examines the dynamic linkage between the budget deficit and interest rate in Bangladesh over a long period of time by applying standard techniques of time series analysis, i.e. cointegration, error correction models and Granger causality tests. It is evident that the data series are integrated of order one, i.e. they are non stationary at their levels and first difference makes them stationary. Then Johansen Juselius technique established that the considered variables are cointegrated, implying that there is a stable long run relationship between the two. However, to take care for the short run disequilibriating relationship, we have estimated the error correction model, which shows that the impact of budget deficit on interest rate is not instantaneous. The error correction model also shows bidirectional causality between the variables, which is also supported by the Granger causality test.

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