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Budget deficit and growth: In search of ceiling for Bangladesh

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Abstract: The impact of fiscal deficit measured by deficit in national budget on the growth of respective economy has been a widely researched area with plenty of debatable results. Shedding light in search of the optimum level of budget deficit, the current paper tried to contribute to the field of literature on this issue which is perhaps inadequate as far as Bangladesh economy is concerned. A total of 40 years of time series data spanning form 1975 - 76 to 2014 - 15 has been employed. Identification of integration order of the variables was examined performing Augmented Dickey Fuller (ADF), Phillips - Perron (PP) and Kwiatkowski-Phillips-Schmidt-Shin (KPSS) tests. Establishing the existence of cointegration among variables following the Johansen's procedure, long run cointegrating vector has been estimated depending on VECM. The threshold has been identified solving the estimated long run cointegrating relationship for a local maximum. Findings can be summarized by saying that the long run impact of budget deficit on growth would remain positive; nevertheless, there would be no short run adjustment. Depending on the model definition and the particular exogenous variable(s), the threshold budget deficit has been measured to range between 4.55 to 5.0 percent of GDP.

JEL Classifications: H620, O400, C320

Keywords: Economic growth, budget deficit, threshold, cointegration, stationarity, VECM
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1. Introduction

The impact of fiscal deficit on the growth of respective economy has been a widely researched area with plenty of debatable results. The obvious differences in findings are expected not only because of the development stage the every country is in but also how the country addresses the financing issue of the fiscal deficit. However, the issue is more important for the developing countries than the developed one since they always have a target growth level as a part of their development policy. Alongside the foreign assistance, it requires a sustainable increase in domestic expenditure from government perspective to achieve and maintain the target growth in those countries. On the way of doing so many of these countries usually face a deficit on their budget balance. Bangladesh is not an outlier in this regard. Reaching the social and economic benchmarks of "Vision 2021" and "Perspective Plan" requires sustainable increase in GDP growth with a target level of 8 per cent by the end of "7th Five Year Plan". As a development effort the government of Bangladesh, therefore, has been increasing the expenditure since the inception of the economy. Similar as the most developing countries this increasing pattern of expenditure led the budget balance of Bangladesh economy to ever remain in deficit. Figure 1A (Appendix) presents a snapshot of periodical average budget deficit that the economy has been going through.

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It can be argued from the trend that budget deficit in terms of percentage of GDP came down in recent years compared to what it was in 70's and 80's. In the second half of 70s the average deficit was 6.57 per cent which dropped down to 4.36 per cent in the first half of current decade. Although the amount has always been hovering around 4 to 6 percent, a keen look in the individual average values and also the size in absolute value of budget deficit would establish that in recent years the economy has been experiencing some sort of stimulation in the deficit. One explanation for this could be such that the rate of increase in revenue effort has not been sufficient enough to meet the rate of increase in public expenditure. Thus, it would be interesting to study quantitatively:

- What is the impact of budget deficit on the growth potential of Bangladesh's economy?
- What might be the maximum level of budget deficit that the economy can tolerate while maximizing growth?

If the maintained amount of deficit found to be well below the threshold, then the economy can increase the public expenditure even further, addressing the issue of deficit financing properly. On the contrary, if the maintained amount is found to be above the threshold, then the economy can cut the expenditure for growth enhancement.

This study has been developed in the following way: First section represents backgrounds and motivational description under introduction. A description of existing literature is presented in section two. Section three includes the discussion regarding methodological process and data. The estimation results and analysis have been included in section four. Finally, the section five concludes including the summery of the study.

2. Literature review

Theoretically, the three different kinds of relationships generally exist between budget deficit and economic growth. Keynesian advocates the positive relationship between budget deficit and economic growth. Neo-Classical view on the other hand explains the opposite relationship between budget deficit and economic growth. However, Ricardian approach says no relationship between budget deficit and economic growth (Ahmad, 2013). According to Keynesian view, deficit budget accelerates the growth of GDP in the developing countries. Because deficit budget occurs when expenditure exceeds the revenue earned from collecting tax and non-tax. Thus, increase of disposable income or increase of consumption (either private or public consumption, i.e. government expenditure) will increase the aggregate demand of a country and ultimately this will enhance the GDP growth. Unfortunately, this process will not continue up to the infinite time period and might bring different result rather; it will be valid only in the short run. Since people are forward looking (at least in the long run), they will take their spending decision not only based on their current income but expected future income. As a result, consumer will save rather than spend implying neutral relationship between deficit budget and economic growth; which is also known as Ricardian equivalence (Mankiw, 2010).

Many research works have been done to find out the relationship between budget deficit and economic growth. Depending on the geographical location of the place or places the works concerned with they can be divided into two broad groups: "International Perspective" and "Bangladesh and South Asian Perspective".

International perspective

The relationship between budget deficit and economic growth from Malaysian perspective has been examined by Rahman (2012) and Lee & Ng (2015). Rahman (2012) used quarterly data for the period 2000 to 2011 for four variables namely GDP, government debt, productive expenditure and nonproductive expenditure to develop an ARDL model. It was found that there is no long-run relationship between budget deficit and economic growth in Malaysia. In a similar study, Iya et al. (2014) tried to estimate the effect of fiscal deficit on economic growth for Nigeria using time series data for the period 1981 to 2009. Exploiting Granger causality and Johansen cointegration procedure, they have also found no evidence to support the long-run relationship between real GDP and government fiscal deficit in Nigeria. Using panel data model, Van & Sudhipongpracha (2015) have explored the relationship between government budget deficit and economic growth for Vietnam. They have estimated a fixed effect panel data model using five Southeast Asian countries for the period 1989 to 2011. It was found that Vietnamese national government fiscal deficit had no direct impact on the country's economic progress.

Unlike to Rahman (2012), Iya et al. (2014) and Van & Sudhipongpracha (2015), Awe & Funlayo (2014) found significant long-run relationship between budget deficit and economic growth for Nigerian economy. They have also used Johansen cointegration test and developed an Error Correction Model (ECM) exploiting time series data for the period 1980 to 2011. The findings of ECM have suggested that in the short run the impact of budget deficit on the growth is negative and significant. On the other hand, Lee & Ng (2015) estimated a simple growth model with OLS using time series yearly data from 1991 to 2013. Unlike to Rahman (2012), Lee & Ng (2015) found that budget deficit adversely affects economic growth of Malaysia. Odhiambo et al. (2013) tried to examine the impact of fiscal deficit on economic growth for Kenya. By using time series data spanning from 1970 to 2007 and OLS as the estimation technique, it was observed that there is a positive impact of fiscal deficit on economic growth in Kenya. Duokit & Ekong (2016) tried to investigate the same relationship between budget deficit and economic growth for Sierra Leone. The Engle-Granger Two Step procedure has been applied using annual time series data spanning from 1980 to 2009. The study has also found positive impact of budget deficit on the economic growth of the country.

Onwioduokit & Bassey (2014) have estimated Threshold Autoregressive Model (TAR) model to find the threshold level of fiscal deficit for Gambia exploiting annual time series data for the period 1980 to 2009. The study has used Engle-Granger cointegration test for identifying the long-run relationship. It found a positive effect of fiscal deficit on real GDP growth of Gambia. The study also identified an optimum 6% threshold level of fiscal deficit for Gambia. Adam & Bevan (2005) has found threshold effect at a level of fiscal deficit of 1.5% of GDP using a panel of 45 developing (non-OECD) countries for the period 1970 to 1999. A growth payoff has been observed for reducing deficit to this level; nevertheless the magnitude of the payoff is subject to deficit financing method. They have also found evidence for interaction effect arguing that high debt stock will exacerbate the adverse effect of high fiscal deficit. Salma et al. (2016) observed double threshold effect of fiscal balance on economic growth while using threshold least square regression approach using a panel of 40 developing countries over the period 1990 to 2012. The first threshold is found at a fiscal deficit level of 4.8% while the second threshold is observed at a fiscal surplus level of 3.2% of GDP. They conclude that economic growth will be affected adversely whenever supersede these two numbers. Arestis et al. (2004) used Threshold Autoregressive Model (TAR) to find the threshold effect for the US budget deficit exploiting quarterly data spanning from 1947 to 2002. The study revealed that government would intervene for reducing deficit only when it reached a specific threshold.

Bangladesh and South Asian perspective

Vuyyuri & Seshaiah (2004) have tried to study the interaction of budget deficit with other macroeconomic variables for India. Annual time series data for the period 1970 to 2002 have been used to follow a cointegration approach and develop a VECM. The findings revealed that there is no significant relationship between budget deficit and GDP. Using annual time series data for the period 1971 to 2007, Ahmad (2013) also found insignificant relationship between budget deficit and economic growth for Pakistan. In terms of Granger causality although it found bidirectional relationship between budget deficit and GDP, Vuyyuri & Seshaiah (2004) found only GDP Granger causes budget deficit. A similar study for Bangladesh economy done by Asrafuzzaman et al. (2013); they found that budget deficit Granger causes trade deficit and vice versa in the short run but not in the long run. This study concludes that government should reduce budget deficit for improving the trade balance.

Unlike to Vuyyuri & Seshaiah (2004) and Ahmad (2013), Mohanty (2012), Fatima et al. (2012) and Hassan & Akhter (2014) found significant adverse effect of budget deficit on economic growth for India, Pakistan and Bangladesh respectively. Another study done by Fatima et al. (2011) using simultaneous equation model and Two Stage Least Square (2SLS); the estimation method tried to estimate the direct and indirect impact of fiscal deficit for Pakistan. It also found that fiscal deficit adversely affect the economic growth of the country.

Aslam (2016) exploited Johansen cointegration technique and Vector Error Correction Model (VECM) as the estimation technique using annual time series data spanning from 1959 to 2013. It found that although there is long-run relationship between budget deficit and economic growth in Sri Lanka, no significant short-run relationship has been observed. In particular, the findings showed that Sri Lankan budget deficit has a positive effect on the county's economic growth. Navaratnam & Mayandy (2016) examined the impact of fiscal deficit on economic growth in selected South Asian countries (Bangladesh, India, Nepal, Pakistan and Sri Lanka). Applying cointegration, error correction and Granger causality with an annual time series data spanning from 1980-2014 they found that fiscal deficit has a negative impact on economic growth. However, they found that fiscal deficit causes economic growth in Bangladesh.

Therefore, although there are many studies about finding out the impact of deficit budget on economic growth of a country in the field of research worldwide, the number is not very large as far as only Bangladesh is concerned. Also, very few of them devoted to find out the optimum amount of budget deficit, the threshold of budget deficit. Consequently, a study with appropriate data and variable in this regard for Bangladesh would be a valid contribution.

3. Data and methodology

Data and variables

The current study exploits yearly data spanning from 1975-76 to 2014-15 for Bangladesh to address the questions mentioned in section one. Different issues of Statistical Year Book of Bangladesh, Bangladesh Economic Review and World Development Indicators (WDI) were the sources of data. Assuming that GDP growth follows a regular Cobb-Douglas production function we have estimated the growth equation with budget deficit, trade GDP ratio and money supply as exogenous along with the principle variables, labor and capital. Hence, the following function would be estimated:

$$RGDP = f(GP1564, GFCF, M2, TSGDP, BD)$$

Here $RGDP$ is the constant price GDP, $P1564$ is the growth of working age population used as proxy of labor, $GFCF$ is the gross fixed capital formation used as the proxy of capital, $M2$ is the proxy of money supply, $TSGDP$ is the trade GDP ratio and BD is the budget deficit.

Testing the stationarity and finding the integration order

Before applying the standard time series econometric technique for the estimation the stationarity status of all the variables have been examined using Augmented Dickey Fuller (ADF) (Dickey & Fuller, 1979), Phillips-Perron (PP) (Phillips & Perron, 1988) and Kwiatkowski-Phillips-Schmidt-Shin (KPSS) (Kwiatkowski, Phillips, Schmidt, & Shin, 1992) test. The former two methods test the nonstationarity of the variable against stationarity while the later one does the same in the other way around.

On a general note for testing the stationarity status of a variable in the model the following test regression has been estimated:

$$\Delta y_t = \alpha y_{t-1} + \sum_{i=1}^{p} \gamma_i \Delta y_{t-i} + x_t'\delta + u_t$$

Here, y_t is the variable of concern; x_t contains deterministic components of either drift term or both drift and trend term; and u_t are assumed to be white noise. The significance of α has been tested using the following test statistic:

$$\tau = \frac{\hat{\alpha}}{SE(\hat{\alpha})}$$

The PP stationarity testing procedure differs from the conventional ADF one on the ground of dealing with serial correlation and heteroscedasticity in the errors differently. While the ADF procedure follows a parametric method to tackle the serial correlation, the PP process suggests following a nonparametric design. In this case the estimated test regression would be as follows:

$$\Delta y_t = \alpha y_{t-1} + x_t'\delta + u_t$$

The significance of α has been tested using the following test statistic:

$$\tilde{t}_\alpha = t_\alpha \left(\frac{\gamma_0}{f_0}\right)^{1/2} - \frac{T(f_0 - \gamma_0)(SE(\hat{\alpha}))}{2f_0^{1/2}S}$$

Here $\tilde{t}_\alpha$ is assumed to have an asymptotic distribution which is independent of serial correlation in the test regression. Additionally, γ_0 is a consistent estimate of the error variance in test regression; f_0 is an estimator of residual spectrum at zero frequency; t_α is the t - ratio of α; $SE(\hat{\alpha})$ is the coefficient standard error; and S is the regression standard error.

As mentioned earlier, the KPSS procedure differs from the above two procedures in the sense that it assumes stationarity of the concerned variable under null. The test regression can be considered to take the following form:

$$y_t = x_t'\delta + \alpha_t + u_t$$

$$\alpha_t = \alpha_{t-1} + \varepsilon_t$$

Similar as before, here y_t is the variable of concern; x_t contains deterministic components; and ε_t is a white noise process. The null hypothesis saying that y_t is stationary has been tested using the following Lagrange multiplier (LM) KPSS test statistic:

$$KPSS = \frac{\left(T^{-2}\sum_{t=1}^{T}\hat{S}_t^2\right)}{\hat{\lambda}^2}$$

In the above formula, $\hat{S}_t = \sum_{j=1}^{t}\hat{u}_j$, $\hat{u}_t$ is the residual from the regression of y_t on x_t; and $\hat{\lambda}^2$ is the consistent estimate of the long-run variance of $\hat{u}_t$.

Selection of lag order, estimation of VAR and cointegration test

After identifying the integration order of the variables in estimation process we tried to estimate a Vector Autoregressive (VAR) model with proper lag length for performing the statistical test of the existence of long run equilibrium relationship among the variables, popularly known as cointegration test. The appropriate lag selection is considered as vital because of the tradeoff of degrees of freedom and as well as risk of autocorrelation resulting from model misspecification. Following multivariate version of Schwarz Baysian Information Criterion (BIC) and Akaike Information Criterion (AIC) have been minimized to select the lag order:

$$BIC(p) = ln\left(det(\hat{\Sigma})\right) + \frac{k(kp+1)ln(T)}{T}$$

Where, $\det(\hat{\Sigma})$ is the determinant of $\hat{\Sigma} = \frac{\sum_{t=1}^{T} \widehat{u_t} \hat{u}_t'}{T}$. By definition when $\ln(T)$ has been replaced by 2 in the above expression the resulting formula stands for AIC.

The presence of long-run equilibrium relationship has been tested following the procedure suggested by Johansen (1988). Following the representation of Enders (2008) and allowing for higher order autoregressive process the Johansen cointegration test has been performed estimating the regression given by:

$$\Delta y_t = \Lambda_0 + \gamma y_{t-1} + \sum_{i=1}^{p-1} \gamma_i \Delta y_{t-i} + u_t$$

Where, y_t is a $(n*1)$ vector of variables in the process; Λ_0 is the $(n*1)$ vector of constants; u_t is the $(n*1)$ vector of errors with mean zero and variance Σ_u, $\gamma = -\left(I - \sum_{i=1}^{p} \Lambda_i\right)$ with I as $(n*n)$ identity matrix and Λ_i as $(n*n)$ matrix of parameters and $\gamma_i = -\sum_{j=i+1}^{p} \Lambda_j$. The Johansen diagnostic procedure depends on the association of rank and characteristic roots of γ matrix in the above equation. For example, $rank(\gamma) = 1$ would imply that there is one characteristic root of matrix γ that differs from zero establishing the existence of one cointegrating vector. In practice the following two test statistics have been calculated:

$$\theta_{trace}(r) = -T \sum_{i=r+1}^{n} ln\left(1 - \hat{\theta}_i\right)$$

$$\theta_{max}(r, r+1) = -T ln\left(1 - \hat{\theta}_{r+1}\right)$$

Here, T denotes the sample size and the estimated number of characteristics roots in γ matrix is denoted by $\hat{\theta}$. Two different types of alternative tests have been made under a common null using the above two statistics. Both statistics have tested the null saying that number of distinct cointegrating vector is less than or equal to r. Nevertheless, the alternative is in a general nature for the former statistic while in case of the later it says there is $(r+1)$ cointegrating vectors.

Estimation of long run coefficients and detection of threshold level

Assuming that the unrestricted VAR model with appropriate lag length would have such a γ matrix that satisfies the "reduced rank condition", the corresponding VECM can be represented as follows:

$$\Delta y_t = \Lambda_0 + \rho t + \alpha\beta' y_{t-1} + \sum_{i=1}^{p-1} \gamma_i \Delta y_{t-i} + u_t$$

As the VECM has been presented, it is confirmed that VECM is nothing but a VAR with first difference variables along with cointegration. Here, α and β are the matrix of error correction and cointegrating coefficients respectively. Finally, estimation of the above VECM results in the estimation of cointegrating vectors (i.e. the estimation of long run coefficients) which can be used further to present the long run model in the following manner:

$$\widehat{RGDP}_t = \widehat{\beta_0} + \widehat{\beta_1} BD_t + \hat{\alpha} X_t$$

Here, all α and β would be characterized as the long-run impacts of respective variables on the dependent variable $RGDP$; *BD* is the budget deficit; and X_t is the vector of all other explanatory variables in the system.

For identification of the impact and threshold level of budget deficit, the long-run equation has been augmented with the square of the variable BD anticipating that the sign of its coefficient would be negative as we want to maximize the growth. Hence, solving the first order condition of optimization process for a "local maximum" we would derive the threshold level as follows:

$$\widehat{RGDP}_t = \widehat{\beta_0} + \widehat{\beta_1} BD_t + \widehat{\beta_2} BD_t^2 + \hat{\alpha} X_t$$

First order condition with respect to BD is given by:

$$\frac{\delta \widehat{RGDP_t}}{\delta BD_t} = \widehat{\beta_1} + 2\widehat{\beta_2} BD_t = 0$$

$$or,\ 2\widehat{\beta_2} BD_t = \widehat{\beta_1}, (as\ expected\ sign\ of\ \widehat{\beta_2}\ is\ negative)$$

$$So, Threshold, BD_t^* = \frac{\widehat{\beta_1}}{2\widehat{\beta_2}}$$

In the above expression the numerical value of $\frac{\widehat{\beta_1}}{2\widehat{\beta_2}}$ would be characterized as the growth maximizing level of budget deficit that the country can afford. Considering the method of deficit financing and burden of debt that the economy would incur, when the budget deficit exceeds that threshold, it would be detrimental to country's economic growth in the long run.

4. Estimation results and findings

Testing for mean reversion and detecting integration order for variables

With a purpose of avoiding the risk of having spurious results as a first step we tried to check the mean reverting behavior of the variables and, hence, the stationarity characteristics of them using the several testing procedure. By following the classical time series econometric literature, if a variable has its first two moments i.e. mean and variance remains independent of time then. it would revert its mean and would be regarded as stationary; i.e. technically it would not have any "unit root". Application of all variables with stationary property in estimation process usually would remove the risk of having spurious results. Thus, when the variables are found to be non-mean reverting or nonstationary, one straight forward transformation for restoring stationarity property is to follow "differencing" method. The number of times a researcher has to follow "differencing" to make it mean reverting would be called the "order of integration". For example, when a variable has been found to be mean reverting in the "level" form, the order of integration would be then "zero", i.e. the variable would be I(0). While, if it has to be differenced for once to restore its mean reversion, the order of integration would be "one" i.e. the variable would be I(1).

Table 1 contains the summary of stationary test results. The raw test results, containing values for test statistic along with respective probability, have been presented in Table 1A, 2A and 3A (see the Appendix). As the summary results indicate the variables $LRGDP$ and $LM2$ are stationary in difference under the presence of drift; and both drift and trend follow ADF and PP test. Also, the conclusion remains same for them when we consider both drift and trend in KPSS test for $LRGDP$ and when only drift is considered for LM2. Thus they can be argued as an I(1) variable. The variable $LGFCF$ has been concluded to remain difference stationary in most of the trend specification under ADF and PP test and, therefore, can be characterized as a I(1) in nature.

TABLE 1. SUMMARY OF STATIONARY TEST RESULTS

VARIABLE NAMES	ADF			PP			KPSS	
	NULL: NON STATIONARY (NS)			NULL: NON STATIONARY (NS)			NULL: STATIONARY (S)	
	Trend Specification			Trend Specification			Trend Specification	
	N	C	CT	N	C	CT	C	CT
LRGDP	NS	NS	NS	NS	NS	NS	NS	NS
D(LRGDP)	NS	S	S	NS	S	S	NS	S
LGFCF	NS	NS	S	NS	NS	S	NS	NS
D(LGFCF)	S	S	S	S	S	S	S	NS
LM2	NS	NS	NS	NS	NS	NS	NS	NS
D(LM2)	NS	S	S	NS	S	S	S	NS
TSGDP	NS	NS	NS	NS	NS	NS	NS	NS
D(TSGDP)	S	S	S	S	S	S	S	S
GP1564	NS	NS	NS	NS	NS	NS	NS	NS
D(GP1564)	NS	NS	S	NS	NS	NS	NS	S
BDSGDP	NS	S	S	NS	S	S	NS	S
D(BDSGDP)	S	S	S	S	S	S	S	NS

Note: Here "C" and "CT" indicate "Constant" and "Constant and Trend" respectively, while "N" is for "No Constant and Trend". Besides, "S" and "NS" stands for "Stationary and "Non Stationary".

A keen look on the results would reveal that $TSGDP$ is a difference stationary variable irrespective of trend specification in all three tests that has been applied. Therefore it would be an I(1) variable. When both drift and trend have been considered, the $GP1564$ has been found to become trend stationary following ADF and KPSS test. Finally, the concern variable of the paper, the $BDSGDP$ was also observed to be stationary in the difference in all three tests under no drift and trend specification. Thus, all the variables in the system can be thought to be as difference stationary and regarded as I(1) in nature.

Identification of lag order and estimation of VAR

As all the variables has been concluded to have the same order of integration which is I(1) in particular, according to the standard theory of time series econometrics they might form cointegrating relationship. Intuitively saying, there might exist equilibrium relationship among the variables in the system during long run. The Johansen multi-equation cointegration test has been applied in particular in search of the existence of long run equilibrium relationship. The test argues for estimation of a VAR model with proper lag length. An unrestricted VAR using the above variables has been estimated at first and minimizing the information criterion lag order has been selected. The results have been presented in Table 4A (se the Appendix). It can be observed from the table that the information criterion suggested by Schwarz procedure is minimized at lag length 1, while the same suggested by Akaike is minimum at lag length 3 for model 2, 3 and 4. However, for model 1 both information criterions are minimized with 1 lag. Since for large sample SBC is more credible then AIC we have used 1 lag as the appropriate lag order for estimating VAR model and testing for cointegration.

Testing for cointegration and estimation of cointegrating vector

As discussed in the methodology section, we have performed the Johansen system cointegration test for detecting the presence of cointegration among the variables. Table 5A1, 5A2, 5A3 AND 5A4 (see the Appendix) contains the results. Two test statistics based on "trace" and "eigen value" have been reported. The null hypothesis that has been tested here, initially begins with saying " No Cointegrating Vector" and subject to rejection it has been updated each time saying "At most i Cointegrating Vector" where i may be one, two and so forth. According to the test results, as far as "trace statistic" is considered, we can argue the presence of at best 4 cointegrating vectors among the variables in model 1 and 3. Because, all the null hypotheses saying "At most i Cointegrating Vector" where i varies from 0 to 4 can be comfortably rejected for having low probability value. Following similar conclusion, it can be stated that there might remain at best 5 and 6 cointegrating vectors among variables in model 2 and 4 respectively. Alongside when the test results based on "eigen value" has been considered, it was revealed that there might exist at best 1 cointegrating vector among the variables in model 1, 3 and 4. Thus, it can be argued with evidence that there exists cointegration or long-run equilibrium relationship among these variables.

The cointegrating vector containing the long-run coefficients has been estimated following the estimation of a VECM. In particular, we have given effort to measure the long-run impact of budget deficit on economic growth measured by growth of real GDP and a level of threshold for the budget deficit while maximizing the growth.

Table 2 contains the estimation results of cointegrating vector of coefficients for all the models. As the table shows, the model 1 is the basic economic model with variables $LRGDP$, $LGFCF$, $GP1564$, $BDSGDP$ and $SBDSGDP$. The long-run impact of GDP growth with respect to gross fixed capital formation, growth of working age population and budget deficit as share of GDP has found to be statistically significant. In particular, it can be stated from the results that 1 percent increase in gross fixed capital formation will bring an increase in GDP growth by 0.457 percent in the long run holding other things else constant. The responsiveness of GDP growth against working age population growth is negative. It could be due to the fact that the economy is already overburdened with population size. Besides, because of low investment within the economy in relation to the necessity level and lack of appropriate skill a significant portion of the working age population remain unemployed and thus failed to contribute to the economy. Along with this variables model 2 has been augmented with an exogenous variable $LM2$ which is the money supply. The estimation results revealed for this model the long-run impact of gross fixed capital formation and budget deficit remained positive and significant as before, however the growth of working age population turned out to be insignificant though it contains the previous sign. In model 3 we dropped the exogenous variable $LM2$ and augmented the original model with another exogenous variable $TSGDP$, i.e. trade share of GDP. Here the conclusion regarding the long-run impact of gross fixed capital formation, growth of working age population and budget deficit as share of GDP remained same as in the model 1. Also the magnitude of the coefficients of those variables revealed to be quite close to what they had earlier in case of model 1. Nevertheless, the long-run impact of trade share of GDP has been observed to be though positive but very small and insignificant statistically. Finally, we have made the model a generalized one by augmenting it with both exogenous variables, i.e. $LM2$ and $TSGDP$, together with all other original variables which were present in the model. The estimation results of model 4 reveal that the long run responsiveness of GDP growth with respect to gross fixed capital formation, growth of working age population and budget deficit would be positive. More specifically the response with respect to the mentioned variables would be 1.11 (significant at 5 percent level), 0.168 (significant at 10 percent level) and 0.831 (significant at 1 per cent level) respectively. Although the sign of variable LM2 has been found to be expected it turned out to be insignificant. On the other hand, though TSGDP revealed to be significant, its sign altered to an unexpected direction.

TABLE 2. ESTIMATION OF COINTEGRATING VECTORS: LONG RUN COEFFICIENTS

	MODEL 1	MODEL 2	MODEL 3	MODEL 4
LRGDP	1.000	1.000	1.000	1.000
	-	-	-	-
LGFCF	-0.457*	-0.363*	-0.464*	-1.112**
	(0.019)	(0.089)	(0.024)	(0.441)
GP1564	0.103*	0.025	0.099*	-0.168***
	(0.010)	(0.016)	(0.014)	(0.091)
LM2		-0.131**		-0.233
		(0.058)		(0.263)
TSGDP			-0.0004	0.018*
			(0.001)	(0.006)
BDSGDP	-0.093*	-0.210*	-0.082*	-0.831*
	(0.024)	(0.029)	(0.027)	(0.122)
SQBDSGDP	0.010*	0.021*	0.009*	0.090*
	(0.024)	(0.002)	(0.002)	(0.011)
Constant	-5.149	-5.036	-5.076	-4.699
ECT	0.053	0.009	0.053	0.001
	(0.035)	(0.378)	(0.034)	(0.005)
Threshold	4.65	5.00	4.55	4.61
NULL: NO HETEROSCEDASTICITY IN VECM RESIDUALS				
χ^2	418.865	745.928	764.125	481.810
Prob.	0.306	0.381	0.221	0.130

Note: Numbers inside the parenthesis show standard errors;. * , **, and *** - indicate significance at 1%, 5% and 10% level respectively.

Since one of our purpose was to estimate the level of threshold of budget deficit for the economy, all the aforementioned models contain the variable $SQBDSGDP$ which is the square of budget deficit as share of GDP. Addition of this variable made all the models nonlinear in variables. According to the discussion in methodology section, maximization of GDP would require a positive coefficient of budget deficit shares of GDP while a negative coefficient of square of budget deficit shares of GDP. In all the models these two variables has been examined to be statistically significant along with the expected sign. However, the magnitudes of these coefficients were different for different models. Following the required calculation using the coefficients of the aforementioned two variables, it was found that the threshold level of budget deficit for the economy would be 4.55, 5.00, 4.65 and 4.61 percent of GDP for model 1, 2, 3 and 4 respectively. Thus, if anyone considers original model only with money supply as the exogenous variable then budget deficit in excess of 5 percent would be detrimental; while if the general model, i.e. model 4, is considered, the maximum tolerable level of deficit would be 4.61 percent of

GDP for the economy. One factor should be worth mentioning here that none of the above models have the error correction term (ECT) as statistically significant establishing the absence of short run adjustment among these variables. Figure 2A (see the Appendix) presents the graph of cointegrating relationship among the variables in all 4 models.

Post estimation diagnostics: Heteroscedasticity and autocorrelation

As post estimation diagnostics equal variance (homoscedasticity) and independence of VECM residuals (no autocorrelation) has been examined following White's heteroscedasticity test and Portmanteau test of autocorrelation respectively. Table 2 and 3 contains the test results. The null hypothesis saying that "No Heteroscedasticity in VECM residuals" was tested using χ^2 statistic calculated following White's procedure. The results showed that the probability value for all χ^2 statistics in all 4 models is sufficiently higher leading to the non rejection of abovementioned null. Therefore, spreadness of the distribution of VECM residuals remained constant in all models. Again, the null hypothesis for Portmanteau test would be stated as "No Autocorrelation up to lag h" where h is the length of lag of residuals up to which the independence of residuals would be tested. Specifically, for all models we have examined the independence of VECM residuals for a maximum lag length of 5. As the results shows for none of the models we have not been able to reject the null hypothesis of autocorrelation among VECM residuals due to sufficient large probability values. Thus the residuals can also be argued to be independent from each other at least up to lag length 5.

TABLE 3. PORTMANTEAU AUTOCORRELATION TEST FOR VECM RESIDUALS

	MODEL 1		MODEL 2		MODEL 3		MODEL 4	
	NULL: NO RESIDUAL AUTOCORRELATION UP TO LAG H							
Lag Order (h)	Q - Stat.	Prob.	Q - Stat.	Prob.	Q - Stat.	Prob.	Q - Stat.	Prob.
1	8.211	-	12.803	-	10.302	-	19.384	-
2	21.576	0.998	36.089	0.999	42.115	0.990	62.578	0.990
3	34.796	0.999	58.720	0.999	62.305	0.999	90.434	0.999
4	48.236	1.000	85.138	0.999	90.545	0.999	142.530	0.995
5	73.319	0.999	117.35	0.999	125.76	0.997	183.622	0.996

Note: * - indicates significant at 1% level.

5. Conclusion

Considering the particular stage of development the Bangladesh economy is currently in, and also to make the national development target a realized one alongside the private sector effort, the government of Bangladesh has also been increasing the fiscal space in terms of expenditure. This ever increasing expenditure the government usually finances either by taking debt from domestic sources or from foreign sources; whenever the domestic revenue effort has been found to be insufficient. From investment perspective it can be argued that this increase in expenditure leading to deficit in budget could be beneficial for growth of the economy. On contrary, from "investment crowding out" and "debt burden along with inefficient deficit financing" perspective it can also be stated that this deficit could be detrimental to growth.

In this paper, the attempt was made to investigate the impact of budget deficit on the growth of Bangladesh economy employing time series data spanning from 1975-76 to 2014-2015. Also allowing the regression model to be nonlinear in variables and following standard optimization technique an effort was given in search of ceiling or threshold level for budget deficit. The regular growth model has been augmented with two more exogenous variables namely money supply and trade share of GDP along with the focus variable budget deficit as share of GDP.

Application of several stationarity tests revealed common integration order of all variables concerned. More specifically, all the variables has been detected to be difference stationary and hence I(1). In anticipation of existence of cointegration or long-run relationship among the variables the VAR with sufficient lag has been estimated and presence of cointegration has been justified by the Johansen approach. Finally, the cointegrating vector containing the long-run coefficients was estimated following the estimation of VECM. As the result shows, it can be argued with evidence that budget deficit would have positive impact on the economic growth as far as long run is considered. Nevertheless, as error correction terms were insignificant it can be argued that the short-run dynamics between budget deficit and economic growth for Bangladesh economy is absent. Importantly, the threshold values that have been calculated remained within the range of 4.5 to 5 percent of GDP. Any expenditure amount exceeding that level, at least here technically, would influence a detrimental effect of economic growth. In recent years the economy has been experiencing an increasing trend in budget deficit indicator and become significantly closer to this threshold amount. Also, a look in deficit financing method would establish that, though regular fluctuations have been there, still the reliance on foreign source is profound. This dependency is continuously generating overwhelming amount of debt burden which might cause freezing effect on growth in the long run. Besides, in recent years the increasing tendency of fund withdrawing from banking channel as a part of deficit financing using domestic source might accelerate the crowding out effect in future time causing a decline in economic growth. Thus, the policy makers should remain cautious when opening the new window of expenditure at the excuse of growth enhancement.

The contribution of the paper can be thought of as twofold. First, it has given effort to identify the impact of budget deficit on growth from a long-run perspective which is more theoretically sound. Because, any kind of public expenditure should require a substantial time to transmit its benefits into economic growth. Second, the paper tried to find out the optimum level of budget deficit while maximizing the growth which will help the policy makers to decide how much room to expand or how much should shrink. However, among all one important limitation of the current work would be the use of "local maximum" method. The threshold found here cannot be considered from a global perspective. There is also possibility of applying some other time series methodology when finding the threshold namely Threshold Autoregression (TAR) and Self Exciting Threshold Autoregression (SETAR) model. Finally variation can be introduced in the growth model adding different set of variables. However, all these issues would remain as further window of research regarding this issue.

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Appendix

TABLE 1A. AUGMENTED DICKEY-FULLER (ADF) TEST RESULTS

VARIABLES	NULL: THE SERIES HAS UNIT ROOT					
	TREND SPECIFICATION					
	None	Prob.	Constant	Prob.	Constant & Trend	Prob.
LRGDP	21.618	1.000	4.703	1.000	-0.603	0.973
D(LRGDP)	0.412	0.797	-5.986*	0.000	-9.776*	0.000
LGFCF	4.793	1.000	-1.423	0.560	-3.380**	0.068
D(LGFCF)	-4.034*	0.000	-6.444*	0.000	-6.365*	0.000
LM2	1.899	0.984	-1.409	0.567	-2.471	0.339
D(LM2)	-1.294	0.177	-3.722*	0.007	-3.924**	0.020
TSGDP	0.516	0.823	-0.958	0.758	-2.483	0.333
D(TSGDP)	-6.597*	0.000	-6.698*	0.000	-6.570*	0.000
GP1564	-0.867	0.333	1.317	0.998	-1.053	0.923
D(GP1564)	-1.114	0.236	-1.230	0.650	-5.356*	0.000
BDSGDP	-0. 774	0.373	-3.852*	0.005	-7.306*	0.000
D(BDSGDP)	-11.866*	0.000	-11.714*	0.000	-11.496*	0.000

Note: *, ** - indicate significance at 1% and 5% level respectively.

TABLE 2A. PHILLIPS-PERRON (PP) TEST RESULTS

VARIABLES	NULL: THE SERIES HAS UNIT ROOT					
	TREND SPECIFICATION					
	None	Prob.	Constant	Prob.	Constant & Trend	Prob.
LRGDP	16.898	1.000	7.589	1.000	-0.314	0.987
D(LRGDP)	-0.176	0.615	-6.190*	0.000	-9.848*	0.000
LGFCF	4.278	1.000	-1.448	0.548	-3.380***	0.068
D(LGFCF)	-4.026*	0.000	-6.468*	0.000	-6.380*	0.000
LM2	6.194	1.000	-1.872	0.341	-2.484	0.333
D(LM2)	-1.135	0.228	-3.669*	0.008	-3.897**	0.021
TSGDP	0.837	0.887	-0.818	0.802	-2.483	0.333
D(TSGDP)	-6.599*	0.000	-6.866*	0.000	-6.715*	0.000
GP1564	-0.867	0.333	1.404	0.998	-0.800	0.956
D(GP1564)	-1.114	0.236	-1.170	0.676	-0.495	0.979
BDSGDP	-0.334	0.558	-4.219*	0.001	-7.231*	0.000
D(BDSGDP)	-21.481*	0.000	-27.037*	0.000	-26.963*	0.000

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

TABLE 3A. KWIATKOWSKI, PHILLIPS, SCHMIDT AND SHIN (KPSS) TEST RESULTS

VARIABLES	NULL: THE SERIES IS STATIONARY	
	TREND SPECIFICATION	
	Constant	Constant & Trend
LRGDP	0.775*	0.207**
D(LRGDP)	0.722**	0.053
LGFCF	0.788*	0.153**
D(LGFCF)	0.225	0.150**
LM2	0.778*	0.129***
D(LM2)	0.324	0.183**
TSGDP	0.640**	0.177**
D(TSGDP)	0.146	0.111
LVBD01	0.788*	0.141***
D(LVBD01)	0.229	0.167**
GP1564	0.610**	0.233*
D(GP1564)	0.531**	0.082
BDSGDP	0.590**	0.105
D(BDSGDP)	0.148	0.123***

Note: With "Constant" trend specification 1%, 5% and 10% critical values are 0.7390, 0.4630 and 0.3470 respectively. With "Constant and Trend" specification the above critical values are 0.2160, 0.1460 and 0.1190 respectively. Here *, ** and *** indicate significance at 1%, 5% and 10% level respectively.

TABLE 4A. VAR LAG STRUCTURE SELECTION FOR DIFFERENT MODELS

LAG	AIC	BIC
MODEL 1: ENDOGENOUS VARIABLES: LRGDP, LGFCF, GP1564, BDSGDP, SBDSGDP		
0	5.102	5.322
1	-4.162*	-2.842*
2	-4.063	-1.644
3	-3.875	-0.356
MODEL 2: ENDOGENOUS VARIABLES: LRGDP, LGFCF, GP1564, LM2, BDSGDP, SBDSGDP		
0	2.204	2.468
1	-9.484	-7.637*
2	-9.836	-6.406
3	-10.202*	-5.187
MODEL 3: ENDOGENOUS VARIABLES: LRGDP, LGFCF, GP1564, TSGDP, BDSGDP, SBDSGDP		
0	10.052	10.316
1	0.802	2.650*
2	1.034	4.465
3	0.027*	5.042
MODEL 4: ENDOGENOUS VARIABLES: LRGDP, LGFCF, GP1564, LM2, TSGDP, BDSGDP, SBDSGDP		
0	6.694	7.001
1	-4.784	-2.320*
2	-5.316	-0.697
3	-7.680*	-0.906

Note: * - indicates lag order selected by the respective criterion.

TABLE 5A1. JOHANSEN COINTEGRATION TEST (MODEL 1: *LRGDP, LGFCF, GP1564, BDSGDP, SBDSGDP*)

HYPOTHESIZED NO. OF CE(S)	EIGENVALUE	TRACE STATISTIC	0.05 CRITICAL VALUE	PROB.**
UNRESTRICTED COINTEGRATION RANK TEST (TRACE)				
None*	0.6824	106.108	69.818	0.000
At most 1*	0.5332	63.664	47.856	0.000
At most 2*	0.3706	35.475	29.797	0.010
At most 3*	0.3433	18.340	15.494	0.018
At most 4	0.0723	2.780	3.841	0.095

Note: Trace test indicates 4 cointegrating eqn(s) at the 0.05 level; * - denotes rejection of the hypothesis at the 0.05 level; **- MacKinnon-Haug-Michelis (1999) p-values.

HYPOTHESIZED NO. OF CE(S)	EIGENVALUE	MAX - EIGEN STATISTIC	0.05 CRITICAL VALUE	PROB.**
UNRESTRICTED COINTEGRATION RANK TEST (MAXIMUM EIGENVALUE)				
None *	0.6824	42.443	33.876	0.003
At most 1	0.5332	28.189	27.584	0.041
At most 2	0.3706	17.135	21.131	0.165

Note: Max-eigenvalue test indicates 1 cointegrating eqn(s) at the 0.05 level; * - denotes rejection of the hypothesis at the 0.05 level; ** - MacKinnon-Haug-Michelis (1999) p-values.

TABLE 5A2. JOHANSEN COINTEGRATION TEST (MODEL 2: *LRGDP, LGFCF, GP1564, LM2, BDSGDP, SBDSGDP*)

HYPOTHESIZED NO. OF CE(S)	EIGENVALUE	TRACE STATISTIC	0.05 CRITICAL VALUE	PROB.**
UNRESTRICTED COINTEGRATION RANK TEST (TRACE)				
None*	0.8378	177.051	103.847	0.000
At most 1*	0.6306	109.746	76.972	0.000
At most 2*	0.5063	72.891	54.079	0.000
At most 3*	0.4510	46.768	35.192	0.001
At most 4*	0.3969	24.578	20.261	0.011
At most 5	0.1465	5.865	9.164	0.201

Note: Trace test indicates 5 cointegrating eqn(s) at the 0.05 level; * - denotes rejection of the hypothesis at the 0.05 level; ** - MacKinnon-Haug-Michelis (1999) p-values.

HYPOTHESIZED NO. OF CE(S)	EIGENVALUE	MAX - EIGEN STATISTIC	0.05 CRITICAL VALUE	PROB.**
UNRESTRICTED COINTEGRATION RANK TEST (MAXIMUM EIGENVALUE)				
None *	0.8378	67.304	40.956	0.000
At most 1*	0.6306	36.855	34.805	0.028
At most 2	0.5063	26.122	28.588	0.100

Note: Max-eigenvalue test indicates 2 cointegrating eqn(s) at the 0.05 level; * - denotes rejection of the hypothesis at the 0.05 level; ** - MacKinnon-Haug-Michelis (1999) p-values.

TABLE 5A3. JOHANSEN COINTEGRATION TEST
(MODEL 3: *LRGDP, LGFCF, GP1564, TSGDP, BDSGDP, SBDSGDP*)

HYPOTHESIZED NO. OF CE(S)	EIGENVALUE	TRACE STATISTIC	0.05 CRITICAL VALUE	PROB.**
UNRESTRICTED COINTEGRATION RANK TEST (TRACE)				
None*	0.6906	129.499	95.753	0.000
At most 1*	0.5468	86.088	69.818	0.001
At most 2*	0.4894	56.799	47.856	0.005
At most 3*	0.4193	31.924	29.797	0.028
At most 4	0.2280	11.809	15.494	0.166

Note: Trace test indicates 4 cointegrating eqn(s) at the 0.05 level; * - denotes rejection of the hypothesis at the 0.05 level;
** - MacKinnon-Haug-Michelis (1999) p-values.

HYPOTHESIZED NO. OF CE(S)	EIGENVALUE	MAX - EIGEN STATISTIC	0.05 CRITICAL VALUE	PROB.**
UNRESTRICTED COINTEGRATION RANK TEST (MAXIMUM EIGENVALUE)				
None *	0.6906	43.410	40.077	0.020
At most 1	0.5468	29.288	33.876	0.160
At most 2	0.4894	24.875	27.584	0.106

Note: Max-eigenvalue test indicates 1 cointegrating eqn(s) at the 0.05 level; * - denotes rejection of the hypothesis at the 0.05 level;
** - MacKinnon-Haug-Michelis (1999) p-values.

TABLE 5A4. JOHANSEN COINTEGRATION TEST
(MODEL 4: *LRGDP, LGFCF, GP1564, LM2, TSGDP, BDSGDP, SBDSGDP*)

HYPOTHESIZED NO. OF CE(S)	EIGENVALUE	TRACE STATISTIC	0.05 CRITICAL VALUE	PROB.**
UNRESTRICTED COINTEGRATION RANK TEST (TRACE)				
None*	0.8784	227.545	134.678	0.000
At most 1*	0.6477	149.580	103.847	0.000
At most 2*	0.5919	110.978	76.972	0.000
At most 3*	0.5160	77.811	54.079	0.000
At most 4*	0.4968	50.954	35.192	0.000
At most 5*	0.4215	25.541	20.261	0.008
At most 6	0.1332	5.290	9.164	0.253

Note: Trace test indicates 6 cointegrating eqn(s) at the 0.05 level; * - denotes rejection of the hypothesis at the 0.05 level;
** - MacKinnon-Haug-Michelis (1999) p-values.

HYPOTHESIZED NO. OF CE(S)	EIGENVALUE	MAX - EIGEN STATISTIC	0.05 CRITICAL VALUE	PROB.**
UNRESTRICTED COINTEGRATION RANK TEST (MAXIMUM EIGENVALUE)				
None *	0.8784	77.967	47.078	0.000
At most 1	0.6477	38.601	40.956	0.090
At most 2	0.5919	33.167	34.805	0.077

Note: Max-eigenvalue test indicates 1 cointegrating eqn(s) at the 0.05 level; * - denotes rejection of the hypothesis at the 0.05 level;
** - MacKinnon-Haug-Michelis (1999) p-values.

FIGURE 1A. TREND OF PERIODICAL AVERAGE FOR BUDGET DEFICIT IN BANGLADESH

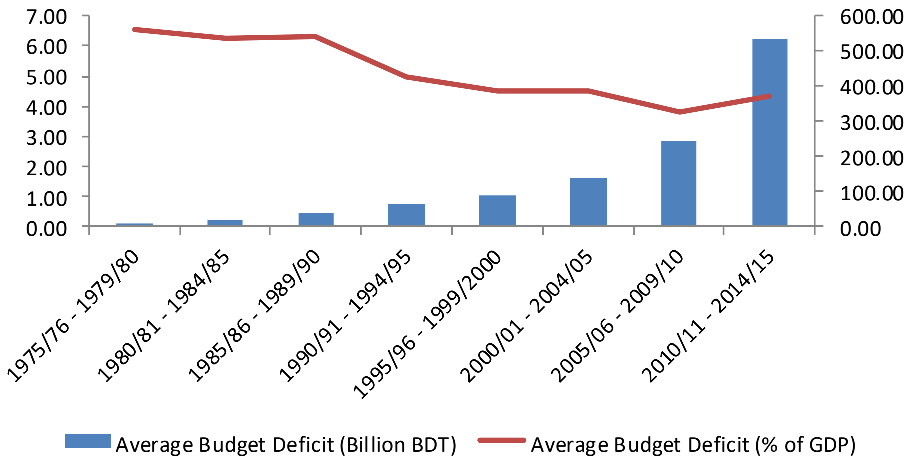


FIGURE 2A. COINTEGRATING RELATIONSHIP IN DIFFERENT MODELS

MODEL 1

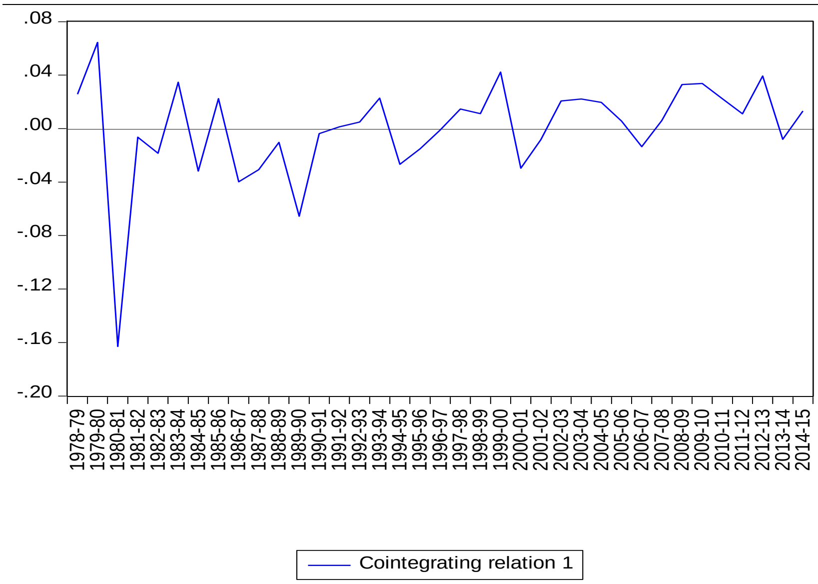
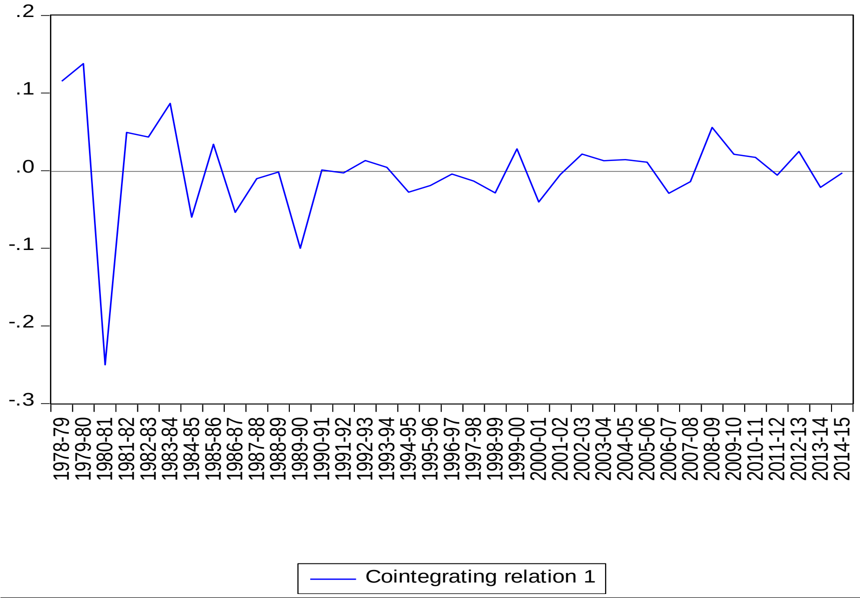


FIGURE 2A (contd). COINTEGRATING RELATIONSHIP IN DIFFERENT MODELS

MODEL 2



MODEL 3

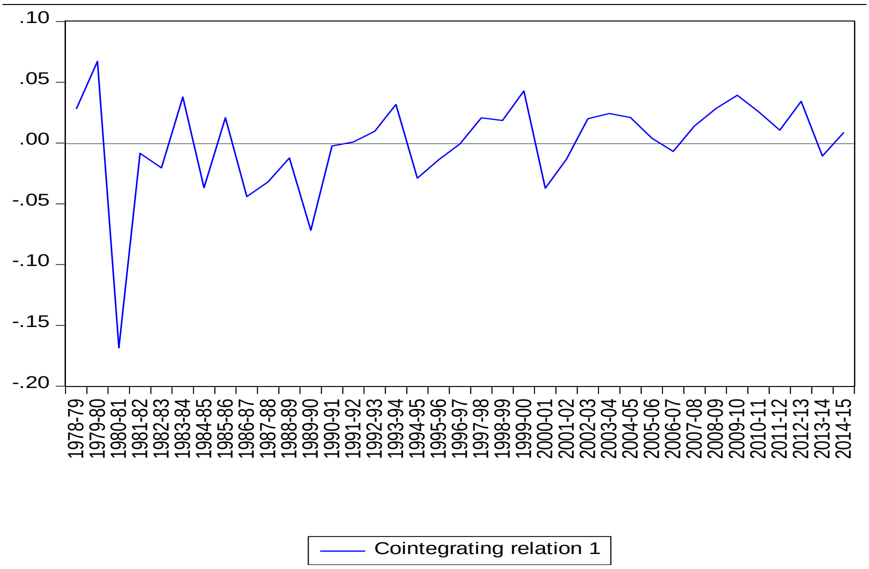


FIGURE 2A (contd). COINTEGRATING RELATIONSHIP IN DIFFERENT MODELS

MODEL 4