Public Debt and Economic Growth Nexus: Evidence from South Asia

Abstract

It is well established in literature that the public debt and economic growth bear positive and non-linear relationship. However, in recent literature, evidence of no causal relationship is found when accounted for endogeneity in case of advanced economies (Panizza & Presbitero, 2014). Chudik, Mohaddes, Pesaran, & Raissi, (2017) analyse the data on forty countries and find no evidence of universally applicable threshold effect in the relationship between debt and growth. These advancements in the debt-growth literature provides the motivation to re-explore the relationship between public debt and economic growth under non-linearity and endogeneity in context of developing economies of South Asia including Pakistan, India, Bangladesh and Sri-Lanka for the period 1980-2014. There exists a significant, positive but nonlinear relationship between the public debt and economic growth for the selected set of developing countries when accounted for endogeneity and non-linearity. The negative association between the public debt and economic growth for SAARC region is found when the debt level is higher than 61% of GDP which is quite lower than developed economies (90% of GDP). Individual threshold levels for debt-to-GDP ratio divulge that Sri Lanka, Pakistan and India need to control their public borrowings as their current debt levels are higher and/or around the respective threshold levels.

Key Words: Endogeneity, Non-linearity, Threshold, FMOLS
INTRODUCTION

The hypothesis of nonlinear relationship between debt and economic growth has got its due attention in the literature (Reinhart & Rogoff, 2009; Reinhart & Rogoff, 2010; Checherita-Westphal & Rother, 2012; Kumar & Woo, 2010 and Eberhardt & Presbitero, 2015) and, in general, there is a consensus among the researchers regarding the existence of debt-threshold effect on growth however, Chudik, Mohaddes, Pesaran, & Raissi, (2017) analyse the data on forty countries and find no evidence of universally applicable threshold effect in the relationship between debt and growth.

Endogeneity issue has recently been highlighted in the debt-growth literature (Kumar & Woo, 2010; Panizza & Presbitero, 2014; & Chudik, Mohaddes, Pesaran, & Raissi, 2017). On balance, researchers find significant relationship between public debt and economic growth after catering for endogeneity. On the contrary, for developed economies, Panizza & Presbitero, (2014) establish that debt and economic growth bear no relationship when controlled for endogeneity.

With the given advancements in the debt-growth literature on the threshold effect (non-linearity) and endogeneity issues, we hardly find any study focusing on both the problems simultaneously in context of developing economies of South Asia. This study is an attempt to bridge this gap in literature by exploring the relationship between public debt and economic growth by incorporating non-linearity and endogeneity in the econometric model for the major developing economies of South Asia including India, Pakistan, Bangladesh & Srilanka1 for the period 1980-2014.

In general, literature related to the aforementioned developing economies establish that the burden of debt is unsustainable and affecting the growth negatively when raised to a certain level. Mahmood, Arby, & Sherazi, (2014) find the large fiscal and current account imbalances as the major reasons behind this negative impact of debt on growth. The study emphasizes to address the long standing issue of twin deficit through credible policy measures to achieve debt sustainability. Siddiqui & Malik, (2001)highlight the mismanagement of resources,

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1The contribution of these four economies to the total GDP of the region is 99% (Mahmood, Arby, & Sherazi, 2014).

The well known endogeneity problem is handled by applying the alternative yet controversial instrumental variable technique by Panizza & Presbitero, (2014) and find no causal relationship between high debt and low growth for developed economies. However, they confirm the association between the increase in debt and low growth in OLS results at 10 percent level of significance. To our knowledge, related to selected economies, Kumara & Cooray, (2013) is the only study which caters for the endogeneity issue by using the lags of the variable as instruments for Sri Lankan economy. Given that there are some fundamental difficulties in finding the external instrumental variables for debt (Reinhart, Reinhart, & Rogoff, 2012), this study

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addresses the potential endogeneity problem by using the FMOLS technique which provides consistent long-run estimates under endogeneity.

METHODOLOGY
Mankiw, Romer and Weil (1992) assumed that households fix the saving and educational spending ratios which allows us to have an augmented Solow model by assuming the Cobb-Douglas form:

\[ Y = AK^\alpha L^\beta \quad \text{where} \quad \alpha > 0, \beta > 0 \& A > 0 \]  

(1)

According to Bräuninger, (2003), the steady state growth rate increases if an increase in public debt is used to redistribute tax burden of every individual from youth to middle age. Hence, in context of open economy, public debt may not be harmful for growth.

Bräuninger, (2003) provides the proposition that the steady-state growth is possible if the deficit ratio stays below a critical level by deriving the following result.

\[ \hat{R} = \hat{H} = \hat{Y} = A(s[1 + b - g] - b)^\alpha(z[1 + b - g])^\beta \]  

(2)

where, s, b, g and z are the saving ratio, deficit ratio, government purchase ratio and educational spending ratio respectively. The effect of deficit ratio is given by:

\[ \frac{d\hat{Y}}{db} = \frac{\beta \hat{Y}}{(1 + b - g)} + \frac{(s - 1)\alpha \hat{Y}}{s(1 + b - g) - b} \]

\[ \frac{d\hat{Y}}{db} < 0 \text{ if } b > b' = \frac{(s - \alpha)(1 - g)}{(1 - s)} \]

It is pertinent to mention the assumption that the budget deficit adds to public debt \( \hat{D} = B = bY \) made while deriving the aforementioned results.

Endogeneity
Panizza & Presbitero, (2012) establish that the OLS parameters are biased due to the existence of endogeneity problem in context of a bivariate model in which growth is a function of debt.

\[ G = a + bD + u \]
\[ D = m + kG + \nu \]

where, economic growth (G) is a function of public debt (D) and vice-versa. Where reduced forms of both the equations would be:

\[
G = \frac{a + bm}{1 - bk} + \frac{bv + u}{1 - bk}
\]

\[
D = \frac{m + ak}{1 - bk} + \frac{v + ku}{1 - bk}
\]

To calculate \( \hat{b} \) we know that:

\[
\hat{b} = \frac{\text{Cov} (G, D)}{\text{Var} (D)}
\]

\[
\hat{b} = \frac{b \sigma_v^2 + k \sigma_u^2}{\sigma_v^2 + k^2 \sigma_u^2}
\]

And the bias of the OLS estimator is:

\[
E (\hat{b}) - b = \frac{k (1 - bk)}{\sigma_v^2 + k^2 \sigma_u^2}
\]  \hspace{1cm} (3)

Since stability requires that \( bk < 1 \) shows that OLS estimations are unbiased if and only if \( k = 0 \). (i.e. if debt is not endogenous).

According to Phillips & Hansen (1990) and Phillips (1995), in presence of endogeneity, limiting distribution of OLS parameters contains second order bias and non-centrality bias come from the fact that regression errors are serially correlated. Phillips and Hansen (1990) proposed a correction in \( \beta^{OLS} \) formula by applying a transformation which allows for correcting for endogeneity bias and non-centrality bias. The resulting method is known as FMOLS.

**Non-linearity**

According to Checherita-Westphal & Rother, (2012), the simplest test for non-linearities is to include the quadratic term in the model. Through signs and significance of quadratic
specification ($\beta_1 \& \beta_2$), it is easier to establish the existence of non-linear relationship between debt and growth. Threshold or optimal point can be calculated through first order condition.

$$\text{Growth}_{it} = \beta_i + \beta_1 \text{Debt}_{it} + \beta_2 \text{Debt}_{it}^2 + X_{it}\eta + \epsilon_{it}$$  \hspace{1cm} (4)$$

where, the $X$ matrix contains the growth rates of labour and capital, human capital (Govt. expenditure on education as percentage of GDP), inflation, trade openness, and dependency ratio (ratio of population aged 0-14 and 65 above to total population). The data on the aforementioned variables are taken from the World Development Indicators and Penn tables for the time period 1980-2014.

**RESULTS & DISCUSSION**

Due to regional integration, economic variables start depending on each other and a shock happening in a particular country may have large impact on its neighboring country if integration is very high (Pesaran, 2004). This study is based on panel data which requires the testing for cross-sectional dependence in the error terms and the results divulge to accept the null hypothesis of cross sectional independence (p-value=0.1032). This leads us to the panel unit root test proposed by Im, Pesaran, & Shin, (2003) with the assumption of cross sectional independence. It is evident from the results summarized in table 1 below that growth rate of GDP, human capital, labor growth and inflation are stationary at levels while the other variables are integrated of order one. This further strengthen the power of our selected method as Fully Modified estimators allows modeling variables with different order of intergration reported by Chiang & Kao, (2000).

Fisher’s cointegration test proposed by Maddala & Wu, (1999) is the most suitable choice due to its less restrictive alternative hypothesis and mixed order of integration of variables. Both the Fisher’s cointegration statistics, trace and maximum eigen value tests, confirm the existance of cointegration among the varaibles (see appendix, Table 1).

Durbin–Wu–Hausman test (augmented regression test) is applied to test the existence of endogeneity issue in the model. The data do not provide enough evidence (p-value=0.049) to support the null hypothesis of exogeneity (see appendix, table 2). This leads to the inconsistency of OLS. Thus, Fully Modified OLS is applied to estimate the empirical model and results are summarized in table 2.
Table 1: Unit Root Test Results

<table>
<thead>
<tr>
<th>Variables</th>
<th>Level</th>
<th>First Difference</th>
</tr>
</thead>
<tbody>
<tr>
<td>GDP Growth</td>
<td>-3.04148</td>
<td>(0.0012)</td>
</tr>
<tr>
<td>Capital Growth</td>
<td>0.93442</td>
<td>(0.8250)</td>
</tr>
<tr>
<td>Labor Growth</td>
<td>-3.05048</td>
<td>(0.0011)</td>
</tr>
<tr>
<td>Human Capital</td>
<td>-2.39392</td>
<td>(0.0083)</td>
</tr>
<tr>
<td>Debt/GDP</td>
<td>-1.20834</td>
<td>(0.1135)</td>
</tr>
<tr>
<td>Inflation</td>
<td>-3.37978</td>
<td>(0.0004)</td>
</tr>
<tr>
<td>Trade Openness</td>
<td>2.27268</td>
<td>(0.9885)</td>
</tr>
<tr>
<td>Dependency Ratio</td>
<td>3.70669</td>
<td>(0.9999)</td>
</tr>
</tbody>
</table>

*P-values are in the parenthesis*

Table 2: Fully Modified Ordinary Least Square

<table>
<thead>
<tr>
<th>Variables</th>
<th>Coefficients</th>
<th>Standard Error</th>
<th>t-values</th>
<th>Prob.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Capital Growth</td>
<td>0.007897</td>
<td>0.003112</td>
<td>2.537477</td>
<td>0.0124</td>
</tr>
<tr>
<td>Labor Growth</td>
<td>0.696475</td>
<td>0.148292</td>
<td>4.696642</td>
<td>0.0000</td>
</tr>
<tr>
<td>Human Capital</td>
<td>0.017182</td>
<td>0.008989</td>
<td>1.911413</td>
<td>0.0582</td>
</tr>
<tr>
<td>Debt/GDP</td>
<td>0.258933</td>
<td>0.020798</td>
<td>12.44971</td>
<td>0.0000</td>
</tr>
<tr>
<td>Debt/GDP^2</td>
<td>-0.002069</td>
<td>0.000163</td>
<td>-12.66404</td>
<td>0.0000</td>
</tr>
<tr>
<td>Dependency Ratio</td>
<td>-0.054461</td>
<td>0.009907</td>
<td>-5.496966</td>
<td>0.0000</td>
</tr>
<tr>
<td>Inflation</td>
<td>-0.057829</td>
<td>0.021281</td>
<td>-2.717459</td>
<td>0.0075</td>
</tr>
<tr>
<td>Trade Openness</td>
<td>0.022279</td>
<td>0.006296</td>
<td>3.538805</td>
<td>0.0006</td>
</tr>
</tbody>
</table>

R-squared 0.232839
Adjusted R-squared 0.190885
Long-run Variance 1.073117
Durbin-Watson stat 1.772961

Dependent Variable: GDP Growth

All the conventional variables carry the expected signs and significance. For instance, labour, capital, human capital and trade openness have positive and significant impact on growth. On the other hand, dependency ratio and inflation are growth retarding. The coefficient for capital is positive and significant which show that increase in capital accelerate economic growth. The increase in capital formation will enhance the production capacity of an economy. The increase in overall output level of country induces positive effect on growth. The estimated coefficient on
labour is slightly larger than one would expect to predict from neoclassical theory. The possible explanation could be the rise in labour reduces the rate in technological progress. These results are in line with the findings in Shahzad & Javed, (2015); Salotti & Trecroci, (2012); and Panizza & Presbitero (2014). The R square of model is quite low but that is not an issue in our research as low R-squared values are problematic when you need precise predictions established by Florian, (2016).

Statistical significance and the opposite signs of debt-to-GDP ratio and its squared form prove the existence of nonlinear relationship between debt and growth. This is in line with the finding in Kumara & Cooray, (2013) and Panizza & Presbitero, (2014). The positive sign of debt to GDP is indicative of the fact that debt helps to accelerate the growth however, the negative sign of its square form divulges the existence of a threshold point beyond that the debt will bring deleterious impacts on the economy. Differentiating the growth model with respect to debt-to-GDP variable allows us to compute the threshold levels for the selected set of countries. Results are summarized in table 3.

Table 3: Threshold levels

<table>
<thead>
<tr>
<th>Countries</th>
<th>Threshold level</th>
<th>Current Level (2014)</th>
</tr>
</thead>
<tbody>
<tr>
<td>SAARC</td>
<td>61%</td>
<td>--</td>
</tr>
<tr>
<td>Pakistan</td>
<td>62%</td>
<td>64%</td>
</tr>
<tr>
<td>India</td>
<td>66%</td>
<td>66%</td>
</tr>
<tr>
<td>Bangladesh</td>
<td>40%</td>
<td>19%</td>
</tr>
<tr>
<td>Sri-Lanka</td>
<td>66%</td>
<td>75%</td>
</tr>
</tbody>
</table>

In case of Pakistan, the level of debt sustainability is 62% of GDP which is in line with the findings in Saqib, (2014). The debt sustainability level for Sri-Lanka is 66% of GDP which is slightly lower than the findings in Kumara & Cooray, (2013) which was 68% of GDP. This difference of two percentage points may be due to the use of non-overlapping growth spells by Kumara & Cooray, (2013) and the difference in time period. The threshold level for India is 66% of GDP which is equal to the current debt level of country. In case of Bangladesh, the level is lowest that is 40% of GDP, which can be backed by the fact that overtime the heavy reliance of economy on debt has decreased in Bangladesh and the statistics show that the debt-to-GDP share remain lower than 50% of GDP during the selected time period.
While comparing with the current situation, India and Pakistan, has debt levels approximately equal to their respective threshold levels which reveals that further debt will bring negative impacts on economy. In case of Sri-Lanka the situation is a worst as the threshold level is 66% of GDP and current level of debt is 75% of GDP which mean that the government need to take steps to lower down overall debt of country to avoid its negative impacts.

CONCLUSION

We explore the link between economic process and debt beneath the assumptions of endogeneity & nonlinearity and therefore the results reveal the many dependence of economic process on debt for the chosen developing countries of the SAARC region. The brink levels for individual countries indicate that the Sri Lanka’s current level of debt (75% of GDP) is way on the far side the benchmark level (66% of GDP). Asian country and Asian nation square measure around their various threshold levels (62% & 66% of GDP). Any borrowing can bring negative impacts on their economies. However, Bangladesh’s current debt level (19% of GDP) is well below the brink level (40% of GDP). Reinhart and Rogoff, (2010) conclude that the low level of debt appears to own terribly little impact on rate as compare to countries that have accumulated high quantity of debt. But, accumulation of debt is simply property once it's unbroken beneath the brink level. We discover the negative association between debt and economic process once the general public debt-to-GDP quantitative relation is beyond the benchmark that is in line with the findings in Reinhart and Rogoff, (2010).
References


## Appendix

### Table 1: Panel Co-integration Test Results

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>None</td>
<td>131.7</td>
<td>0.0000</td>
<td>200.1</td>
<td>0.0000</td>
</tr>
<tr>
<td>At most 1</td>
<td>206.7</td>
<td>0.0000</td>
<td>76.87</td>
<td>0.0000</td>
</tr>
<tr>
<td>At most 2</td>
<td>119.0</td>
<td>0.0000</td>
<td>60.37</td>
<td>0.0000</td>
</tr>
<tr>
<td>At most 3</td>
<td>70.51</td>
<td>0.0000</td>
<td>25.71</td>
<td>0.0012</td>
</tr>
<tr>
<td>At most 4</td>
<td>48.03</td>
<td>0.0000</td>
<td>20.01</td>
<td>0.0103</td>
</tr>
<tr>
<td>At most 5</td>
<td>31.34</td>
<td>0.0001</td>
<td>12.48</td>
<td>0.1309</td>
</tr>
<tr>
<td>At most 6</td>
<td>23.38</td>
<td>0.0029</td>
<td>12.76</td>
<td>0.1204</td>
</tr>
<tr>
<td>At most 7</td>
<td>17.68</td>
<td>0.0237</td>
<td>15.34</td>
<td>0.0528</td>
</tr>
<tr>
<td>At most 8</td>
<td>12.68</td>
<td>0.1233</td>
<td>12.68</td>
<td>0.1233</td>
</tr>
</tbody>
</table>

### Table 2: Endogeneity Test results

Null hypothesis: Debt/GDP is exogenous

<table>
<thead>
<tr>
<th>2SLS Residuals Stats</th>
<th>Coefficient</th>
<th>Std. Error</th>
<th>t-Statistic</th>
<th>Prob.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>-0.018911</td>
<td>0.011516</td>
<td>-1.982178</td>
<td>0.0489</td>
</tr>
</tbody>
</table>