GDP of India and Pakistan: A Co-Integration Model

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Abstract

An attempt has been made to define relationship between India and Pakistan through GDP. For this, GDP data for the period 1960-2011 have been taken from the RBI website to establish the regression model using co-integration approach. The linearity of the GDP between these two countries has been examined through scatter plot. The unit root of residuals has been obtained by adopting Augmented Dickey-Fuller test to see the stationarity of the data. The GDP prediction for India for the year 2011 has been made in comparison to the GDP of Pakistan.

Keywords: India, Pakistan, Relationship, GDP, Co-integration Approach and Regression Model.

1. INTRODUCTION

In 1947, two new sovereign nations were formed – the union of India and the dominion of Pakistan. Soon after their independence, India and Pakistan established diplomatic relations but the violent partition and numerous territorial disputes would overshadow their relationship. Numerous attempts have been made to improve their relationships by sorting out historical and political issues. Despite these efforts on both sides to resolve their differences, there seems to be a trend that whenever India and Pakistan as closer toward negotiations, some incidents derail the process. The people of both countries know that elimination of conflict will reduce costs and open up opportunities including bilateral trade, energy, transportation infrastructure, tourism and industrial development. The scope for mutually beneficial economic cooperation between both the nations is enormous. India is amongst the six fastest growing developing countries of world, Pakistan stands in 27th position. There may be many factors which affect lower position of Pakistan but still it was felt that there should be some relations between two nations. The purpose of this initiative is to examine the economic growth relation of these two independent countries in terms of GDP. Bhat and Jain (2004) used co-integration analysis with structural breaks and suggested that per capita GDP and private health expenditure are co-integrated.
and Javid (2009) found that there is a positive relation between GDP and Export. Majagaiya Kundan P. and Qingliang Gu (2010) tried to find a long run equilibrium relationship between FDI and GDP of Nepal and also causality runs from FDI to GDP but no relation is found. LIU Zhuang (2011) found that there is a long term relationship between GDP of China and Sudan which is not causal but China’s GDP have increasing effect on Sudan GDP and explains some part of variance of Sudan’s GDP. Sarbapriya Ray (2012) showed through co-integration test that India GDP and foreign direct investment are co-integrated and have long run equilibrium relationship.

While considering above facts and practical situations in mind, in the present study, efforts for defining the relationship between India and Pakistan have been made through GDP using co-integration approach. For this purpose, a regression model is developed by taking GDP data for the period 1960-2011 from RBI website. The linearity of the GDP between these two countries has been examined through scatter plot. The unit root of residuals has been obtained by adopting Augmented Dickey-Fuller test to see the stationarity of the data. The GDP prediction for India for the year 2011 has been made in comparison to the GDP of Pakistan.

2. Data

Here the annual data of GDP per capita (current US$) for India and Pakistan have been taken for the period 1960-2011 from World Bank website. The two countries India and Pakistan have been considered as they got independent at the same time and may have some relations between their economic growths in terms of GDP. The natural logarithmic transformation is used so as to get stationary and linear relationship between GDPs.

3. Statistical Methods

Engel-Granger approach has been used as GDP series are annual series having time series trends. First of all Augmented Dickey Fuller test is applied to know whether the GDP of India and Pakistan are stationary. If they are stationary then OLS method is adopted, otherwise OLS regression model is fitted with GDP of India as dependent and GDP of Pakistan as independent variables as follows:

$$GDP_{India_t} = \alpha + \beta GDP_{Pakistan_t} + \varepsilon_t$$
The resulting residuals have been tested to know unit root. If the residuals have no unit root meaning thereby that the residuals are stationary and then GDP of India and Pakistan are co-integrated, that is, they have long run equilibrium relations. Finally, error correction model is fitted (Equilibrium correction model) as follows:

\[ \Delta GDP_{India_t} = \beta_1 \Delta GDP_{Pakistan_t} + \beta_2 (GDP_{India_{t-1}} - \beta GDP_{India_{t-1}}) + u_t \]

In the above equation \((GDP_{India_{t-1}} - \beta GDP_{India_{t-1}})\) is the error correction term and is the residual obtained from OLS regression, \(\beta\) is co-integration coefficient and defines the long run relationship between the two variables and \(\beta_1\) is short run relation between changes in GDP of India and Pakistan. The coefficient \(\beta_2\) defines the speed of adjusting back to equilibrium.

4. Statistical Analysis

The relationship between GDP of both the nations has been established by predicting GDP of India from GDP of Pakistan. The annual GDP data for the period 1960 to 2011 have been taken from World Bank website.

The GDP of India versus Pakistan GDP is as follows from where we observe that there does not appear to linear and there is curvature in the plot.
To reduce the curvature we tried the natural logarithm of the GDPs of India and Pakistan and the resulting scatter plot is as follows from where a linear relation is observed as.

Before running OLS regression we have to see whether the variables $l_{gdp\_india}$ and $l_{gdp\_pakistan}$ are stationary. If they came out to be stationary we will continue with OLS estimation method to find relations but if the variables would come out to be non-stationary we will use Co-integration and Error Correction Model to find any relations between two variables.

The differenced series is created as $d\_l\_gdp\_india$ and $d\_l\_gdp\_pakistan$. From the time series plot of $l\_gdp\_india$, it is observed that there is an increasing trend in the log of GDP of India with a slight shift in GDP from 1990-1992 and high variability from 1960-1966. Hence the series seems to be non-stationary.
From the time series plot of d_l_gdp_india we observe that the series mean on an average settles to zero and the variance also does not change much except from 1960 to 1966. Hence first difference of the series l_gdp_india seems to make it stationary.

From the time series plot of l_gdp_pakistan we observe that there is an increasing trend in the log of GDP of Pakistan with a high variability in 1970-1975.

From the time series plot of d_l_gdp_pakistan we observe that the series mean on an average settles to zero and the variance also does not change much except from 1970 to 1975. Hence first difference of the series l_gdp_pakistan seems to make it stationary.
To test for stationarity of the series we apply Augmented Dickey-Fuller (ADF) test with trend and intercept on l__gdp_india and l_gdp_pakistan as both the series have increasing trend and none of the trend and intercept for d_l_gdp_india and d_l_gdp_pakistan as both the series have neither trend nor intercept) as means settles to zero. All this follows from the above time series plots.

Applying ADF test with trend and intercept for l__gdp_india we get the results as follows from where we observe that at 5% level we have not enough evidence to reject the null hypothesis that L_GDP_INDIA has a unit root (as p=0.5282>0.05) and hence is non-stationary series.

Applying ADF test with neither trend nor intercept for d_l_gdp_india we get the results as follows from where it is found that at 5% level there are enough evidence to reject the null hypothesis that D_L_GDP_INDIA has a unit root (as p<0.0001) and hence is stationary series. Thus, L_GDP_INDIA is integrated of order 1.

Applying ADF test with trend and intercept for l__gdp_pakistan we get the results as follows from where we observe that at 5% level we have not enough evidence to reject the null hypothesis that L_GDP_PAKISTAN has a unit root (as p=0.3690>0.05) and hence is non-stationary series.

Applying ADF test with neither trend nor intercept for d_l_gdp_pakistan we get the results as follows from where it is found that at 5% level there are enough evidence to reject the null hypothesis that D_L_GDP_PAKISTAN has a unit root (as p<0.0001) and hence is stationary series. Thus, L_GDP_PAKISTAN is integrated of order 1.
Table 1 ADF Test for stationarity:

<table>
<thead>
<tr>
<th>Variable</th>
<th>t-statistic</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>L_GDP_INDIA</td>
<td>-2.109049</td>
<td>0.5282</td>
</tr>
<tr>
<td>D_L_GDP_INDIA</td>
<td>-3.560361</td>
<td>0.0007</td>
</tr>
<tr>
<td>L_GDP_PAKISTAN</td>
<td>-2.412478</td>
<td>0.3690</td>
</tr>
<tr>
<td>D_L_GDP_PAKISTAN</td>
<td>-5.055265</td>
<td>0.0001</td>
</tr>
</tbody>
</table>

As both the series l_gdp_india and l_gdp_pakistan are non-stationary so OLS method is not justified. Hence, Engle-Granger (EG) test is applied to test whether the two series are cointegrated.

For this we first run OLS regression of l_gdp_india on l_gdp_pakistan and the results are as follows:

Table 2 Engle-Granger (EG) test with intercept to test whether the two series are cointegrated

<table>
<thead>
<tr>
<th>Variable</th>
<th>Coefficient</th>
<th>Std. Error</th>
<th>t-Statistic</th>
<th>Prob.</th>
</tr>
</thead>
<tbody>
<tr>
<td>L_GDP_PAKISTAN</td>
<td>1.104901</td>
<td>0.034536</td>
<td>31.99313</td>
<td>0.0000</td>
</tr>
<tr>
<td>C</td>
<td>-0.693686</td>
<td>0.197258</td>
<td>-3.516648</td>
<td>0.0010</td>
</tr>
</tbody>
</table>

From the following residual plot, it is observed that the mean hovers around zero and there is no upward trend so that residuals seem to be stationary.
As there is zero mean and no trend in residuals so ADF test is applied with no intercept and trend. And, the results show that there are strong evidence to reject the null hypothesis and so residual series has a unit root (as p=0.0001<0.05) and hence is stationary series.

**Table 3 ADF Test for stationarity:**

<table>
<thead>
<tr>
<th>Variable</th>
<th>t-statistic</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Residual</td>
<td>-4.072896</td>
<td>0.0001</td>
</tr>
</tbody>
</table>

As the residuals are stationary so it is concluded that the series l_gdp_india and l_gdp_pakistan are cointegrated. Our residuals from the co-integrating regression capture deviations from the equilibrium of l_gdp_india and l_gdp_pakistan. Therefore, we can estimate both the short and long term effects of l_gdp_pakistan on l_gdp_india by including the lagged residuals from the co-integrating regression as our measure of the error correction mechanism. The proposed model is

\[
\Delta(l_{gdp\_india})_t = \alpha + \beta_1 \Delta (l_{gdp\_pakistan})_{t-1} + \beta_2 \text{Residual}_{t-1} + \varepsilon_t.
\]

The results indicate that corresponding to a one unit change in GDP of Pakistan in last year there is a decrease of 10.8321% in change in GDP of India. The coefficient of short-run relation -0.1215 is negative and hence model is stable and also the coefficient of -0.12, suggests 12% movement back towards equilibrium following a shock to the model, one time period later.

Sample (adjusted): 1962 2010
Included observations: 49 after adjustments
So the resulting estimated equation for forecasting GDP of India from GDP of Pakistan is as follows:

\[
\text{D}_L \text{GDP}_{\text{INDIA}} = 0.063739 - 0.108321 \times \text{D}_L \text{GDP}_{\text{PAKISTAN}} (-1)
- 0.121464 \times \text{RESIDUAL} (-1)
\]

Here, we have

\[
\text{Residual} = \text{L}_\text{GDP}_{\text{INDIA}} - 1.104901 \times \text{L}_\text{GDP}_{\text{PAKISTAN}} + 0.693686
\]

From above equation, we get

\[
\text{D}_L \text{GDP}_{\text{INDIA}} (2011) = 0.0264
\]

So, \(\text{L}_\text{GDP}_{\text{INDIA}}(2011) - \text{L}_\text{GDP}_{\text{INDIA}}(2010) = 0.0264\)

\(\text{L}_\text{GDP}_{\text{INDIA}}(2011) = \text{L}_\text{GDP}_{\text{INDIA}}(2010) + 0.0264 = 7.24215 + 0.0264 = 7.26855\)

Hence \(\text{GDP}_{\text{INDIA}}(2011) = \exp (7.26855) = 1434.468964\) which is very close to actual value of GDP of India in 2011 (GDP=1508.53997)

5. CONCLUSION

The study reveals that the GDP of India and Pakistan are co-integrated with some long run behavior. However, there is a negative impact of Pakistan GDP on India’s GDP due to some intrinsic civil problems in the country as well as instability of the government. On the other hand, the GDP expenditure of Pakistan on Military is much more in comparison to the expenditure in other welfare schemes for the society.
6. REFERENCES


