Determinants of Economic Growth in Asian Countries: A Panel Data Perspective

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Abstract
Panel data analysis refers to two or multi-dimensional data set containing observations on multiple phenomena observed over multiple time periods (Baltagi, 2005; Gujarati, 2003 among many others). Real gross domestic product (CGDP) per capita is the most commonly used measure of a country’s economic welfare. It is the number reached by valuing all the productive activity within the country at a specific year’s prices. Determinants of economics growth are evaluated, gathered for nine Asian countries for forty years that leads to use the panel data analysis, whereas panel data may have group effects, time effects or both. Data is taken from Penn Word Table (an expanded set of international comparisons), Version 6.1 (2003) for different Asian countries contributing in the world economy. In this article, the comparison of ordinary least square, fixed and random effects for panel data analysis is carried out. Different specification tests, e.g. Breusch Pagan Lagrange Multiplier test, F-test, and Hausman specification test, etc., are used to make selection among ordinary least square, fixed effect model or random effect model. Random effect model seems best to handle such situation.

Keywords: Fixed effect; Gross domestic product; panel data analysis; random effect; specification test

I. Introduction
Gross domestic product (GDP) is used as an indicator of economic health of a country and also gauges a country’s standard of living. It is monetary value of all the finished goods and services, produced within a country’s borders in a specified time.
period and calculated on annual basis. So GDP is a measure of average real income in a
country but not a complete measure of economic well being. For measuring complete
economic well being, real gross domestic product (CGDP) is used and is intended to be a
measure of particular types of economic activity within a country, because it is the
number reached by valuing all the productive activity within the country at a specific
year’s price. Economic activities, such as price-parity comparisons have direct
implications for real quantity comparison, and purchasing power parity (PPP) is
calculated over GDP. GDP comparisons are the most common of real quantity
comparisons, while price associated with GDP, PPP is the most common of the price
comparison.

The purpose of current study is to evaluate the determinants of economic growth
(CGDP) on the basis of panel data analysis for different Asian countries, i.e. Pakistan,
Bangladesh, India, Iran, Sri-Lanka, Indonesia, Philippines, Thailand and Japan,
contributing in world economy. We are interested in finding out how CGDP per capita
depends on the exchange rate, purchasing power parity over GDP, price level of GDP,
price level of Government, price level of investment, per capita GDP relative to the US
and real GDP chain per worker. Data is taken from Penn Word Table (PWT: an expanded

Panel data models in macroeconomic have become popular since last decades. The
idea of a panel data set is that a cross-section of observational units, typically individuals
or economic entities, is selected and a response and explanatory variables are observed
for each unit. So panel data set contains observations on multiple phenomena observed
over multiple time periods. Panel data sets generally include chronological blocks or
cross-sections of data, within each of which resides a time series. The data we have
selected holds the above mentioned characteristics, which leads us to carry out panel data
analysis.

Panel data are of two types; balanced panel data which has equal number of
observations for each individual (cross-section), whereas unbalanced panel data does not
contain equal number of observations for each individual.

Primary reason for increased utilization of panel data is that it offers opportunity
for controlling unobserved individual and/ or time specific heterogeneity, which may be
correlated with the included explanatory variables. Both time series and cross-section
when combined, enhances the quality and quantity of data in ways that would be
impossible using only one of these two dimensions (Gujarati, 2003). Klevmoarken
(1989), Hsiao (2003, 2005), Woolridge (2002), Baltagi (2005), Greene (2005), etc.,
listed several benefits for using panel data, such as it increases the precision of parameter
estimates, allows to sort out model temporal effects without aggregation bias, gives more
informative data, less collinearity among variables, more efficiency, etc. Hausman and
Taylor (1981) revealed that by combining time-series and cross-sectional data,
individual-specific unobservable effects (may be correlated with other explanatory
variables) can be controlled.

Hsiao (2004) provided the review of linear panel data models with slope
heterogeneity, various types of random coefficients models, heterogeneous dynamic
panels, testing for homogeneity under weak exogeneity, simultaneous equation random
coefficient models and more recent developments in the area of cross-sectional
dependence in panel data models, and also suggested a common framework for dealing
with them. For panel data estimation they used Bayesian approach.

The evidence in Nelson and Ploseer (1982) that hypothesis cannot be rejected for
most long-term United States (US) macroeconomic time series, ran contrary to many
economic theories that relied on the idea of cyclical fluctuations around stable long run
trends and set off an explosion of research. They investigated real GDP, real exchange
rates, and real interest rates, among many variables for which the unit root question
arises.

Heston and Summers (1996) studied CGDP data with other economic variables
using cross-sectional and some other techniques. They said that, in the policy arena,
comparable national income estimates across countries are needed for variety of reasons.
They founded that benchmark quantity and price data may not be right because of a
country’s unregistered economic activities, goods prices in different countries and
expenditure of national accounts. Also the comparison of the share of GDP devoted to the
national accounts of rich and poor countries is misleading.

Bahmani-Oskooee and Abm (2001) studied the productivity bias hypothesis claims
that a relatively more productive country should experience a real appreciation in
currency. Their results were stronger than previous research in support of the productivity
bias hypothesis by pooling data across countries and over time period. Their empirical
results strongly supported the hypothesis were not sensitive to model specification and
estimation procedure. They also tested the relevance of other variables such as a measure
of resource abundance and the black market premium in explaining the national price
levels, which confirms the previous research.

Frees et al. (2001) examined the case studies from three different areas of
insurance (health care, workers’ compensation and group term life). The purpose of their
study was to illustrate how the broad class of panel data models can be applied to
different functional areas and to data that have different features. Data they used having
heteroscedasticity, random and fixed effect covariates, outlier, serial correlation and
limited dependent variable bias. They also showed how examination of the data could
provide opportunities to enhance the model specification using graphical and numerical
diagnostic tools from standard statistical software.

Greene (2001) treated the selection of the random and fixed effects models as a
Hobson’s choice. Due to computational difficulties and the inconsistency caused by small
time (T(i)) problem, fixed effects model are unattractive and implemented the
computation in over twenty different modeling frameworks (linear regression, binary
choice, multinomial choice, count data, log linear models, limited dependent variables,
survival models, stochastic frontier, etc). The estimation of the fixed effects model is
quite feasible even in panels with huge number of groups.

Aten and Menezes (2002) discussed complex issues, among many related to
international comparisons of poverty that how to adjust the purchasing power of
currencies (PPPs) to reflect the relative price levels of the goods and services faced by
poor consumers. They concluded that the variation in prices and expenditures across
cities and across income group is significant and they suggested that the use of natural average price and expenditure in a study of poverty levels may be misleading, because poor consumers often face different prices than the average consumer, and price levels for food in some of the poorer cities are higher than those in higher income cities.

Rapach (2002) realized that panel data procedures have been proposed as an avenue to increase power. He applied four different panel unit root tests to international real GDP and real GDP per capita data. The results strongly indicate the international real GDP and real GDP per capita levels are non-stationary.

Choi et al. (2004) revealed that complications for panel data estimation of half-life of purchasing power parity (PPP) deviations are introduced by (i) inappropriate cross-sectional aggregation of heterogeneous coefficients (ii) small sample estimation bias of dynamic lag coefficients and (iii) time aggregation of commodity prices. They got information for different countries in the world (i.e country level data) and after manipulation they concluded that cross-sectional heterogeneity of convergence rates to PPP do not appear to be a quantitatively important source of bias.

Liao (2006) presented a method for analyzing categorical panel data with attrition, and assessed the robustness of the method. For micro panels of moderate time dimension, approximate solutions to the incidental parameter problem from a time-series perspective are a promising avenue for progress.

Besides the popularity of panel data, problems may arise when designing panel surveys, which include design and data collection problem, measurement errors, selectivity problems, short time series dimension, cross-section dependence, etc. (Baltagi, 2005).

II. Methodology

We used ordinary least square (OLS), fixed effect model (FEM) and random effect model (REM) for estimation of CGDP data. A balanced panel data set is used which has equal number of observations for each individual (cross-section) and for best model selection, FEM hypothesis testing, REM versus FEM, Hausman specification test and Breusch-Pagan Lagrange Multiplier test are used (see Breusch and Pagan, 1979, Gujarati, 2003, Hsiao, 2003 etc).

Data is taken from PWT, based on benchmark data, consists of price and expenditure data for basic heading of consumption, government expenditures, investment and imports & exports in local currency units, including nine Asian countries, i.e. Pakistan, Bangladesh, India, Iran, Sri-Lanka, Indonesia, Philippines, Thailand and Japan. The base year for this data is 1996 as mentioned in the PWT. We are interested in finding out how real gross domestic product per capita depends on the exchange rate, purchasing power parity over GDP, price level of GDP, price level of government, price level of investment, per capita GDP relative to the US and real GDP chain per worker. Data for each country on the above mentioned variables is taken for the period 1961-2000. So there are nine cross-sectional units and 40 time periods. In all there are 360 observations. Different types of panel data models are applied to above mentioned data. They include the constant coefficients model, the fixed effects model, i.e. least squares dummy variable (LSDV) model and the random effects model.
In constant coefficient model all intercepts and coefficients are assumed to be same (i.e. there is neither significant country nor significant temporal effects), in this way space and time dimensions of the pooled data are disregarded, data is pooled and an ordinary least squares (OLS) regression model is run. So these models are highly restricted assumptions about the model. Regardless of the simplicity of the model, the pooled regression may disfigure the true picture of the relationship between Y and the X’s across the cross-sections.

Different variations with reference to cross-section or time are applied to the fixed effects models here. The fixed effects model has constant slopes but intercepts differ according to the cross-sectional (group) unit. For $i$ classes $i-1$ dummy variables are used to designate the particular country, this model is sometimes called the LSDV model. Another fixed effects panel model where the slope coefficients are constant, but the intercept varies over individual/country as well as time. FEM with differential intercepts and slopes can also be applied on data, but inclusion of lot of variables and dummies may give results for which interpretation is cumbersome, because many dummies may cause the problem of multicollinearity. There is also a fixed effects panel model in which both intercepts and slopes might vary according to country and time. This model specifies $i-1$ country dummies, $t-1$ time dummies, the variables under consideration and the interactions between them. If all of these are statistically significant, there is no reason to pool (Gujarati, 2003).

In the random effects model the intercept is assumed to be a random outcome variable, whereas the random outcome is a function of a mean value plus a random error. Two way random effects model is used for estimation purpose.

Swamy (1971) suggested the random effects model and Swamy and Arora (1972) and Swamy et al. (1988a, 1989) suggested an extension of the random effects model as;

$$y_{it} = \beta'_i x_{it} + \epsilon_{it}, \quad t = 1, \ldots, T(i), \quad i = i, \ldots, N$$

$$\beta_i = \beta + v_i$$

where $E[v] = 0$ and $Var[v] = \Omega$.

This model is a generalized, group-wise heteroscedastic model.

For best model selection among these three types of models, significance test with an $F$ test, Hausman Specification Test, Breusch-Pagan Lagrange Multiplier test are conducted.

**a. Pooled OLS**

While using the assumption that all coefficients are constant across time and individuals, we assume that there is neither significant country nor significant temporal effects, we could pool all of the data and run an ordinary least squares (OLS) regression model;

$$CGDP_{it} = \beta_{1i} + \beta_{2} X_{it} + \beta_{3} PPPX_{it} + \beta_{4} P_{it} + \beta_{5} PG_{it} + \beta_{6} PI_{it}$$

$$+ \beta_{7} Y_{it} + \beta_{8} RGDPWORK_{it} + \epsilon_{it}$$

Where $i$ stands for the $i$th cross-sectional unit and $t$ for the $t$th time period.
b. Fixed Effects Models
To take into account the individuality of each country/cross-sectional unit, intercept is varied by using dummy variable for fixed effects. Dummy for Pakistan is used as comparison.

Fixed effect models for cross section (intercept or individual)

\[
Y_{it} = \alpha_1 + \alpha_2 D_{2i} + \alpha_3 D_{3i} + \alpha_4 D_{4i} + \alpha_5 D_{5i} + \alpha_6 D_{6i} + \alpha_7 D_{7i} + \alpha_8 D_{8i} + \alpha_9 D_{9i} + \beta_2 X_{iit} + \beta_3 P_{iit} + \beta_4 P_{iit} + \beta_5 P_{iit} + \beta_6 P_{iit} + \beta_7 Y_{it} + \beta_8 RGDPWORK_{it} + \epsilon_{it}
\]

Where \( D_{2i} = 1 \) if the observation belongs to cross-section 2 (Bangladesh), 0 otherwise; \( D_{3i} = 1 \) if the observation belongs to cross-section 3 (India), 0 otherwise. Similarly follows in the same ways for all cross-sections/group. Since there are nine countries, only eight dummies are used to avoid falling in to the dummy variable trap (Gujarati, 2003), we didn’t use the dummy for Pakistan. In other words \( \alpha_1 \) represents the intercept of Pakistan and \( \alpha_2, \alpha_3, \ldots, \alpha_9 \), the differential intercept coefficients, tell by how much the intercepts of the countries differ from the intercept of Pakistan as Pakistan is the comparison country.

c. Random Effects Models
In the random effects model the intercept is assumed to be a random outcome variable, whereas the random outcome is a function of a mean value plus a random error. Two way random effects model is used for estimation purpose.

\[
CGDP_{it} = \beta_1 + \beta_2 X_{iit} + \beta_3 P_{iit} + \beta_4 P_{iit} + \beta_5 P_{iit} + \beta_6 P_{iit} + \beta_7 Y_{it} + \beta_8 RGDPWORK_{it} + \epsilon_{it}
\]

Instead of treating \( \beta_{i1} \) as fixed, it is assumed to be a random variable with a mean value of \( \beta_1 \) and the intercept for an individual company can be expressed as;

\[
\beta_{i1} = \beta_1 + \epsilon_i \quad i = 1, 2, \ldots, N
\]

Where \( \epsilon_i \) is a random error with a mean value of zero and variance of \( \sigma^2_{\epsilon} \). Therefore

\[
CGDP_{it} = \beta_1 + \beta_2 X_{iit} + \beta_3 P_{iit} + \beta_4 P_{iit} + \beta_5 P_{iit} + \beta_6 P_{iit} + \beta_7 Y_{it} + \beta_8 RGDPWORK_{it} + \epsilon_{it} + \mu_{it}
\]

\[
CGDP_{it} = \beta_1 + \beta_2 X_{iit} + \beta_3 P_{iit} + \beta_4 P_{iit} + \beta_5 P_{iit} + \beta_6 P_{iit} + \beta_7 Y_{it} + \beta_8 RGDPWORK_{it} + w_{it}
\]

Where \( w_{it} = \epsilon_{it} + u_{it} \)
Under these circumstances, the random error \( v \) is heterogeneity specific to a cross-sectional unit. This random error \( v \) is constant over time. Therefore, \( E[v_i^2 | x] = \sigma^2_i \).

The random error \( e_i \) is specific to a particular observation. For \( v \) to be properly specified, it must be orthogonal to the individual effects. Because of the separate cross-sectional error term, these models are sometimes called one-way random effects models. Owing to this intra-panel variation, the random effects model has the distinct advantage of allowing for time-invariant variables to be included among the regressors.

**d. Model Specification Test**

One can think of fixed effects and random effects can be the same model, having different assumptions about \( \text{Cov}(\beta_i, X_{it}) \). There are different tests available for fixed and/or random effect models. These tests include Hausman test, Breusch-Pagan test, Bhargarva and Sargan Test. In the current study we are using F-test, Hausman test, and Breusch-Pagan test.

**Fixed Effects Hypothesis Testing**

To check which model is better, we use a formal test for two models. Pooled regression model is used as the baseline for our comparison. We can perform this significance test with an F-test resembling the structure of the F test for \( R^2 \) change.

\[
F_{\text{group effects}} = \frac{(R_{\text{fix}}^2 - R_{\text{pooled}}^2) / (N - 1)}{(1 - R_{\text{LSDV}}^2) / (NT - N - k)}
\]

Here \( T \) is the total number of temporal observations, \( N \) is the number of groups or cross-sections, and \( k \) is the number of regressors in the model. If we find significant improvements in the \( R^2 \), then there is a statistically significant group effects.

**Random or Fixed Effect Models**

The most commonly used specification test is Hausman specification test, which tests the null hypothesis that the coefficients estimated by the efficient random effects estimator are the same as the ones estimated by the consistent fixed effects estimator. If they are insignificant, then it is safe to use random effects. If we get a significant P-value, however, we should use fixed effects. The Hausman test is a kind of Wald \( \chi^2 \) test with \( k-1 \) degrees of freedom (where \( k = \) number of regressors) on the difference matrix between the variance-covariance of the LSDV with that of the Random Effects model. The Wald statistic is

\[
W = (\beta_{FE} - \beta_{RE})' (V_{FE} - V_{RE})^{-1} (\beta_{FE} - \beta_{RE})
\]

**Breusch-Pagan Lagrange Multiplier (LM) Test**

The Breusch-Pagan LM statistic, tests the null hypothesis that the pooled OLS estimator is adequate against the random effects alternative. The specific hypothesis under investigation is the following.

\( H_0: \sigma_T = 0 \)

\( H_a: \sigma_T \neq 0 \)

The LM Statistics is
III. Results and Discussions

After having the thorough discussion regarding the methods used in the current study we have reached on the following results.

Table 1 OLS Results for CGDP Data

<table>
<thead>
<tr>
<th>Variable</th>
<th>Coefficient</th>
<th>Std. Error</th>
<th>t-statistic</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Constant</td>
<td>5.74</td>
<td>0.1094</td>
<td>52.442</td>
<td>&lt;0.00001*</td>
</tr>
<tr>
<td>XRAT</td>
<td>0.000146</td>
<td>0.000386</td>
<td>−0.578</td>
<td>0.5633</td>
</tr>
<tr>
<td>PPP</td>
<td>−0.02035</td>
<td>0.004184</td>
<td>−4.395</td>
<td>0.00023*</td>
</tr>
<tr>
<td>P</td>
<td>0.002039</td>
<td>0.007724</td>
<td>2.845</td>
<td>0.0035*</td>
</tr>
<tr>
<td>PG</td>
<td>−0.02035</td>
<td>0.004184</td>
<td>−4.395</td>
<td>0.00023*</td>
</tr>
<tr>
<td>PI</td>
<td>0.007472</td>
<td>0.002548</td>
<td>2.933</td>
<td>0.0035*</td>
</tr>
<tr>
<td>Y</td>
<td>−0.005999</td>
<td>0.004184</td>
<td>−1.434</td>
<td>0.1525</td>
</tr>
<tr>
<td>RGDPWOK</td>
<td>0.000193</td>
<td>1.34 × 10^{-05}</td>
<td>14.403</td>
<td>&lt;0.00001*</td>
</tr>
</tbody>
</table>

* Significant at 5% level of significance.

Table 2 Fixed Effects Model (LSDV) for CGDP Data

<table>
<thead>
<tr>
<th>Variable</th>
<th>Coefficient</th>
<th>Std. Error</th>
<th>t-statistic</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Constant</td>
<td>5.56</td>
<td>0.113483</td>
<td>49.03</td>
<td>&lt;0.00001*</td>
</tr>
<tr>
<td>XRAT</td>
<td>0.0000968</td>
<td>0.0000696</td>
<td>1.39</td>
<td>0.16497</td>
</tr>
<tr>
<td>PPP</td>
<td>0.000484</td>
<td>0.000356</td>
<td>1.35</td>
<td>0.17546</td>
</tr>
<tr>
<td>P</td>
<td>0.001776</td>
<td>0.007490</td>
<td>2.371</td>
<td>0.01269</td>
</tr>
<tr>
<td>PG</td>
<td>−0.026830</td>
<td>0.006073</td>
<td>−4.4181</td>
<td>0.0001*</td>
</tr>
<tr>
<td>PI</td>
<td>0.012096</td>
<td>0.002671</td>
<td>4.5282</td>
<td>&lt;0.00001*</td>
</tr>
<tr>
<td>Y</td>
<td>−0.028842</td>
<td>0.009589</td>
<td>−3.01</td>
<td>0.00283*</td>
</tr>
<tr>
<td>RGDPWOK</td>
<td>0.000248</td>
<td>0.0000144</td>
<td>17.09</td>
<td>&lt;0.00001*</td>
</tr>
<tr>
<td>Bangladesh</td>
<td>−0.405687</td>
<td>0.121007</td>
<td>−3.35</td>
<td>0.00089*</td>
</tr>
<tr>
<td>India</td>
<td>−0.016046</td>
<td>0.118627</td>
<td>−0.1353</td>
<td>0.89248</td>
</tr>
<tr>
<td>Indonesia</td>
<td>−0.492438</td>
<td>0.136785</td>
<td>−3.6001</td>
<td>0.00036*</td>
</tr>
<tr>
<td>Iran</td>
<td>−0.678589</td>
<td>0.152959</td>
<td>−4.44</td>
<td>0.0001*</td>
</tr>
<tr>
<td>Japan</td>
<td>0.532792</td>
<td>0.450337</td>
<td>1.18</td>
<td>0.23759</td>
</tr>
<tr>
<td>Sri Lanka</td>
<td>0.030021</td>
<td>0.131192</td>
<td>0.2288</td>
<td>0.81913</td>
</tr>
<tr>
<td>Philippines</td>
<td>0.177152</td>
<td>0.124606</td>
<td>1.42</td>
<td>0.15602</td>
</tr>
<tr>
<td>Thailand</td>
<td>0.875107</td>
<td>0.133264</td>
<td>6.57</td>
<td>&lt;0.00001*</td>
</tr>
</tbody>
</table>
Table 3  Corresponding Cross-Section/ Country Intercept Value (Fixed Effect)

<table>
<thead>
<tr>
<th>Intercept</th>
<th>Country</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Pakistan</td>
<td>5.564</td>
</tr>
<tr>
<td>2</td>
<td>Bangladesh</td>
<td>5.159</td>
</tr>
<tr>
<td>3</td>
<td>India</td>
<td>5.548</td>
</tr>
<tr>
<td>4</td>
<td>Indonesia</td>
<td>5.072</td>
</tr>
<tr>
<td>5</td>
<td>Iran</td>
<td>4.886</td>
</tr>
<tr>
<td>6</td>
<td>Japan</td>
<td>6.097</td>
</tr>
<tr>
<td>7</td>
<td>Sri Lanka</td>
<td>5.594</td>
</tr>
<tr>
<td>8</td>
<td>Philippines</td>
<td>5.741</td>
</tr>
<tr>
<td>9</td>
<td>Thailand</td>
<td>6.439</td>
</tr>
</tbody>
</table>

Table 4  Random Effects Model for CGDP data: All Factors Included

<table>
<thead>
<tr>
<th>Variable</th>
<th>Coefficient</th>
<th>Std. Error</th>
<th>t-Statistic</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>CONST</td>
<td>5.51</td>
<td>0.13349</td>
<td>41.27</td>
<td>0.0000*</td>
</tr>
<tr>
<td>XRAT</td>
<td>9.41×10⁻⁶</td>
<td>6.85×10⁻⁶</td>
<td>1.37</td>
<td>0.1702</td>
</tr>
<tr>
<td>PPP</td>
<td>0.00044</td>
<td>0.000344</td>
<td>1.28</td>
<td>0.2011</td>
</tr>
<tr>
<td>P</td>
<td>0.00186</td>
<td>0.007328</td>
<td>0.2538</td>
<td>0.7997</td>
</tr>
<tr>
<td>PG</td>
<td>-0.02605</td>
<td>0.005987</td>
<td>-4.35</td>
<td>0.0000*</td>
</tr>
<tr>
<td>PI</td>
<td>0.01145</td>
<td>0.002591</td>
<td>4.43</td>
<td>0.0000*</td>
</tr>
<tr>
<td>Y</td>
<td>-0.01748</td>
<td>0.006059</td>
<td>-2.88</td>
<td>0.0041*</td>
</tr>
<tr>
<td>RGDPWOK</td>
<td>0.000232</td>
<td>1.28×10⁻⁵</td>
<td>18.20</td>
<td>0.0000*</td>
</tr>
</tbody>
</table>

Table 5  Effects Specification

<table>
<thead>
<tr>
<th></th>
<th>t-Statistic</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cross-section random S.D. / Rho (Sigma_u)</td>
<td>0.242910</td>
<td>0.1805</td>
</tr>
<tr>
<td>Idiosyncratic random S.D. / Rho (Sigma_e)</td>
<td>0.517539</td>
<td>0.8195</td>
</tr>
</tbody>
</table>

Table 6  Cross-Section Random Effects (Intercept Value)

<table>
<thead>
<tr>
<th>Cross Section</th>
<th>Country</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Pakistan</td>
<td>0.0531</td>
</tr>
<tr>
<td>2</td>
<td>Bangladesh</td>
<td>-0.2979</td>
</tr>
<tr>
<td>3</td>
<td>India</td>
<td>0.0347</td>
</tr>
<tr>
<td>4</td>
<td>Indonesia</td>
<td>-0.3727</td>
</tr>
<tr>
<td>5</td>
<td>Iran</td>
<td>-0.5582</td>
</tr>
<tr>
<td>6</td>
<td>Japan</td>
<td>0.1208</td>
</tr>
<tr>
<td>7</td>
<td>Sri Lanka</td>
<td>0.0689</td>
</tr>
<tr>
<td>8</td>
<td>Philippines</td>
<td>0.1824</td>
</tr>
<tr>
<td>9</td>
<td>Thailand</td>
<td>0.7887</td>
</tr>
</tbody>
</table>

From Table 1 it is clear that all the coefficients are statistically significant except PPP (p-value 0.5633), P (p-value 0.7919) and Y (p-value 0.1525) while $R^2$ (0.7155) is
reasonably high, also there is positive relationship of \( \text{LNCGDP} \) to \( \text{XRAT}, \ P, \ PI, \ RGDPWOK \) and \( \text{PPP}, \ PG \) and \( \text{Y} \) have negative effect on \( \text{CGDP} \). To take into account the individuality of each country/ cross-sectional unit, intercept is varied by using dummy variable for fixed effects. Dummy for Pakistan is used as comparison country. Usual \textit{OLS} method is applied for all variables. A low p-value (0.00001) counts against the null hypothesis that the pooled \textit{OLS} model is adequate, which is in favor of the fixed effects as an alternative.

Individuality of each country/ cross-sectional unit is accounted by letting the intercept vary for each country. It is also assumed that the slope coefficients are still constant across cross-section (following Gujarati, 2003). The intercept of Pakistan is taken as comparison country. From Table 2 it is evident that the estimated coefficients of factors; \( \text{PG}, \ PI, \ Y \) and \( \text{RGDPWOK} \) are highly significant (p-value < 0.00001) and \( \text{R}^2 \) (0.808865) is high, while dummy for countries \textit{Bangladesh and Indonesia}, \textit{Iran} and \textit{Thailand} coefficients are significant (Table 3). The \textit{CGDP} has positive relationship with \( \text{XRAT}, \ \text{PPP}, \ P, \ PI \) and \( \text{RGDPWOK} \), and dummy for countries \textit{Japan}, \textit{Sri Lanka}, \textit{Philippines} and \textit{Thailand}. While \( \text{PG}, \ Y \) and dummy for countries \textit{Bangladesh, India, Indonesia} and \textit{Iran} have negative relationship with \textit{CGDP}.

The difference in the intercepts of the countries may be due to the unique policy of Government about trade of import and export of goods, prices of goods in other countries, exchange rate, \textit{CGDP} relative to United States and/ or other economic variables. To measure the random deviation (error component) of individual intercept from mean value of all cross-sectional intercept which is \( \beta_i \) one way Random Effects model is applied on the \textit{CGDP} data. From Table 4, it is clear that all the coefficients have significant effect (p-value \leq 0.0001) on \textit{CGDP} except \( \text{XRAT}, \text{PPP}, \ P \). While \( \text{PPP}, \ P, \ PI \) and \( \text{RGDPWOK} \) have a certain relation with \textit{CGDP}, and \( \text{XRAT}, \text{PG}, \ Y \) has depressing relationship with \textit{CGDP}. The mean value of the random error component \( e_i \) is the common intercept value of 5.51. The cross-section’s random value of Pakistan of 0.0531 tells us by how much the random error component of Pakistan differs from the common intercept value. Similarly Cross-section random value of \textit{Bangladesh} = -0.2979, \textit{India} = 0.0347, \textit{Indonesia} = -0.3727, \textit{Iran} = -0.5582, \textit{Japan} = 0.1208, \textit{Sri Lanka} = 0.0689, \textit{Philippines} = 0.1824 and \textit{Thailand} = 0.7687 differs from the common intercept value as given in the table 6.

\[
F_{\text{group effects}} = \frac{(R^2_{\text{fix}} - R^2_{\text{pooled}})/(N - 1)}{(1 - R^2_{\text{LSDV}})/(NT - N - k)}
\]

\[
= \frac{(0.808865 - 0.7155) / 8}{(1 - 0.808865) / (360 - 9 - 7)}
\]

\[
= \frac{0.011671}{0.000556} = 21.0045
\]

P-value = 0.0000

For significance test with an \( F \) test with \( R^2 \) have low p-value which counts against the null hypothesis that the Pooled \textit{OLS} model is adequate, in favor of the fixed effects alternative.
Hausman test

To choose FEM or REM the Hausman test should be used which has an asymptotic
chi-square distribution. The statement of hypothesis related to FEM and ECM (Error
Component Model).

\[ H_0: \text{FEM and ECM estimators do not differ substantially} \]
\[ H_1: \text{FEM and ECM estimators differ substantially} \]

\[ H = 15.0306 \]
\[ P-value = \text{prob(chi-square}(7) > 15.0306) = 0.0356085 \]

Small p-value, by Hausman test shows that coefficient estimated by random
effects model and fixed effects model are not same. The P-value is significant which is in
favour of fixed effects when we stack the cross section but Hausman test matrix is not
positive definite (this result may be treated as "fail to reject" the random effects
specification) when stacking is with respect to time series.

To choose Pooled OLS or REM the Breusch-Pagan test should be used which has
chi-square distribution. The statement of hypothesis related to OLS and ECM (Error
Component Model). For Breusch and Pagan LM test, low p-value counts against the null
hypothesis that the pooled OLS model is adequate, in favor of the random effects
alternative.

Table 7 Specification Tests

<table>
<thead>
<tr>
<th>Spec. Tests</th>
<th>p-value</th>
<th>Tested</th>
<th>Selection</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hausman</td>
<td>0.0356085</td>
<td>Fixed/Random</td>
<td>Fixed</td>
</tr>
<tr>
<td>Breusch-Pagen</td>
<td>0.00001</td>
<td>OLS/Random</td>
<td>Random</td>
</tr>
<tr>
<td>F-test</td>
<td>0.00001</td>
<td>OLS/Fixed</td>
<td>Fixed</td>
</tr>
</tbody>
</table>

IV. Conclusion

To evaluate the determinants of economic growth the panel data analysis is carried
out. PPP, P and Y were not found as an important factor for CGDP, by pooled OLS
model, while LSDV model is appropriate as compared to pooled OLS. XRAT, PPP and P
are non-effecting factors for LSDV. While increased \( R^2 \) and decreased standard error
makes LSDV best choice as compared to pooled OLS. For Random effect model XRAT,
PPP and P are found to be non-significant.

Although Hausman test is in favour of fixed effects model but, Hausman matrix is
not a positive definite matrix, making it in favour of random effects model, when
stacking the time series for this panel data. When stacking with reference to the cross
section, Hausman matrix becomes positive definite which make the fixed effects as an
alternative choice.

Breusch-Pagan test statistic having large value of \( LM \) (i.e. 341.87), for comparison
of OLS and REM goes in favour of random effects model. Small Hausman statistic and
large \( LM \) statistic indicates that the appropriate specification is the random effects model.
So REM is best choice for this data.
References


