J. Appl. Environ. Biol. Sci., 6(5S)43-54, 2016

ISSN: 2090-4274
Journal of Applied Environmental and Biological Sciences
www.textroad.com

OLS Assumptions Violation and Its Treatment: An Empirical Test of Gross Domestic Product Relationship with Exchange Rate, Inflation and Interest Rate

Dr. Muhammad Tariq[1], Dr. Javed Iqbal[2], Dr. Shahid Jan[3], Dr. Zilakat Khan Malik[4],

[1,2]Assistant Professor, Department of Economics, Abdul Wali Khan University Mardan, Pakistan
[3]Associate Professor, Department of Management Sciences, Abdul Wali Khan University Mardan, Pakistan
[4]Professor, Department of Economics, Abdul Wali Khan University Mardan, Pakistan

Received: February 3, 2016
Accepted: April 12, 2016

ABSTRACT

We have conducted an empirical test of the consequences and solution of OLS assumption violation specifically focusing on autocorrelation and heteroscedasticity problems in data. For this purpose, the relationship of Gross Domestic Product with the inflation, exchange rate and interest rate has been examined for Pakistan by using data from 1973-2008. Hodric-Prescott filter method has been used for making the data stationary. For obtaining reliable results and maintaining the BLUE properties of the coefficients appropriate consideration of the serial correlation and heteroscedasticity assumptions cannot be underestimated.

1. INTRODUCTION

Economic theory is considered as a first guiding tool for understanding the interrelationship between the variables. However, it only states whether there is a positive or negative relationship between the variables. But it does not say anything about the exact nature of the relationship that how much one variable is affected by changes in other variables. However, for finding out the exact nature and direction of relationship between the variables, the role of econometrics cannot be underestimated.

Econometrics solves this problem and provides useful qualitative and quantitative techniques for measuring the relationship between variables. Econometrics used the tools of mathematics and statistics which helps in the quantitative measurement of the relationship between variables. It provides models for explaining this relationship in a very simple manner. Whereas modeling helps in examining the relationship and behavior between the variables by bringing them together keeping the other factors constant.

Although the application of econometrics models and its techniques is vast but its usage is more popular for checking the relationship between macroeconomic variables. Modeling of the relationship between macroeconomic variables helps in the judgment of the exact nature of the relationship between the variables. It highlights the different problems facing by the researchers while working with data and also provides them useful techniques for handling these problems. This study is based on time series data. The focus of the study is on to highlight different problems facing by researchers in time series analysis and implementation of appropriate measures for its solution. It is expected that this research work will help the policy makers in channelizing the resources optimally which will work as a guideline for future policy making.

2. LITERATURE REVIEW

Agalega and Antwi (2013) studied the relationship between macroeconomic variables and Gross Domestic Product for Ghana. The purpose of the study was to analyze the impact of changes in inflation and interest rates on the Gross Domestic Product (GDP) in Ghana. The time period of the study was from 1980 to 2010. Ordinary least squares method has been applied for the measurement of the relationship between all variables. The results of the study were that interest and inflation showed a significant relationship with the GDP. However, inflation showed a positive relationship with the GDP and interest rate showed a negative relationship with GDP. The study recommended that the government along with Bank of Ghana should designed and pursue monetary policies that helps in stabilizing the macroeconomic conditions in the country. Bhatia and Jain (2013) conducted a diagnostic study for investigating the relationship of macroeconomic variables and growth insurance. The key variables of the study were , GDP, Population, Per Capita Income, Inflation and Unemployment. Annual data during the period 1991-2012 has been used in the study. It is found that all the variables showing a significant relationship with each other. Population and per capita GDP showed a positive whereas inflation showed a negative relationship with the insurance growth. Kibria et al (2014) studied the impact of interest rate, exchange

* **Corresponding Author:** Dr. Muhammad Tariq, Assistant Professor, Department of Economics, Abdul Wali Khan University Mardan, Pakistan. tariq_noor@awkum.edu.pk

rate, inflation and FDI on GDP of Pakistan during the period 1980 to 2013. The study used different correlation coefficient, regression analysis and Granger causality for examining the association of the macroeconomic variables and Gross Domestic Product. The correlation results showed a negative relationship between the inflation and interest and GDP. The Granger Causality test showed a unidirectional relationship of the variables with the GDP. The results showed a significant relationship of all variables with GDP. The study recommended that the SBP should follow strict monetary policy for the macroeconomic stability in the country.
Syed and Sheikh (2013) studied the impact of selected macroeconomic variables on the GDP of Pakistan. The study used Principal Component analysis and Maximum Likelihood method for analyzing the relationship of the macroeconomic variables with the GDP. The universe of the study was 64 districts. The results of the study showed a strong relationship of most of the variables with the Gross Domestic Product. However, it is further mentioned that this relationship changed with the passage of time.

3. Econometric Model

The following model has been developed for studying the relationship of the GDP with interest rate, inflation and exchange rate.

$$GDP_i = a_0 + a_{INT}\, INT + a_{INF}\, INF + a_{EXR}\, EXR + e_i$$

In the above model GDP has been taken as a dependent variable whereas, interest rate, inflation and exchange rate has been included as an independent variables.

- $GDP$is the Gross Domestic Product of Pakistan which has been converted into real form by using financial year 1976 as a base period and log of it has been taken.
- $INT$is the nominal discount rate. It is used into real form after adjusting it for inflation.
- INF is the inflation rate of Pakistan which is shows the annual percentage change in consumer price index
- EXR is the nominal exchange rate of Pakistan rupee against US dollar.

The time period of the study is from 1973 to 2008. All the data has been collected from various issues of Economic Survey of Pakistan and International Financial Statistics of IMF. Eviews 6 is used for the computation of the regression results. Financial year 1976 is used as a based period for converting nominal values into real form. The period of the study is from 1973 to 2008. Time series annual data has been used collected from economic survey of Pakistan various years issues and international financial statistics.
Eviews. 6 is used for analysis of the data.

3.1 Hypothesis

- Gross Domestic Product which is dependent variable here is a linear function of the exchange rate, inflation and interest rate
- The mean value of the disturbance term u is zero
- All the disturbance terms are homoscedastic having equal variance spread for all values of X's around the regression line.
- The covariance between the error term and Exchange rate, inflation and interest rate is zero showing that all the independent variables are non stochastic.
- The error terms are not correlated showing that there is no problem of series correlation in the data.
- The error term has a normal distribution with zero mean and constant variance.
- The explanatory variables, exchange rate, inflation and interest rate are independent showing that there is no problem of exact linear relationship between them.

2.2 Consequences of the Violating the Assumption Ordinary Least Squares Method

- Violation of assumption one creates the problem of specification errors such as wrong explanatory variables, the problem of nonlinearity and changing parameters.
- Violation of the assumption two leads to biased intercept.
- Violation of the assumption three leads the problem of unequal variances so although the coefficients estimates will be still unbiased but the standard errors and inferences based on it may give misleading results.
- Violation of the assumption creates an error in variables.
- Violation of assumption five makes the regression coefficients inefficient and they will be no longer BLUE. However, they will be still unbiased and consistent. The standard errors of the OLS estimators will be biased and inconsistent and therefore hypothesis testing will be no longer valid. Also the value of R^2 and t statistics will be overestimated showing better fit of the data and higher significance of the estimates.
- Violation of the normality assumption makes the standard error wrong and inferences based on it will be not reliable anymore.
- Violation of the assumption six made the t-statistic and F-statistic results non reliable.

4. EMPIRICAL RESULTS

The present section is based on the empirical results of the study. First the GDP value will be regressed on the explanatory variables and then the behavior of the residuals will be tested by carrying out different tests. Then the stability of the parameters will be tested. If the results show that there is no problem of serial correlation in data and the regression parameters are stable then the regression results will be considered reliable. But if it does not fulfill at least one of the assumption, then appropriate remedial measures will be applied for removal of these problems from data. Again the regression will be carried out and a comparative analysis of both the regressions will be made. The regression results obtained are given in table 4.1 which is as under:

Table. 4.1: Regressions Results

Dependent Variable : GDP
Method : Least Squares
Sample : 1973-2008

Variable	**Coefficient**	**t-stat**	**prob.**	
EX	2.04* (0.32)	6.25	0.00	
IF	1.89* (0.53)	3.56	0.00	
R	0.11* (0.04)	3.08	0.01	
C	4.50* (1.75)	2.57	0.01	
R2	0.67	Akaik Info Criterion		2.66
Adjusted R2	0.64	Schwarz Criterion		2.84
F-Stat	21.56	Durbin Watson Stat		0.78
Prob (F-Stat)	0.00			

1. "*" shows 5 % level of significance
2. A rise in exchange rate means devaluation
3. Figures in parenthesis shows SE of the estimates

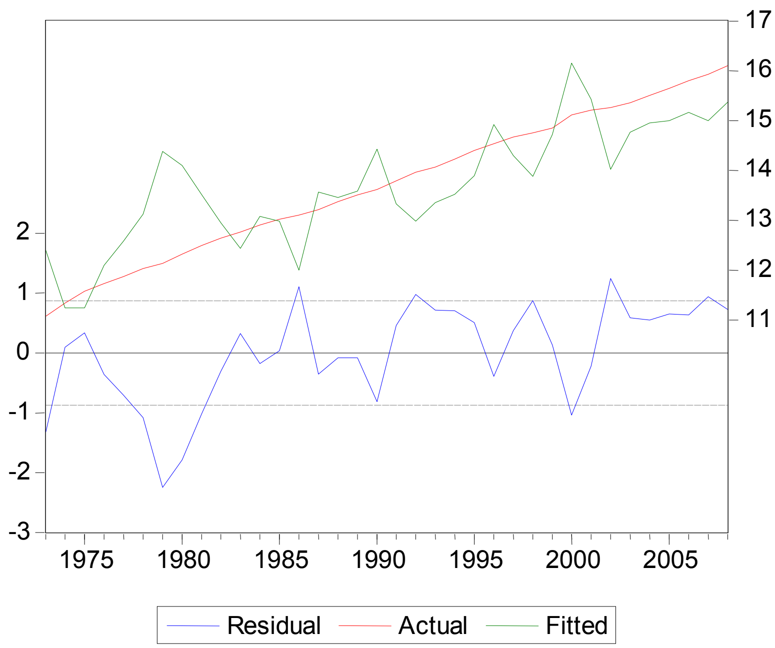
Table 4.1 shows the regressions restful. After regressing Gross domestic product on exchange rate, inflation and interest rate the following results were obtained. The results showed positive relationship between exchange rate and gross domestic product for Pakistan and it is significant at 5% level of significance. This views support the traditional economists views that devaluation of the currency improved the trade balance of a country and puts expansionary effects on output. Similarly, interest rate is also significant at 5% level of significance and the results showed a positive relationship between interest rate and GDP growth. This results is opposed of the view that there is inverse relationship between interest rate and GDP, and increase in interest rate reduce the level of output by affecting investment and firms productivity costs. However, in case of Pakistan the results showed positive relationship between the two. This may be because of the role of interest rate in channelizing the resources towards accumulation by attracting foreign investment in the country. Moreover, inflation is also turned out significant at 5% level of significance but interestingly its sign is positive against the prior expectations. The t value is greater than 2 for all the variables showing that all the variables are significant.

R-squared which is a measure of goodness of fit and shows the proportion of the variation in dependent variable explained by the independent variables. The R^2 value is 0.67 showing that the fit is good. The Akaike information and Schwarz criteria are also mentioned which is useful when choosing between two models. The F statistics is also given which showed the overall significance of the model. Durbin Watson statistics is used for checking the serial correlation of the error term. When the value of Durbin Watson statistics is 2 it means that there is no auto correlation between the error terms. Similarly, its value less than and greater than 2 indicates negative and positive correlation between residuals respectively. The Durbin Watson statistics is useful for Ist Order Auroregression scheme only, and it is not reliable for higher order scheme. If there is lag value of the dependent variables in the right side of the equation it does not provide reliable results. The value of the Durbin Watson statistics is 0.78 showing that there is serial correlation problem in the data.

4.1 Residual Tests

For evaluation of goodness of the fitted model, analysis of the residual behavior is important. It helps in avoidance of specification error in regression function and inconsistency in error terms. Examination of the residuals behavior works as an important tool for verification of the assumption of ordinary least squares. Figure 4.1 showed the actual, fitted and residual values. The residual is the difference between the original and estimated data. The results of both the figures show that there are spikes in and data and it lies outside the range at some points.

Figure. 4.1: Residual Test Results



4.2: Autocorrelation Test

For examining the serial correlation in data, and confirmation of the above results Correlogram Q-Statistics, Correlogram squared Residuals and Breusch- Godfrey Serial Correlation LM test are used given in figures 4.2, 4.3 and 4.4 respectively.

Figure 4.2: Correlogram test results

<table>
<tr><th>obs</th><th>Actual</th><th>Fitted</th><th>Residual</th><th>Residual Plot</th></tr>
<tr><td>1973</td><td>11.0767</td><td>12.3973</td><td>-1.32060</td><td>| * . | . |</td></tr>
<tr><td>1974</td><td>11.3432</td><td>11.2464</td><td>0.09679</td><td>| . |* . |</td></tr>
<tr><td>1975</td><td>11.5759</td><td>11.2424</td><td>0.33349</td><td>| . | * . |</td></tr>
<tr><td>1976</td><td>11.7350</td><td>12.0948</td><td>-0.35975</td><td>| . *| . |</td></tr>
<tr><td>1977</td><td>11.8736</td><td>12.5834</td><td>-0.70976</td><td>| .* | . |</td></tr>
<tr><td>1978</td><td>12.0371</td><td>13.1197</td><td>-1.08262</td><td>| *. | . |</td></tr>
<tr><td>1979</td><td>12.1373</td><td>14.3830</td><td>-2.24576</td><td>|* . | . |</td></tr>
<tr><td>1980</td><td>12.3208</td><td>14.1044</td><td>-1.78366</td><td>| * . | . |</td></tr>
<tr><td>1981</td><td>12.4930</td><td>13.5113</td><td>-1.01825</td><td>| * | . |</td></tr>
<tr><td>1982</td><td>12.6459</td><td>12.9506</td><td>-0.30465</td><td>| . *| . |</td></tr>
<tr><td>1983</td><td>12.7629</td><td>12.4378</td><td>0.32516</td><td>| . |* . |</td></tr>
<tr><td>1984</td><td>12.9045</td><td>13.0820</td><td>-0.17747</td><td>| . *| . |</td></tr>
<tr><td>1985</td><td>13.0220</td><td>12.9870</td><td>0.03498</td><td>| . * . |</td></tr>
<tr><td>1986</td><td>13.1080</td><td>12.0021</td><td>1.10588</td><td>| . | .* |</td></tr>
<tr><td>1987</td><td>13.2147</td><td>13.5667</td><td>-0.35205</td><td>| . *| . |</td></tr>
<tr><td>1988</td><td>13.3800</td><td>13.4600</td><td>-0.08003</td><td>| . * . |</td></tr>
</table>

<table>
<tr><td>1989</td><td>13.5108</td><td>13.5909</td><td>-0.08019</td><td>| . * . |</td></tr>
<tr><td>1990</td><td>13.6169</td><td>14.4305</td><td>-0.81361</td><td>| .* | . |</td></tr>
<tr><td>1991</td><td>13.7928</td><td>13.3300</td><td>0.46284</td><td>| . |* . |</td></tr>
<tr><td>1992</td><td>13.9642</td><td>12.9864</td><td>0.97783</td><td>| . | * |</td></tr>
<tr><td>1993</td><td>14.0663</td><td>13.3507</td><td>0.71566</td><td>| . | *. |</td></tr>
<tr><td>1994</td><td>14.2255</td><td>13.5224</td><td>0.70305</td><td>| . | *. |</td></tr>
<tr><td>1995</td><td>14.4048</td><td>13.8966</td><td>0.50826</td><td>| . | * . |</td></tr>
<tr><td>1996</td><td>14.5341</td><td>14.9232</td><td>-0.38907</td><td>| . *| . |</td></tr>
<tr><td>1997</td><td>14.6715</td><td>14.2990</td><td>0.37251</td><td>| . |* . |</td></tr>
<tr><td>1998</td><td>14.7574</td><td>13.8803</td><td>0.87707</td><td>| . | * |</td></tr>
<tr><td>1999</td><td>14.8503</td><td>14.7203</td><td>0.13005</td><td>| . |* . |</td></tr>
<tr><td>2000</td><td>15.1143</td><td>16.1517</td><td>-1.03737</td><td>| *. | . |</td></tr>
<tr><td>2001</td><td>15.2099</td><td>15.4278</td><td>-0.21788</td><td>| . *| . |</td></tr>
<tr><td>2002</td><td>15.2660</td><td>14.0209</td><td>1.24506</td><td>| . | . * |</td></tr>
<tr><td>2003</td><td>15.3567</td><td>14.7712</td><td>0.58546</td><td>| . | * . |</td></tr>
<tr><td>2004</td><td>15.5024</td><td>14.9553</td><td>0.54716</td><td>| . | * . |</td></tr>
<tr><td>2005</td><td>15.6442</td><td>14.9959</td><td>0.64830</td><td>| . | * . |</td></tr>
<tr><td>2006</td><td>15.8036</td><td>15.1651</td><td>0.63851</td><td>| . | * . |</td></tr>
<tr><td>2007</td><td>15.9327</td><td>14.9947</td><td>0.93796</td><td>| . | * |</td></tr>
<tr><td>2008</td><td>16.1031</td><td>15.3764</td><td>0.72672</td><td>| . | *. |</td></tr>
</table>

Figure. 4.3: Correlogram Q-Statistics Results

<table>
<tr><th>Autocorrelation</th><th>Partial Correlation</th><th></th><th>AC</th><th>PAC</th><th>Q-Stat</th><th>Prob</th></tr>
<tr><td>. |**** |</td><td>. |**** |</td><td>1</td><td>0.561</td><td>0.561</td><td>12.315</td><td>0.000</td></tr>
<tr><td>. |** |</td><td>.*| . |</td><td>2</td><td>0.242</td><td>-0.107</td><td>14.665</td><td>0.001</td></tr>
<tr><td>. |** |</td><td>. |*. |</td><td>3</td><td>0.233</td><td>0.210</td><td>16.908</td><td>0.001</td></tr>
<tr><td>. |*. |</td><td>.*| . |</td><td>4</td><td>0.101</td><td>-0.169</td><td>17.343</td><td>0.002</td></tr>
<tr><td>. |*. |</td><td>. |*. |</td><td>5</td><td>0.085</td><td>0.157</td><td>17.660</td><td>0.003</td></tr>
<tr><td>. |*. |</td><td>. | . |</td><td>6</td><td>0.110</td><td>-0.038</td><td>18.208</td><td>0.006</td></tr>
<tr><td>. | . |</td><td>.*| . |</td><td>7</td><td>0.003</td><td>-0.067</td><td>18.209</td><td>0.011</td></tr>
<tr><td>. | . |</td><td>. |*. |</td><td>8</td><td>0.059</td><td>0.143</td><td>18.380</td><td>0.019</td></tr>
<tr><td>. |*. |</td><td>. | . |</td><td>9</td><td>0.143</td><td>0.033</td><td>19.416</td><td>0.022</td></tr>
<tr><td>. |*. |</td><td>. |*. |</td><td>10</td><td>0.152</td><td>0.113</td><td>20.629</td><td>0.024</td></tr>
<tr><td>. |*. |</td><td>. | . |</td><td>11</td><td>0.139</td><td>-0.046</td><td>21.685</td><td>0.027</td></tr>
<tr><td>. | . |</td><td>.*| . |</td><td>12</td><td>-0.027</td><td>-0.195</td><td>21.726</td><td>0.041</td></tr>
<tr><td>.*| . |</td><td>. | . |</td><td>13</td><td>-0.148</td><td>-0.063</td><td>23.035</td><td>0.041</td></tr>
<tr><td>.*| . |</td><td>.*| . |</td><td>14</td><td>-0.145</td><td>-0.090</td><td>24.338</td><td>0.042</td></tr>
<tr><td>.*| . |</td><td>. | . |</td><td>15</td><td>-0.138</td><td>0.023</td><td>25.582</td><td>0.043</td></tr>
<tr><td>. | . |</td><td>. |*. |</td><td>16</td><td>-0.025</td><td>0.144</td><td>25.626</td><td>0.060</td></tr>
</table>

The tests results showed that there is autocorrelation between the variables. The Q-statistics is based on the assumption that there is no autocorrelation between the error terms. If the Q-statistics values remained significant it means that the null hypothesis of no autocorrelation is rejected and there is Autocorrelation. The results showed that all the Q-statistic values are insignificant showing that the null hypothesis of no autocorrelation cannot be rejected. This results is also confirm by the values of autocorrelation and partial autocorrelation which are not closer to zero.

The Correlogram of the squared residuals test is also applied for checking the autocorrelation. If it is exist it will be an indication of hetroscedasticity.

Figure. 4.4: Correlogram Squared Residuals

<table>
<tr><th>Autocorrelation</th><th>Partial Correlation</th><th></th><th>AC</th><th>PAC</th><th>Q-Stat</th><th>Prob</th></tr>
<tr><td>. |*** |</td><td>. |*** |</td><td>1</td><td>0.415</td><td>0.415</td><td>6.7443</td><td>0.009</td></tr>
<tr><td>. |*. |</td><td>.*| . |</td><td>2</td><td>0.077</td><td>-0.115</td><td>6.9858</td><td>0.030</td></tr>
<tr><td>**| . |</td><td>**| . |</td><td>3</td><td>-0.216</td><td>-0.250</td><td>8.9171</td><td>0.030</td></tr>
<tr><td>**| . |</td><td>. | . |</td><td>4</td><td>-0.216</td><td>-0.024</td><td>10.913</td><td>0.028</td></tr>
<tr><td>**| . |</td><td>.*| . |</td><td>5</td><td>-0.207</td><td>-0.112</td><td>12.807</td><td>0.025</td></tr>
<tr><td>. |*. |</td><td>. |*. |</td><td>6</td><td>0.085</td><td>0.213</td><td>13.138</td><td>0.041</td></tr>
<tr><td>. |*. |</td><td>. | . |</td><td>7</td><td>0.144</td><td>-0.011</td><td>14.110</td><td>0.049</td></tr>
</table>

<table>
<tr><td>. | . |</td><td>**| . |</td><td>8</td><td>-0.025</td><td>-0.244</td><td>14.140</td><td>0.078</td></tr>
<tr><td>.*| . |</td><td>. | . |</td><td>9</td><td>-0.107</td><td>0.019</td><td>14.725</td><td>0.099</td></tr>
<tr><td>. | . |</td><td>. |*. |</td><td>10</td><td>-0.058</td><td>0.074</td><td>14.900</td><td>0.136</td></tr>
<tr><td>. | . |</td><td>. | . |</td><td>11</td><td>-0.036</td><td>-0.017</td><td>14.971</td><td>0.184</td></tr>
<tr><td>. | . |</td><td>. | . |</td><td>12</td><td>0.001</td><td>-0.038</td><td>14.971</td><td>0.243</td></tr>
<tr><td>. | . |</td><td>. | . |</td><td>13</td><td>0.072</td><td>-0.016</td><td>15.279</td><td>0.290</td></tr>
<tr><td>. | . |</td><td>. | . |</td><td>14</td><td>0.011</td><td>-0.031</td><td>15.286</td><td>0.359</td></tr>
<tr><td>. | . |</td><td>. | . |</td><td>15</td><td>-0.055</td><td>0.016</td><td>15.486</td><td>0.417</td></tr>
<tr><td>.*| . |</td><td>. | . |</td><td>16</td><td>-0.074</td><td>-0.052</td><td>15.865</td><td>0.462</td></tr>
</table>

According to results there is serial correlation between the variables as showed by the values of Q-statistics. So the data is also suffering from the problem of unequal spreads of variance.

The autocorrelation between the variables is confirmed with the LM test. The results obtained from LM test is given in figure 3.3.3.The null hypothesis of LM test is based on the assumption that there is no serial correlation between the variables. Both statistic i.e. F-statistic and R-squared showed that the probabilities are below the confidence interval .05 so the null hypothesis of no autocorrelation is rejected, and the conclusion is that there is a serial correlation problem between the error terms.

Table 4.2: Breusch- Godfrey Serial Correlation LM test

F-statistic	8.382598	Prob. F(2,30)0.0013
Obs* R-squared	12.90590	Prob. Chi-squre(2)0.0016

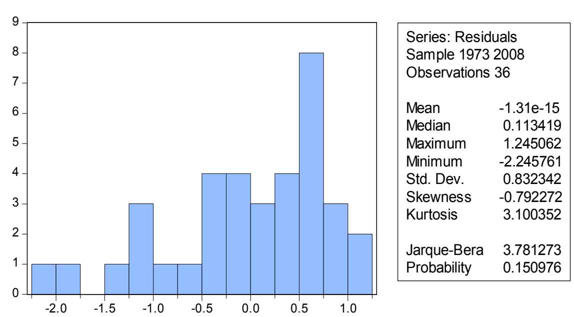
Table: 4.3: Dependent Variable: GDP

Variable	Coefficient	S.E	T-Statistic	Prob.
LRER	-0.061999	0.285978	-0.216797	0.8298
LINF	-0.11654	0.464878	-0.025069	0.9802
R	-0.021541	0.031483	-0.684229	0.4991
C	0.223129	1.557305	0.143279	0.8870
RESID(-1)	0.661699	0.182382	3.628085	0.0010
RESID(-2)	-0.053458	0.196756	-0.271695	0.7877
R2	0.36			
Adj. R2	0.25			
Durbin Watson Statistic	1.70			

4.2 Normality Test

For examining the normality, histogram of the normality test is used given in figure 3.3.1. The tests showed

Figure. 3.4.1



For investigating that whether the error terms has a normal distribution or not the following histogram of normality test is used. Skewness is a measure of symmetry of the histogram. The skewness of a symmetrical distribution such as normal distribution is zero. If the upper tail of the distribution is thicker than the lower tail skewness will be positive and vice versa. Whereas, Kurtosis is a measure of the tail of a histogram. The kurtosis of a normal distribution is 3.if the distribution has a thicker tail then a normal distribution then it exceeds 3. The jarque-Bera Statistic is based on the assumption that the residual has a normal distribution. If the p value is less then the significance level the null hypothesis of normal distribution will be rejected. Here the f p value is greater then the level of significance (0.15.0.05). Hence the null hypothesis that the residuals has normal distribution is accepted

.

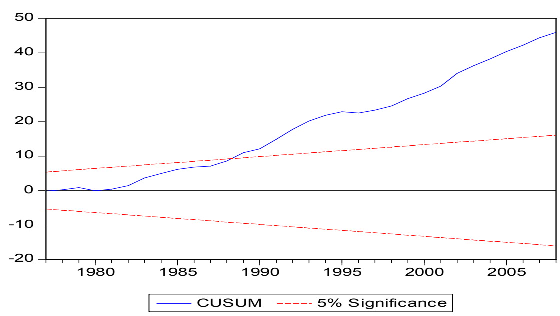
4.3 Stability tests

Stability of parameters is necessary for econometric inferences and forecasting. Examination of instability of parameters which usually occurred because of shift in regime or exclusion of important variable from model, is extremely important otherwise the interpretation of regressions results will be very difficult. Model stability is also important for judgment of the effect of a given policy. Three tests, CUSUM test, CUSUMSquaes Test and Recursive Coefficients test is usually used for examining the stability of parameters. The results obtained from all the test are given in figure. 4.5, 4.6, 4.7 respectively.

4.3.1 CUSUM Test

CUSUM test provides useful information about the stability of the model. It is based on the cumulative sum of the equation errors plot against time with 5% significance confidence bounds. The CUSUM test is based on the null hypothesis that the model parameters are stable with constant coefficients and variance. The cumulative sum of squares residuals run from zero to the end of the period. If the given line of the sum of the errors against time remained within the 5% confidence bound represented by the two critical lines, the parameters will be stable otherwise not. Figure.4.5 shows that the line of cumulative sum of squares is outside the given range hence the model parameters are not stable.

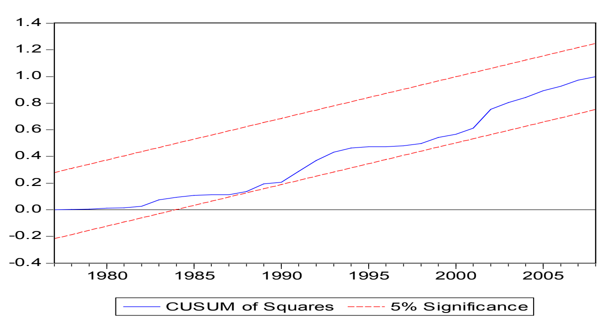
Figure: 4.5: CUSUM test results



4.3.2 CUSUM Squares Tests

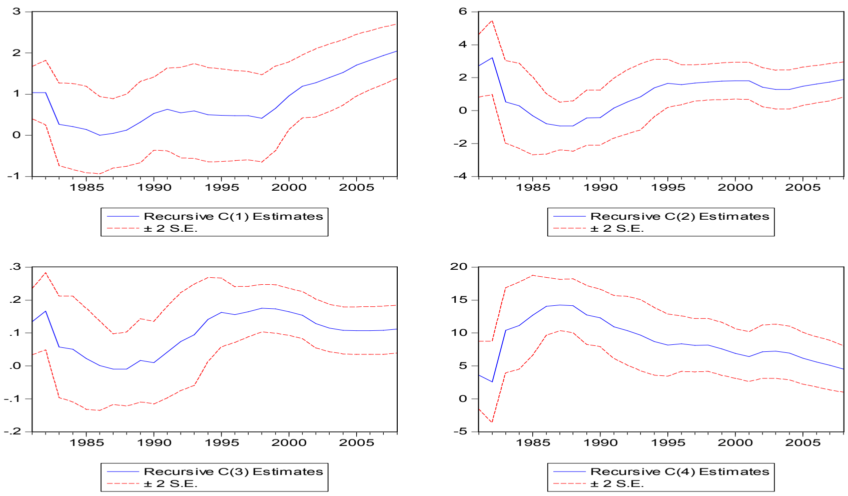
CUSUM Squares Tests is based on the cumulative sum of squares residuals against time instead of cumulative sum of residuals. The results obtained from it are given in figure. 4.6 The results showed that the given model is instable as the line touched the 5% confidence bounds before 1990.

Figure:4.6 CUSUM Squares test results



4.3.3 Recursive Coefficients Test

Figure.4.7:Recursive Coefficients test results



Recursive coefficients test is based on the method of computing parameters from a number of sum samples. The idea behind the recursive test of parameter estimates is, that adding variables one by one and re-estimate the parameters until the whole sample data has been used. The coefficients, c(1), c(2) c(3) and c(4) presents a clear picture. The recursive coefficients curve and standard error curve provides useful information

4.4. Treatment of Autocorrelation, Heteroscedasticity

This section is based on the implementation of appropriate measures for removal of autocorrelation and heteroscedasticity problems for making the regression results reliable. One method for solution of the problems is the inclusion of residual lag values to the right hand side of the equation. The inclusion of the order of lag values in the model depends on the fact that whether the data are monthly, quarterly or yearly. If the data is quarterly fourth order serial correlation will be the starting point. If yearly 12 order serial correlation. As this study is based on the yearly time series data so the starting point is selected 12 lag values of the residuals. Breusch-Godfrey Serial Correlation LM Test is used for this purpose. The details are given in figure 4.4.

4.4.1 LM test for Autocorrelation

Table: 4.4: LM test results

F-statistic	1.508585	Prob. F(12,20)	0.2011
Obs* R-squared	17.10386	Prob. Chi-squre(12)	0.1457

Table:4.5: Regression Results

Dependent Variabe: $RESID$
Method : Least Squares
Sample : 1973-2008

Variable	**Coefficient**	**S.E**	**t-Statistic**	**P-Value**
EXR	-0.23	0.44	-0.52	0.60
INF	-0.35	0.68	-0.52	0.61
INT	-0.03	0.03	-0.75	0.46
a_0	1.38	2.45	0.56	0.58
$RESID(-1)$	0.70	0.22	**3.19**	0.00
$RESID(-2)$	-0.24	0.27	-0.87	0.39
$RESID(-3)$	0.35	0.28	1.28	0.21
$RESID(-4)$	-0.17	0.28	-0.58	0.57
$RESID(-5)$	0.09	0.29	0.34	0.74
$RESID(-6)$	0.12	0.30	0.41	0.68
$RESID(-7)$	-0.14	0.30	-0.48	0.63

$RESID(-8)$	0.11	0.29	0.35	0.73
$RESID(-9)$	0.02	0.30	0.07	0.94
$RESID(-10)$	0.11	0.29	0.39	0.70
$RESID(-11)$	0.12	0.29	0.43	0.67
$RESID(-12)$	-0.24	0.25	-0.97	0.34
R2		0.47		
Adj. R2	0.08			
Durbin Watson Statistic	1.67			

It can be seen that the values of both the F and the observed Rsquared (LM statistics) are greater then the confidence level hence suggesting the acceptance of the null hypothesis of no autocorrelation. However, the regression results shows that only the first lag residual is statistically significant, showing that the serial correlation is of first order and inclusion of 1st lag residual removes autocorrelation from data. This is also showed by the fact that the value of t statistics of the residuals as comparatively higher i.e. **3.168**.

It is clear from table 4.6 that the serial correlation problem is of first order so the above equation is reduced to only Ist order.

Table 4.6:Breusch-Godfrey Serial Correlation LM Test:

F-statistic	17.20542	Prob. F(1,31)	0.0002
Obs*R-squared	12.84908	Prob. Chi-Square(1)	0.0003

Table 4.7: Regression Results {with RESID(-1)}
Dependent Variable: RESID
Method: Least Squares
Date: 09/19/10 Time: 15:23
Sample: 1973 2008
Included observations: 36
Presampl missing value lagged residuals set to zero.

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LRER	-0.086469	0.267341	-0.323442	0.7485
LINF	-0.052622	0.433125	-0.121493	0.9041
R	-0.023652	0.030050	-0.787103	0.4372
C	0.374930	1.431748	0.261869	0.7952
RESID(-1)	0.635867	0.153297	4.147942	0.0002

R-squared	0.356919	Mean dependent var	-1.31E-15
Adjusted R-squared	0.273941	S.D. dependent var	0.832342
S.E. of regression	0.709231	Akaike info criterion	2.278976
Sum squared resid	15.59328	Schwarz criterion	2.498909
Log likelihood	-36.02157	Hannan-Quinn criter.	2.355739
F-statistic	4.301355	Durbin-Watson stat	1.657587
Prob(F-statistic)	0.006969		

As the Durbin Watson statistic is no more valid because of the lag dependent variable in the right side so Durbin h statistics can is appropriate for detection of autocorrelation. The null hypothesis is there is no autocorrelation. Comparing the value of h statistic with the critical value a=0.05(1.96) . If the h statistics is greater than the critical value the null hypothesis of no autocorrelation will be rejected. For this purpose the GDP value is regressed against the explanatory variables after inclusion of its lag value on the right side of the equation. The details are given in table 4.8

Table: 4.8: Regression Results {With LRGDP(-1)}
Dependent Variable: LRGDP
Method: Least Squares

Sample (adjusted): 1974 2008
Included observations: 35 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LRER	0.051188	0.019164	2.671005	0.0121
LINF	0.080188	0.024669	3.250569	0.0028
R	-0.001052	0.001645	-0.639469	0.5274
C	0.035387	0.079377	0.445816	0.6589
LRGDP(-1)	0.986408	0.007212	136.7796	0.0000

R-squared	0.999458	Mean dependent var	13.79661
Adjusted R-squared	0.999385	S.D. dependent var	1.394031
S.E. of regression	0.034560	Akaike info criterion	-3.760652
Sum squared resid	0.035833	Schwarz criterion	-3.538460
Log likelihood	70.81141	Hannan-Quinn criter.	-3.683951
F-statistic	13821.98	Durbin-Watson stat	2.440484
Prob(F-statistic)	0.000000		

By computation the following value of h statistics is obtained(-4.26). Clearly the value of h statistic is smaller than the critical value (-4.26<-1.96), so the null hypothesis of no autocorrelation cannot be rejected this time.

4.4.1 Engle's ARCH test for Heteroscedasticity

Table: 4.9: Heteroskedasticity Test: ARCH

F-statistic	0.01	Prob. F(1,32)	0.90
Obs* R-squared	0.01	Prob. Chi-squre(1)	0.90

Table. 4.10: Regression Results (with $RESID$^2)
Dependent Variabe: $RESID$^2
Method : Least Squares
Sample : 1975-2008

Variable	**Coefficient**	**S.E**	**t-Statistic**	**Prob.**
a_0	0.00	0.00	1.82	0.08
$RESID^2(-1)$	0.02	0.17	0.12	0.91

R2	0.0004
Adj. R2	0.000
Durbin Watson Statistic	1.99

The results showed that the null hypothesis of homoscedasticity cannot be rejected.
Now for obtaining BLUE estimates for resolving AC the Cochrane-ORCUTT ITERATIVE procedure is used. So after adding ar(1) to the right hand side of the equation the OLS estimates are as under:

Table4.11: Regression Results (with $AR(1)$)
Dependent Variabe: GDP
Method : Least Squares
Sample : 1974-2008 (with

Variable	Coefficient	S.E	t-Statistic	Prob.
EXR	0.02	0.02	1.13	0.26
INF	0.08	0.04	2.25	0.03
INT	0.001	0.002	0.75	0.46
a_0	25.5	5.31	4.80	0.00
$AR(1)$	0.98	0.005	193.43	0.00

$R2$	0.99
Adj. $R2$	0.99
Durbin Watson Statistic	1.87

The results showed that the AR value is significant.
For examining the time effect trend is also included in the model. The results are mentioned as under:

Table4.12: Regression Results (with TREND and $AR(1)$)
Dependent Variabe: GDP
Method : Least Squares
Sample : 1974-2008

Variable	Coefficient	S.E	t-Statistic	Prob.
EXR	0.02	0.02	0.82	0.41
INF	0.08	0.03	2.41	0.02
INT	0.04	0.002	1.99	0.45
a_0	11.1	0.09	113.3	0.00
$TREND$	0.13	0.001	79.70	0.00
$AR(1)$	0.53	0.13	3.92	0.00

R2	0.99
Adj. R2	0.99
Durbin Watson Statistic	1.87

The results showed that the value of both AR(1) and trend turned out to be significant indicating the importance of their inclusion in the model. Because of the inclusion of the AR and trend exchange rate became insignificant. However, the other two variables inflation and interest rate are still significant

Conclusion

The study has been an empirical test of the consequences and solution of OLS assumption violation specifically focusing on autocorrelation and heteroscedasticity problems in data.

For this purpose time series data over the period 1973-2008 has been used for examining the relationship of Gross Domestic Product with the inflation, exchange rate and interest rate. Hodric-Prescott filter method has been used for making the data stationary.

The main conclusion of the study was that for maintenance of the BLUE properties of the coefficients consideration of the consequences of violation of serial correlation and heteroscedasticity assumptions are cannot be underestimated.

BIBLIOGRAPHY

Agalega, E and Antwi, S (2013). The Impact of Macroeconomic Variables on Gross Domestic Product: Empirical Evidence from Ghana. International Business Research, Vol. 6, No. 5.

Broda, C. and Romalis, J. (2003). Identifying the Relationship Between Trade and Exchange Rate Volatility. In: Commodity Prices and Markets, East Asia Seminar on Economics, Volume 20.

Bhatia, B. S. and Jain, A. (2013). Relationship of Macroeconomic Variables and Growth of Insurance in India: A Diagnostic Study. International Journal of Advances in Management and Economics, Vol.2, Issue.6, 50-54.

Carrera, J. Vuletin, G. (2003). The effects of exchange rate regimes on real exchange rate volatility: A dynamic panel data approach, paper presented at the 31st Brazilian Economic Meeting No. c67.

Cassel, G (1918). Abnormal Deviations in International Exchanges. The Economic Journal, Vol. 28, No. 112, pp. 413-415.

Chen, S. S. (2004). Real exchange fluctuations and monetary shocks: A revisit. International Journal of Finance and Economics, Issue. 9, pp. 25-32.

Elliott, G., T.J. Rothenberg and J.H. Stock,(1996), Efficient tests for an autoregressive unit root, *Econometrica* 64, 813–836

Enders, Walter. (2005). "Applied Econometric Time Series". New York. John Wiley & Sons. Hasio. 2002. "Panel Data Econometrics". Cambridge University Press 2nd Edition

Greene, W.H. (2004). "Econometric Analysis". 5th edition. New York. Macmillan.

Guajarati, Damodar.(2012). "Basic Econometrics". 4th edition. McGraw-Hill Higher Education.

Kibria, U, Arshad, M. U., Kamran, M, Mehmood, Y, Imdad, S, and Sajid, M.(2014). Do Macroeconomic Variables Affect Stock Returns in BRICS Markets? An ARDL Approach. Research Journal of Management Sciences, Vol. 3, Issue. 9. Pp. 1-6.

Muller, U. K. and Watson, M. W. (2008)."Testing model of low-frequency variability". Econometrica 76, PP. 979–1016.

Razzak, W. (1997). "The Hodrick- Prescott Technique: A Smoother Versus a Filter. An Application to New Zealand GDP". Economic Letters. 57, 163-168.

Syed and Shaikh (2013). Effects of Macroeconomic Variables on Gross Domestic Product (GDP) in Pakistan. Procedia Economics and Finance, Vol. 5, pp. 703-711

Wooldridge, J. (2012) "Introductory Econometrics". 2nd Edition. South-Western College Publisher.

Wooldridge, J.(2001) "Econometric Analysis of Cross Sectional & Panel Data" The MIT Press

.

.