Impact of Structural Adjustment Loans on Health Indicators on Pakistan – Econometric Analysis

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Abstract

The introduction of structural adjustment programs has distorted the overall impact of health care and welfare on economy in general. Consequently, other economical problems also prevent poor from improving their health conditions, with no or marginal impact. The paper aims to examine the impact of Structural Adjustment Loans acquired from world bodies on health conditions and simultaneously on economic growth of Pakistan, based on an econometric model. To test the relationship between such programs, health indicators and economic growth, time series data has been used for the period of 1980-81 to 2009-2010 and analyzed by conducting statistical tests. The empirical results confirm the hypothesis that there is no relationship between the two factors i.e. structural adjustment loans do not contribute towards the improvement of health conditions in Pakistan. The results have been tested for heteroscedasticity, multicollinearity and autocorrelation for validation purposes.

Key words: Economic growth, health indicator, infant mortality rate, structural adjustment loan, per capita income, government expenditure.

1. Introduction

The health sector in Pakistan is sated with varied issues. The international financial institutions argue that government subsidies for health care generate unfavorable environment that facilitate the rich. To create fairness and effectiveness, they argue that users of primary health care facilities should pay user fees, even if they are from the impoverished class. Despite the claims governments make about health care every year, they have been unable to provide people with basic health facilities. Several international funding institutions have provided structural adjustment loans to remove problems on short-term basis. This lending also fails to contribute to the improvement of health facilities and reach the needed. Although privatization of hospitals may to some extent contribute to strengthen the health sector further but overall, it is not having the desired impact on the health conditions of the people.

The Structural Adjustment Program (SAP) is the IMF's lending facility for the under developed countries. Consequently, after receiving these loans it require countries to adopt policies such as: Reductions in government spending; Monetary lessening (high interest rates); Privatization; and Decrease in barriers to trade. Health sector’s factors may be the most noticeable determinants, but the effects of non-health sector inputs are most likely more significant. Although it may be relatively easier to achieve growth and make improvements in health segment, which can be measured by quantitative indicators, but sustaining such improvements in the quality of life are more difficult to create and measure. Another main problem is to assess the effect of SAPs is the unavailability of data on mortality and nutritional status, especially in the economically poor countries. Therefore, while evaluating the
impact of structural adjustment on health conditions and status, it is important to analyze the factors operating inside and outside the health sector, and subsequently scrutinize the long and short term health outcomes.

2. Literature Review

According to Mohan (2000), during global recession financial stringency forces governments to cut back on overall expenditure. And health expenditures are relatively the first to be cut down. As result of such policies like reduction in wages, and the increase prices of necessities, have a serious effect on the health of the poor, especially women and children. But in some countries it is not inevitable that health conditions deteriorate because of recession or structural adjustment. Governments can and do intervene on such occasions to improve the health conditions. The real test for the health sector when adjustment policies are in place is, how to change these adjustment constraints into structural changes that can result in achieving health goals.

Kaushik (1999) suggests a long term strategy for health sector is needed in order to create multiplier effects from health programs. Health initiatives should be carried out keeping in mind the health needs, infrastructure and basic socio-economic structure. It is critical to invest in human development and basic facilities such as housing, transport, safe drinking water supply, and sanitation and accessibility to health services.

As Stewart (1987) further stated, that it is important to consider while undergoing a structural adjustment to in order to reduce mortality and improve child health that if hospitals were to consciously make more efforts towards adopting cost effective methods then the savings would be of a substantial amount. Resources could alternately be utilized for the provision of basic health services. Therefore, it is highly needed to make services more cost effective by streamlining health services, which can lead to healthy population. Non Government Organizations and political leadership can mobilize the population to participate in health programs, Bennet (2001).

The health services in Pakistan are extremely inequitable and urban biased in terms of resources and personnel with the private sector playing a dominant role. The end result is that the health status of the population is not even close to be considered as at a level of development to be measured by per capita income, Tariq (1997). Health indicators in Pakistan are still pitifully low when compared to other low-income countries.

Khan (1999), further explains that privatization is the catchphrase, the thought behind is to ‘set prices right’. The idea is to restrict government expenditure on health by bringing down subsidies and unimportant services and improving on health services. The government’s role related to this is to disseminate information on disease control.

Pakistan’s health policy of 1997 entails that it is private sector’s primary responsibility in the areas of family planning, preventive services and drugs. And Basic Health Units and Rural Health Centers were outsourced to private health physicians. The outcome was that these services provided by the hospitals became more expensive and unaffordable for the poor.

3. Hypothesis

After carefully considering the relationship between the health indicators of Pakistan and the structural adjustment loans through studying previous researches, we state that:

“The structural adjustment loans have not contributed towards improving the health care condition of Pakistan”.

4. Methodology

In order to test the hypothesis, regression analysis was used. The date was gather from several accredited sources like various issues of Economic Survey of Pakistan, World Bank Data Bank, World Health Organization data base, IMF reports etc. The data used is from the time periods of 1980-81 to 2009-2010, which is 30 years. EViews 5 was used for analysis and to perform the statistical tests.
5. Empirical Results

In order to test the hypothesis the regression analysis was undertaken using the OLS techniques. The following econometric model was developed in order to find the effectiveness of Structural loans where the Infant Mortality rate was taken as the Regressand and regresors as Per Capita Income, Government Expenditure on Health, Workers Remittances and Structural Adjustment Loans Received from IMF over the period 1981 – 2010 (30 periods). The Infant Mortality as a function of its various determinants was estimated to be as follows:

\[ IM = C + \beta_1 \text{PCI} + \beta_2 \text{GEH} + \beta_3 \text{WR} + \beta_4 \text{SAL} + u \]

Where:

\( IM \): Infant Mortality per 1000 Persons  
\( \text{PCI} \): Per Capita Income  
\( \text{GEH} \): Government Expenditure on Health  
\( \text{WR} \): Workers Remittances U.S $ Billions  
\( \text{SAL} \): Structural Adjustment Loans  
\( u \): Error Term

After inputting the data into EViews5 the following results were obtained:

<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>C</td>
<td>93.10276</td>
<td>9.958653</td>
<td>9.348931</td>
<td>0.0000</td>
</tr>
<tr>
<td>CI</td>
<td>0.001200</td>
<td>0.002824</td>
<td>0.424769</td>
<td>0.6746</td>
</tr>
<tr>
<td>GEH</td>
<td>-0.001213</td>
<td>0.000249</td>
<td>-4.871857</td>
<td>0.0001</td>
</tr>
<tr>
<td>WR</td>
<td>0.005535</td>
<td>0.001254</td>
<td>4.413161</td>
<td>0.0002</td>
</tr>
<tr>
<td>SAL</td>
<td>0.010926</td>
<td>0.009522</td>
<td>1.147487</td>
<td>0.2620</td>
</tr>
</tbody>
</table>

R-squared: 0.903790  
Adjusted R-squared: 0.888396  
S.E. of regression: 4.915027  
Sum squared resid: 603.9372  
Log likelihood: -87.60225  
Durbin-Watson stat: 1.259952  
Mean dependent var: 92.14333  
S.D. dependent var: 14.71250  
Akaike info criterion: 6.173483  
Schwarz criterion: 6.407016  
F-statistic: 58.71199  
Prob(F-statistic): 0.000000
5.1. **Coefficient of Determination ($R^2$):**

A relatively high $R^2$ value, of 0.90, implies a good fit of the data with the regression line. This suggests that approximately 90% of the variation in the Infant Mortality rate of Pakistan is being explained jointly by all the variables in the regression model specified above ie PCI, GEH, SAL and WR.

5.2. **Individual Significance of $\beta$ Coefficients:**

The $\beta$ coefficients of both Worker’s Remittances and Government Expenditure on health are statistically significant with T Statistic Values of 4.413 and -4.487 respectively. If the T Test rule of thumb is applied then both of these values lie in the rejection region and thus null hypothesis (Ho: $\beta=0$) can be rejected this means that the $\beta$ coefficients of both Worker’s Remittances and Government Expenditure on health are statistically significant.

However the same cannot be said about the $\beta$ coefficients of Per Capita Income and Structural Adjustment Loans. With T Statistic Values of 0.424 and 1.147, the $\beta$ coefficients of both these variables are insignificant. This is the case if the T Test rule of thumb is applied, in which case both the values lie in the acceptance region of the null hypothesis (Ho: $\beta=0$). The insignificance of the $\beta$ coefficient of Structural Adjustment Loans confirms our hypothesis that the structural adjustment loans have not contributed towards improving health care condition of Pakistan.

5.3. **Testing for Overall Significance of the Model:**

E-Views generated an F-statistic value of 58.7, which is a sufficiently high value. At the F Test rule of thumb the F Statistic Value of 58 is statistically significant in the sense that, we reject the null hypothesis that the $\beta$ coefficients are simultaneously equal to 0. That is, the combined impact of all the variables on the infant mortality rate is statistically significant.

6. **Conclusion**

Usually there is a positive relationship between economic growth and human development indicators, including health care conditions of the population. However due to Structural Adjustments Programs economic growth slows down and puts a great amount of burden on the health of the population. The government should not only try to increase Per capita GDP, but it should also focus on the equitable distribution of wealth among people. Such activities will help it eliminate the vicious problem of the poor becoming poorer and the rich getting richer.

6.1. **Durbin-Watson Stat (D.W.):**

This value helps us determine the possible auto-correlation between the residuals. Considering all the assumptions for the test being met, the D.W. Stat was 1.259952 (generated by E-Views). With 30 observations and 4 explanatory variables, $d_L = 1.143$ and $d_U = 1.739$. This means that the D.W. stat for the regression model, which is 1.26, lies inside of the lower and upper bounds. Hence, at 5% level of significance, we have sufficient evidence to say that there is some possible autocorrelation between the residuals. But we cannot conclude since it falls in the indecisive zone i.e.: $d_L \leq d \leq d_U$. This problem is to be remedied if we have to make the model more effective and accurate for the purposes of estimation and forecasting, by making modifications of the $d$ test.
6.2. Chow – Test

Dividing the sample data into two time periods: 1981 – 1994 and 1995 – 2010 to see if there is any structural change. Now by running the three regressions ie: from 1981-1994, 1995-2010 and 1981-2010, we get the following empirical result.

Dependent Variable: IM
Method: Least Squares
Sample: 1981 1994
Included observations: 14

<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>C</td>
<td>59.41177</td>
<td>41.81713</td>
<td>1.420752</td>
<td>0.1891</td>
</tr>
<tr>
<td>PCI</td>
<td>0.008551</td>
<td>0.013593</td>
<td>0.629109</td>
<td>0.5449</td>
</tr>
<tr>
<td>GEH</td>
<td>-0.000997</td>
<td>0.002054</td>
<td>-0.485298</td>
<td>0.6391</td>
</tr>
<tr>
<td>SAL</td>
<td>0.001833</td>
<td>0.013329</td>
<td>0.137533</td>
<td>0.8936</td>
</tr>
<tr>
<td>WR</td>
<td>0.007701</td>
<td>0.005814</td>
<td>1.324558</td>
<td>0.2180</td>
</tr>
</tbody>
</table>

R-squared 0.595598
Adjusted R-squared 0.415864
S.E. of regression 4.112181
Sum squared resid 152.1903
Log likelihood -36.56766
Durbin-Watson stat 2.091335

Dependent Variable: IM
Method: Least Squares
Sample: 1995 2010
Included observations: 16

<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>C</td>
<td>92.76389</td>
<td>7.299555</td>
<td>12.70816</td>
<td>0.0000</td>
</tr>
<tr>
<td>PCI</td>
<td>-0.000605</td>
<td>0.002147</td>
<td>-0.281826</td>
<td>0.7833</td>
</tr>
<tr>
<td>GEH</td>
<td>-0.000607</td>
<td>0.000275</td>
<td>-2.204837</td>
<td>0.0497</td>
</tr>
<tr>
<td>SAL</td>
<td>0.008553</td>
<td>0.009130</td>
<td>0.936875</td>
<td>0.3689</td>
</tr>
<tr>
<td>WR</td>
<td>0.002898</td>
<td>0.001176</td>
<td>2.464140</td>
<td>0.0314</td>
</tr>
</tbody>
</table>

R-squared 0.843812
Adjusted R-squared 0.787017
S.E. of regression 3.113064
Sum squared resid 106.6028
Log likelihood -37.87519
Durbin-Watson stat 1.953395

Hence, RSS_{UR} = RSS_1 + RSS_2 = 258.79

Therefore,

\[ F = \frac{(RSS_R \cdot RSS_{UR})/k}{(RSS_{UR})/(n_1 + n_2 - 2k)} \]

\[ F = \frac{(603.93 - 258.79)/5}{(258.79)/20} \]

\[ F = 5.34 \]
From F table, we find that for 5 and do df the 1% critical F value is 4.10 and 5% value is 2.71. Since F calculated exceeds the F critical value, we may reject the hypothesis of parameter stability.

Since the regression analysis is subjected to several econometric problems, such as auto-correlation, multicollinearity and heteroscedasticity, a series of tests were conducted to identify them.

7. Testing for Heteroscedasticity

7.1 Parks Test

The residuals obtained from the original regression were regressed on explanatory variables ie: PCI, GEH, SAL and WR giving the following results:

<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>C</td>
<td>58.88148</td>
<td>34.12585</td>
<td>1.725422</td>
<td>0.0991</td>
</tr>
<tr>
<td>LOGPCI</td>
<td>-13.22017</td>
<td>7.113501</td>
<td>-1.858461</td>
<td>0.0772</td>
</tr>
<tr>
<td>LOGGEH</td>
<td>2.667726</td>
<td>1.557608</td>
<td>1.712707</td>
<td>0.1015</td>
</tr>
<tr>
<td>LOGSAL</td>
<td>0.281090</td>
<td>0.886031</td>
<td>0.317247</td>
<td>0.7542</td>
</tr>
<tr>
<td>LOGWR</td>
<td>3.756343</td>
<td>2.028097</td>
<td>1.852151</td>
<td>0.0781</td>
</tr>
<tr>
<td>R-squared</td>
<td>0.158325</td>
<td>Mean dependent var</td>
<td>1.615299</td>
<td></td>
</tr>
<tr>
<td>Adjusted R-squared</td>
<td>-0.001994</td>
<td>S.D. dependent var</td>
<td>2.464711</td>
<td></td>
</tr>
<tr>
<td>S.E. of regression</td>
<td>2.467167</td>
<td>Akaike info criterion</td>
<td>4.815059</td>
<td></td>
</tr>
<tr>
<td>Sum squared resid</td>
<td>127.8252</td>
<td>Schwarz criterion</td>
<td>5.057001</td>
<td></td>
</tr>
<tr>
<td>Log likelihood</td>
<td>-57.59577</td>
<td>F-statistic</td>
<td>0.987561</td>
<td></td>
</tr>
<tr>
<td>Durbin-Watson stat</td>
<td>2.313826</td>
<td>Prob(F-statistic)</td>
<td>0.435805</td>
<td></td>
</tr>
</tbody>
</table>

Obviously, there is no statistically significant relationship between the two variables. Following the Park’s test, we may conclude that there is no Heteroscedasticity in the error variance.
7.2. Glejser’s Test

The absolute value of the residuals were obtained from original regression, and regressed on variable PCI, GEH, SAL, and WR, giving the following results

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Variable</strong></td>
<td><strong>Coefficient</strong></td>
<td><strong>Std. Error</strong></td>
<td><strong>t-Statistic</strong></td>
</tr>
<tr>
<td>C</td>
<td>0.003394</td>
<td>0.006585</td>
<td>0.515437</td>
</tr>
<tr>
<td>PCI</td>
<td>9.38E-08</td>
<td>1.87E-06</td>
<td>0.050229</td>
</tr>
<tr>
<td>GEH</td>
<td>3.30E-08</td>
<td>1.65E-07</td>
<td>0.200253</td>
</tr>
<tr>
<td>SAL</td>
<td>9.15E-06</td>
<td>6.30E-06</td>
<td>1.453850</td>
</tr>
<tr>
<td>WR</td>
<td>-3.02E-07</td>
<td>8.29E-07</td>
<td>-0.364724</td>
</tr>
</tbody>
</table>

| **R-squared**            | 0.215015              | Mean dependent var | 0.005522                 |
| **Adjusted R-squared**   | 0.089418              | S.D. dependent var | 0.003406                 |
| **S.E. of regression**   | 0.003250              | Akaike info criterion | -8.469420               |
| **Sum squared resid**    | 0.000264              | Schwarz criterion  | -8.235887                |
| **Log likelihood**       | 132.0413              | F-statistic       | 1.711937                 |
| **Durbin-Watson stat**   | 1.344919              | Prob(F-statistic) | 0.178863                 |

It is evident from the regression above, that there is no significant relationship between the absolute value of the residuals and the regressors PCI, GEH, SAL and WR. This reinforces the conclusion based on the Park test that there is no Heterscedasticity.

8. Testing for Multicollinearity

8.1. **High R^2 but few significant t ratios:**

Multicollinearity means perfect or less than perfect (very high R^2) inter correlation amongst the X-variables. Since R^2 in the original IM model is already very high ie greater than 0.8 ie 0.9 and the individual t test are significant for only two variable. Hence, this shows that there is multi-collinearity to some extent.

8.2. **High Pair-Wise Correlations among Regressors:**

To test for multicollinearity, intercorrelations between the X-variables were obtained, using E-Views, called correlation matrix, to determine the R^2 values for the regression between each X variable and the other X variables in the regression model. The results of inter-correlations were as follows:

<table>
<thead>
<tr>
<th>Dependant Variable</th>
<th>PCI</th>
<th>GEH</th>
<th>WR</th>
<th>SAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>PCI</td>
<td>1</td>
<td>0.808396</td>
<td>-0.02395</td>
<td>0.0433</td>
</tr>
<tr>
<td>GEH</td>
<td>0.808396</td>
<td>1</td>
<td>-0.4217</td>
<td>0.048934</td>
</tr>
<tr>
<td>WR</td>
<td>-0.02395</td>
<td>-0.4217</td>
<td>1</td>
<td>0.206039</td>
</tr>
<tr>
<td>SAL</td>
<td>0.0433</td>
<td>0.048934</td>
<td>0.206039</td>
<td>1</td>
</tr>
</tbody>
</table>
Some of the pair-wise correlations are quite high, suggesting that there might be some multi-collinearity problem. The highest pair wise correlation existing between the independent variables is between PCI and GEH, which is about 80.8%, followed by the pair wise correlation between WR and GEH, which is about – 42.17%. Another pair wise correlation that should be mentioned here is the correlation between SAL and WR, which amounts to 20.6%. All of these are indicators of multicollinearity. In order to test further, auxiliary regressions were run. The results were as follows:

8.3. Auxiliary Regressions

By regressing each explanatory variable on the remaining explanatory variables and computing the corresponding $R^2$ ie. Auxiliary regression through Eviews, we get the following results.

<table>
<thead>
<tr>
<th>Dependent Variable</th>
<th>R2 Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>PCI</td>
<td>0.978375</td>
</tr>
<tr>
<td>GEH</td>
<td>0.909662</td>
</tr>
<tr>
<td>WR</td>
<td>0.867840</td>
</tr>
<tr>
<td>SAL</td>
<td>0.620486</td>
</tr>
</tbody>
</table>

If Klien’s rule of thumb is used to decide which independent variable is collinear with other Independent variables, we see that three of regressions have $R^2$ value is higher than the $R^2$ of the regression analysis. Hence, we conclude that there is indeed some level or degree of multicollinearity amongst the independent variables.

9. Remedial Measures:

9.1. A Priori Information:

There is no such prior information available related to health indicators and there relationship with economic variables and Structural adjustment loans. However, a general belief is, that Health conditions tend to improve with the introduction on Structural adjustment loans provided by IMF or other world bodies, which is not the case here with regard to Pakistan’s health conditions as determined through Infant Mortality Rate ie the key health indicator.

9.2. Combining Cross-Sectional and Time Series Data:

The study has been conducted on time series data available in Pakistan with respect to Health and its relationship with Structural Adjustment Loans. Pooling the data with another country might not make sense here and create problems of interpretation, because we cannot assume that implicitly the elasticity that we obtain from cross sectional for some other region or country analysis will be same that is obtained from the time series data of Pakistan. However, in Pakistan’s case the relationship is negative whereas, literature review reveals that many countries health conditions have been improved with the introduction of SAPs.

9.3. Dropping a Variable and Specification Bias:

Since the topic and the model suggest that PCI, SAL and GEH should be included in the model explaining the relationship with IM dropping any of these variables would constitute specification bias. But when we regress the model by dropping WR following results were obtained which shows that in original model PCI was insignificant , it is now highly significant with t-statistics of 3.15 (following the t 2 rule of thumb) with $R^2$ value of 82% which explains that 82% variation is explained by PCI GEH and SAL on IM
Dependent Variable: IM
Method: Least Squares
Sample: 1981 2010
Included observations: 30

<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>C</td>
<td>68.76226</td>
<td>10.84495</td>
<td>6.340487</td>
<td>0.0000</td>
</tr>
<tr>
<td>PCI</td>
<td>0.009051</td>
<td>0.002869</td>
<td>3.154445</td>
<td>0.0040</td>
</tr>
<tr>
<td>GEH</td>
<td>-0.001611</td>
<td>0.000303</td>
<td>-5.310933</td>
<td>0.0000</td>
</tr>
<tr>
<td>SAL</td>
<td>0.035730</td>
<td>0.010053</td>
<td>3.554149</td>
<td>0.0015</td>
</tr>
</tbody>
</table>

R-squared 0.828838  Mean dependent var 92.14333
Adjusted R-squared 0.809089  S.D. dependent var 14.71250
S.E. of regression 6.428387  Akaike info criterion 6.682890
Sum squared resid 1074.428  Schwarz criterion 6.869717
Log likelihood -96.24335  F-statistic 41.96774
Durbin-Watson stat 1.130120  Prob(F-statistic) 0.000000

9.4. Additional or New Data:

Since Multicollinearity is a sample feature, sometimes simply increasing the the size of the sample may attenuate the collinearity problem. Now increasing the sample size to 40 years, ie n=20, generally the variances of βs will decrease, thus decrease in standard errors too which should enable us to estimate the explanatory variables more precisely. Hence when sample size was increased to 40, following results were obtained:

Dependent Variable: IM
Method: Least Squares
Sample: 1971 2010
Included observations: 40

<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>C</td>
<td>83.94133</td>
<td>5.886019</td>
<td>14.26114</td>
<td>0.0000</td>
</tr>
<tr>
<td>PCI</td>
<td>0.003852</td>
<td>0.001823</td>
<td>2.113126</td>
<td>0.0418</td>
</tr>
<tr>
<td>GEH</td>
<td>-0.001491</td>
<td>0.000188</td>
<td>-7.946440</td>
<td>0.0000</td>
</tr>
<tr>
<td>SAL</td>
<td>0.005507</td>
<td>0.006720</td>
<td>3.819456</td>
<td>0.4181</td>
</tr>
<tr>
<td>WR</td>
<td>6.016150</td>
<td>1.174273</td>
<td>5.123299</td>
<td>0.0000</td>
</tr>
</tbody>
</table>

R-squared 0.853622  Mean dependent var 95.52250
Adjusted R-squared 0.836893  S.D. dependent var 14.71250
S.E. of regression 6.428387  Akaike info criterion 6.682890
Sum squared resid 1314.604  Schwarz criterion 6.869717
Log likelihood -126.6058  F-statistic 51.02665
Durbin-Watson stat 1.311229  Prob(F-statistic) 0.000000

In the original model GEH has a negative relationship with IM and also the SAL was insignificant with t value of 1.47, however, increasing the sample size to 40 (micronumerosity), GEH still has a negative sign but SAL is statistically significant at 5% level. And R^2 has decreased to 85% from 90% hence reducing the collinearity.
10. Testing for AutoCorrelation

10.1. Run Test:

\[ N = \text{total No. of observations} = N_1 + N_2 = 30 \]
\[ N_1 = \text{No. of + symbols (positive residuals)} = 16 \]
\[ N_2 = \text{No. of – symbols (negative residuals)} = 14 \]
\[ R = \text{Number of runs} = 12 \]

under null hypothesis that the successive residuals are independent and \( N_1 > 10 \) & \( N_2 > 10 \) the number of runs is asymptotically normally distributed: therefore using the formulas:

- Mean : \( E(R) = \frac{2N_1N_2}{N+1} = 16 \)
- Variance : \( \sigma^2_R = \frac{2N_1N_2}{(2N_1N_2-N)} \frac{N^2}{N-1} = 7.17 \)
- \( \sigma = 2.7 \)

Using the following properties of the normal distribution, under 95% confidence interval for \( R \):

\( \text{Prob} \left( E(R) - 1.96\sigma_R \leq R \leq E(R) + 1.96\sigma_R \right) = 0.95 \)
\( [16 \pm 1.96(2.7)] = (10.7, 21.3) \)

The calculation above includes 12 ie number of runs.

Following the decision rule: We do not reject the null hypothesis of randomness with 95% confidence, since \( R \) the number of runs lies in the preceding confidence interval ie: we do not reject the hypothesis that the residuals in the IM-SAL model are random. In other words, residuals do not exhibit autocorrelation. Since the number of runs are 12, ie many, there is negative autocorrelation.

10.2. Durbin-Watson d Test:

To conduct another test for auto-correlation, we would use the Durbin-Watson test for autocorrelation. Considering all the assumptions for the test being met, the D.W. Stat was 1.26 (generated by E-Views). This value helps us determine the possible auto-correlation between the residuals. With 30 observations and 4 explanatory variables, \( d_L = 1.143 \) and \( d_U = 1.739 \). This means that the D.W. stat for the regression model, which is 1.26, lies inside of the lower and upper bounds. Hence, at 5% level of significance, we have sufficient evidence to say that there is some possible autocorrelation between the residuals. But we cannot conclude since it falls in the indecisive zone i.e.: \( d_L \leq d \leq d_U \).

This problem is to be remedied if we have to make the model more effective and accurate for the purposes of estimation and forecasting, by making modifications of the \( d \) test.

11. Remedial Measures

11.1. Newey – West Method

After running the HAC procedure in E-Views 5 we obtain the regression results as above. Comparing this regression with the original one, we can see that in both regressions the estimated coefficients and the \( R^2 \) values are the same. But, the HAC standard errors are relatively higher than the ols standard errors and therefore the \( t \) statistics are much smaller than the ols \( t \) ratios. This shows that the OLS has underestimated the true standard errors.
In the presence of such defects, moderately sufficient confidence can be placed in the model. This is because:

- The determinants were derived through previous studies by scholars and economic theory.
- The data was gathered from credible sources, such as State Bank of Pakistan publications and the World Bank Report, which are reliable, hence minimising the chances of measurement error.
- The data entry was revised a couple of times to prevent the occurrence of measurement errors.
- The results of the regression were analysed on the basis of various criteria, in order to justify the econometric model.
- The hypotheses that were initially formulated were tested using t-tests, and they were accepted on the basis of evidence. Hence, practical significance was not confused with statistical significance.
References