EDUCATIONAL EXPENDITURE NEEDS OF LARGE INDIAN STATES: A NORMATIVE VIEW

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Educational Expenditure Needs of Large Indian States: A Normative View

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Abstract

Utilizing the pooled data for 15 large Indian states spanning over six years from 1992-93 to 1997-98, this study employs panel data models to estimate the normative (average) levels of expenditure on primary, secondary and higher education for providing the average standards of educational services. The findings of the study reveal that the actual spending on educational services in low-income states is found to be lower than their 'needs'. This finding implies that the existing fiscal equalization mechanism has not been effective in offsetting the revenue and cost disabilities of the poorer states in India.

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I. Introduction:

Provision of basic education has been recognized as a social obligation of the State. Compulsory primary education for all children up to the age of 14 has been enshrined in the Directive Principles of State Policy in the Constitution. Though education is included in the concurrent list, the major responsibility of providing educational facilities rests on the state governments. But the vast differences in literacy rate, variation in enrolment and dropout rates among states in respect of primary, secondary and higher education levels, calls into question beyond the sincerity with which the states have been pursuing their social obligation. As can be seen from Table 1, the proportion of revenue expenditure spent on education across the 15 large states for the fiscal year 1997-98 is quite uneven (the same is the case with previous years also). The uneven nature might be attributed to the unequal level of development and presence of social pressure groups in these states. It may be necessary and useful in this context to take a normative view of educational expenditure, to assess the extent of disparities in respect of states’ expenditure on education. In this context, there is a need to develop a conceptual framework and evolve an appropriate methodology to classify the states on the basis of the deviation of actual expenditure from its normative level in respect of provision of educational services.

In the absence of any yardstick to measure the extent of relative emphasis laid upon the provision of education by the state governments, the actual expenditures may be considered as a proxy. In other words, the higher (lower) the per capita expenditure on education, the higher (lower) is the emphasis the state lays upon provision of education. But such a view may be misleading when there are significant cost variations in the provision of educational services across
the states. Thus, to meaningfully assess of the relative position of the states, it is necessary to ascertain the cost of providing a ‘standardized’ unit of educational service across the Indian states. One such way is to treat each state as an independent entity and estimate educational cost functions separately for each state based on state specific-factors such as student-teacher ratio, enrolment ratio and infrastructure facilities. However, an exercise of this kind eludes the possibility of a common basis for comparison across the states. In this context, estimating an all-India average (normative) cost of providing a standardized unit of educational service might prove to be more meaningful [see Rao and Agarwal (1992)].

The present paper proceeds from the supply (cost) side and attempts to estimate the normative expenditure levels with regard to the expenditure on education for 15 large Indian states for the fiscal year 1997-98. Based on the normative expenditures, this paper proceeds further to make a comparative analysis of the normative and actual expenditure levels with the objective of classifying states on the basis of the relative emphasis laid on the provision of education. For a meaningful analysis, expenditure on education is categorized into three heads viz., primary, secondary and higher. The expenditure considered in this study relates to total revenue expenditure, which is the sum total of non-plan and plan revenue expenditures.

In order to get reliable estimates for the expenditure functions, cross-section data pertaining to 15 different states are pooled for six years from 1992-93 to 1997-98. Pooled data, which deals with both the inter-temporal dynamics and the individuality of the entities being investigated in the study, provides qualitatively superior estimates. The analysis involving pooled data allows comparison between dissimilar/
heterogeneous units (in our case states). The inclusion of cross-section dimension adds a lot of variability to the pooled data, thereby reducing the extent of collinearity among the variables. In addition, the degrees of freedom are also greatly enhanced. For the above-mentioned reasons, pooled data significantly contribute towards producing more reliable parameter estimates [see Dielman, 1989]. In this exercise we have employed the panel data model in respect of group-wise heteroskedasticity, cross-group error-correlation and autocorrelation\footnote{For an elaborate description of various models of panel data analysis, see Baltagi, 1995.}.

The rest of this paper is organized as follows: Section II, captioned methodology, discusses the selection of variables and panel data models. Section III is devoted to a discussion of results. Finally section IV, provides some policy implications and concluding remarks. Pooled regression models employed in this paper are discussed in Appendix -I.

II. Methodology:

Pooling the data allows the possibility of modelling the differences across units. In other words, pooling of time series and cross-section data helps estimation of average responses underlying a given relationship. This can be done under various sets of assumptions and pooling schemes. In this study, we have considered the various possibilities of the simultaneous occurrence of heteroskedasticity, cross-group error correlation and autocorrelation. The details are discussed in Appendix -I.

In the present context, expenditures on education are seen to vary across the states over time. The reason is that the quantity as well as quality (and hence the cost) of services
vary according to the capacities and priorities of the states to spend on education. But it is desirable to reduce the inter-state disparities in expenditure (and cost of) on education. It is also necessary to ensure that each state provides a minimum level of educational services [see Rao, 1993]. To compare the expenditures across states, it is necessary to have a standard that serves as a yardstick for comparison. However, the choice of a standard measure of comparison is not an easy task. One way of simplifying matters is to consider a normative view and to propose the average level of providing educational services as a proxy for the normative level of expenditure. This line of thinking is pursued in this study.

Sticking to the supply side view, cost functions that reflect the per capita cost of providing educational services in the relevant age group are considered. These functions are based on the quantity as well as price variables. The formulation of the models and hence the choice of determinants has been largely guided by economic logic. The models have been estimated using the pooled data, and the estimated pooled regressions are then used for projecting the normative expenditure levels.

In the cost functions for primary, secondary and higher education the dependent variable for the respective heads is the public expenditure per person in the relevant beneficiary group of population. The independent variable set consists of a vector of quantity and cost determinants of expenditure on relevant heads. Viewing the heterogeneous nature of the Indian states, yearly preliminary regression exercises were first carried out to identify the important determinants. The results of the yearly regressions are not reported here. In line with the principle of parsimony, the numbers of independent variables in the final specifications have been kept at the minimum.
A simple method of estimating normative expenditure levels is to express public services as expenditure per intended beneficiary population group and estimate the cost of achieving an average output level. For example, primary education expenditure is meant to benefit children in the age group 5-9 and therefore expenditure per child in the age group is taken as the starting point for estimation. Similarly, the relevant beneficiary age groups considered in this study for secondary and higher education are 10-18 and 20-24 respectively.²

As a starting point, the independent variable set chosen for the regression specifications included number of students (ENROL), student-teacher ratio (STRATIO), salary levels of the teachers (SALARY), price differences across the states (PRICEDIF), the degree of urbanization of the states (UTOTPP), the literacy rates (LITERACY) of the states, proportion of dropout in primary education (PDROPOUT), proportion of SC/ST students in secondary education (SCSTSEC), proportion of SC/ST students in higher education (SCSTHIGH) etc. The choice of regressors in the final specification has been made by taking into consideration the model diagnostic test statistics. All the variables considered in this study are in their natural logarithm.

² Although equalizing expenditure per beneficiary (in the relevant population group) has the virtue of simplicity, it is not possible to clearly identify the beneficiary group for an expenditure head like education, since the whole society benefits out of education. Expenditure needs of various states with regard to three different expenditure heads pertaining to education were also estimated by considering the total population as the relevant beneficiary group. Owing to poor performance in terms of parameter estimates, the results are not reported here.
A description of the variables appearing in the final specifications, along with sources of data, is presented in Appendix -II. The baseline (final) specifications for the three expenditure heads are as follows:

**Primary Education:**

\[
\ln \text{PRIMARY}_{it} = a_0 + a_1 \ln \text{PENROL}_{it} + a_2 \ln \text{PDROPOUT}_{it} + a_3 \ln \text{LITERACY}_{it} + a_4 \ln \text{PSTRATIO}_{it} + a_5 \ln \text{PRICEDIF}_{it} + \epsilon_{it}
\]

**Secondary Education:**

\[
\ln \text{SECONDARY}_{it} = a_0 + a_1 \ln \text{SENROL}_{it} + a_2 \ln \text{LITERACY}_{it} + a_3 \ln \text{SSTRATIO}_{it} + a_4 \ln \text{PRICEDIF}_{it} + a_5 \ln \text{SCSTSEC}_{it} + \epsilon_{it}
\]

**Higher Education:**

\[
\ln \text{HIGHER}_{it} = a_0 + a_1 \ln \text{HENROL}_{it} + a_2 \ln \text{LITERACY}_{it} + a_3 \ln \text{HSTRATIO}_{it} + a_4 \ln \text{PRICEDIF}_{it} + \epsilon_{it}
\]

In the above equations, \( \{a\} \)'s are parameters and \( \{\epsilon\} \)'s are the error terms. After specifying the models for the three expenditure heads, the next step is to estimate the models using the pooled data. Utilizing the parameter estimates obtained from the panel data regressions, an in-sample forecasting of normative expenditure levels for the fiscal year 1997-98 is done for 15 states with regard to primary, secondary and higher education. These in-sample projections are considered as the ‘normative’ expenditures after making the necessary data adjustments to obtain the absolute figures. Finally, to facilitate comparison, the ratio between actual expenditure levels and normative expenditure levels has been calculated.
III. Empirical Results:

The pooled regression models have been estimated in the present study. While estimating the models, problems arising out of the presence of heteroskedasticity, autocorrelation and cross-group error correlation, as discussed in Appendix - I, have been taken care of. Looking at the model diagnostic statistics (in the present case LM, LR and Wald) as well as the statistical significance of the individual coefficients, we have chosen the final models, i.e., one for each expenditure head. Since adjusted $R^2$ or $R^2$ is not a meaningful summary statistic in the context of pooled data, the same has not been used and hence not reported. LR diagnostic statistics being appropriate for pooled data models in respect of heteroskedasticity coupled with cross group error correlation ($S_2$) is reported in this exercise. Only the estimates of those models that are finally chosen are presented in Table - 2. Since all the variables considered in this study are in their natural logarithm, the coefficients facilitate interpretation in terms of elasticity.

In the case of primary education all the variables except the student-teacher ratio are significant. The expenditure per child in the case of primary education (the relevant age group being 5-9) bears an inverse relationship with the proportion of enrolment in primary education, thereby implying a situation where per child expenditure comes down when the proportion of enrolment goes up. Such a relationship may suggest existence of extra capacity in terms of number of schools, classrooms, teachers etc.,) in the case of primary education and signify a shift in preference from government education to private education. On the contrary, per child expenditure and dropout proportion in primary education are directly related. A higher dropout ratio effectively leads to erosion of enrolment in primary
education. This in turn may lead to increase in the per capita expenditure in the provision of primary education. Therefore, attempts to check dropout rate can control public expenditure on primary education. Again, per child expenditure in primary education and literacy rates across the states tend to move together. Here it may be argued that high literacy rate leads to higher educational awareness, which in turn acts as a social pressure group, demanding better quality of primary education. Hence, per capita cost of providing primary education tends to be higher with increasing literacy rates. The estimated model for primary education further suggests a direct relationship between per child expenditure and price differences across states. This relationship supports the economic hypothesis that higher prices lead to higher cost of providing a standardized unit of service.

In the case of secondary education, expenditure per beneficiary group (age group 10-18) is positively related to the proportion of enrolment, signifying under-provision of capacity. This implies that an increase in enrolment proportion requires an additional commitment by way of creating capacity. Alternatively, the direct relationship may be interpreted as a situation characterizing over utilization of capacity. As in the case of primary education, per child expenditure in secondary education is positively related to literacy rates and price differences across the states. Furthermore, the estimated model suggests that the impact of varying levels of student-teacher ratio and proportion of SC/ST students in secondary education have an insignificant impact on the expenditure per beneficiary group.

Economies of scale operate in the provision of higher education, as the expenditure per beneficiary group (age group 20-24) is found to be inversely related to the proportion of enrolment in higher education. It may be noted that the
expenditure head that is considered here, consists of non-technical university education, the demand for which has been sliding down in per capita terms of the relevant age group, while the capacity that has been created is enormous and hence under-utilized. Thus, the inverse relationship between enrolment proportion and per capita expenditure signifies the presence of excess capacity. Similar to the results obtained from the primary and secondary education, expenditure per beneficiary group in the case of higher education bears a significant direct relationship with literacy rate and price differences across the states. In contrast to the insignificant relationship observed in the case of primary and secondary education, the student-teacher ratio for higher education bears a significant direct relationship with expenditure per beneficiary group. Such a relationship may suggest an overcrowded situation, where the number of students per teacher is already very high. Thus, any further increase in the number of students would require appointment of new teachers in higher education. The diagnostic LR statistic reported for all the regressions rejects the null hypothesis of heteroskedasticity and cross-group correlation.

To facilitate meaningful comparison, actual expenditure levels are expressed as a proportion of the normative expenditure levels for 15 large Indian states with regard to the primary, secondary and higher education. The figures are presented in table -3. Gujarat and Maharashtra emerge as champions for the cause of primary education since, for these states, the actual expenditure levels are much higher than the normative expenditure levels. On the contrary, Bihar, Haryana, Uttar Pradesh and West Bengal lag far behind the normative expenditure levels in terms of their actual expenditure levels.

In respect of secondary education, Andhra Pradesh, Punjab and West Bengal spent significantly more than the
normative levels, whereas Assam, Bihar, Madhya Pradesh, Orissa and Uttar Pradesh spent much less than the normative levels. For higher education, the states that spent significantly more than the normative levels are Andhra Pradesh, Haryana, Kerala and Punjab. Similarly, the states that spent significantly less than the normative levels on higher education are Assam and Uttar Pradesh. Thus, our findings are consistent with the generally maintained hypothesis that rich states spend more and poor states spend less as far as social sectors are concerned. The lone exception being Orissa, where the expenditure on higher education is significantly higher than the normative level.

IV. Policy Implications and Concluding Remarks:

Utilizing the pooled data for 15 large Indian states over six years, from 1992-93 to 1997-98, this study attempts to estimate the normative expenditure levels for providing a standardized unit of service with regard to three disaggregated expenditure heads, viz., primary education, secondary education and higher education. The findings of this study are consistent with the generally maintained hypothesis that 'rich states spend more and poor states spend less as far as social sectors are concerned'. Gujarat and Maharashtra emerge as the champions for the cause of primary education, whereas Andhra Pradesh and Punjab spend substantially more on secondary and higher education. Poor states like Uttar Pradesh and Bihar lag too far behind the normative level for all the three expenditure heads considered in this study.

The findings also suggest existence of unutilized capacity in both primary and higher education. This, to a great extent, can be attributed to the shift in preference from government education to private education. Thus, a policy
implication that might emerge here is that any efforts to rationalize the utilization of existing capacities must involve improvement of the quality of education in the government sector. Furthermore, actual spending on educational services in low-income states is found to be lower than their 'needs'. This implies that the existing fiscal equalization mechanism is unable to offset the revenue and cost disabilities of poorer states. Hence, there is justification for suitable changes in the existing equalization mechanism.

References:


Table - 1

Educational Expenditure as % of Revenue Expenditure (RE) Across 15 Large Indian States: 1997-98.

<table>
<thead>
<tr>
<th>States</th>
<th>Primary Education</th>
<th>Secondary Education</th>
<th>Higher Education</th>
</tr>
</thead>
<tbody>
<tr>
<td>Andhra Pradesh</td>
<td>10.88</td>
<td>7.48</td>
<td>2.82</td>
</tr>
<tr>
<td>Assam</td>
<td>14.01</td>
<td>6.48</td>
<td>2.13</td>
</tr>
<tr>
<td>Bihar</td>
<td>13.61</td>
<td>3.84</td>
<td>2</td>
</tr>
<tr>
<td>Gujarat</td>
<td>21.24</td>
<td>6.81</td>
<td>1.67</td>
</tr>
<tr>
<td>Haryana</td>
<td>6.01</td>
<td>4.34</td>
<td>1.72</td>
</tr>
<tr>
<td>Karnataka</td>
<td>16.97</td>
<td>8.85</td>
<td>2.25</td>
</tr>
<tr>
<td>Kerala</td>
<td>9.3</td>
<td>6.05</td>
<td>2.31</td>
</tr>
<tr>
<td>Madhya Pradesh</td>
<td>10.2</td>
<td>3.39</td>
<td>1.87</td>
</tr>
<tr>
<td>Maharashtra</td>
<td>16.7</td>
<td>7.95</td>
<td>1.75</td>
</tr>
<tr>
<td>Orissa</td>
<td>10.79</td>
<td>5.1</td>
<td>3.18</td>
</tr>
<tr>
<td>Punjab</td>
<td>4.03</td>
<td>7.07</td>
<td>1.67</td>
</tr>
<tr>
<td>Rajasthan</td>
<td>18.94</td>
<td>7.75</td>
<td>1.62</td>
</tr>
<tr>
<td>Tamil Nadu</td>
<td>8.4</td>
<td>6.63</td>
<td>1.72</td>
</tr>
<tr>
<td>Uttar Pradesh</td>
<td>9.58</td>
<td>4.69</td>
<td>1.32</td>
</tr>
<tr>
<td>West Bengal</td>
<td>6.44</td>
<td>9.61</td>
<td>2.49</td>
</tr>
</tbody>
</table>
Table - 2

Parameter Estimates for Different Expenditure Heads: Panel Data Results

Expenditure Head: Primary Education

Dependent Variable: Per Capita Expenditure on Primary Education

<table>
<thead>
<tr>
<th>MODEL</th>
<th>CONSTANT</th>
<th>EXPLANATORY VARIABLES</th>
<th>TEST STATISTICS</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>PENROL</td>
<td>PDROPOUT</td>
</tr>
<tr>
<td>$S_2 R_0$</td>
<td>-0.0845</td>
<td>-0.5937</td>
<td>0.2117</td>
</tr>
<tr>
<td></td>
<td>(-0.062)</td>
<td>(-9.974)*</td>
<td>(8.916)*</td>
</tr>
</tbody>
</table>

Note: Figures in parentheses refer to t-ratios.

* Significant at 1% level.

For degrees of freedom 16, the critical values at 0.99 and 0.95 levels are 32.00 and 26.30 respectively.
### Expenditure Head: Secondary Education

**Dependent Variable: Per Capita Expenditure on Secondary Education**

<table>
<thead>
<tr>
<th>MODEL</th>
<th>CONSTANT</th>
<th>EXPLANATORY VARIABLES</th>
<th>TEST STATISTICS</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>SENROL</td>
<td>LITERACY</td>
</tr>
<tr>
<td>$S_2R_2$</td>
<td>-3.069*</td>
<td>0.1444</td>
<td>0.7618</td>
</tr>
<tr>
<td>(-4.605)*</td>
<td>(2.475)*</td>
<td>(4.35)*</td>
<td>(0.347)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Expenditure Head: Higher Education

**Dependent Variable: Per Capita Expenditure on Higher Education**

<table>
<thead>
<tr>
<th>MODEL</th>
<th>CONSTANT</th>
<th>EXPLANATORY VARIABLES</th>
<th>TEST STATISTICS</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>HENROL</td>
<td>LITERACY</td>
</tr>
<tr>
<td>$S_2R_2$</td>
<td>-11.316*</td>
<td>-0.1921</td>
<td>1.471</td>
</tr>
<tr>
<td>(-19.442)*</td>
<td>(-3.936)*</td>
<td>(18.908)*</td>
<td>(2.566)*</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note: Figures in parentheses refer to t-ratios.

* Significant at 1% level.

For degrees of freedom 16, the critical values at 0.99 and 0.95 levels are 32.00 and 26.30 respectively.
### Table - 3

**Proportion of Actual Expenditure Levels to Normative Expenditure Levels: 1997-98**

<table>
<thead>
<tr>
<th>States</th>
<th>Total Expenditure</th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Primary Education</td>
<td>Secondary Education</td>
<td>Higher Education</td>
<td></td>
</tr>
<tr>
<td>AP</td>
<td>1.01</td>
<td>1.22@</td>
<td>1.70@</td>
<td></td>
</tr>
<tr>
<td>Assam</td>
<td>1.19</td>
<td>0.91</td>
<td>0.87</td>
<td></td>
</tr>
<tr>
<td>Bihar</td>
<td>0.65</td>
<td>0.36#</td>
<td>0.85</td>
<td></td>
</tr>
<tr>
<td>Gujarat</td>
<td>1.67@</td>
<td>1.02</td>
<td>0.88</td>
<td></td>
</tr>
<tr>
<td>Haryana</td>
<td>0.91</td>
<td>1.01</td>
<td>1.33@</td>
<td></td>
</tr>
<tr>
<td>Karnataka</td>
<td>1.11</td>
<td>1.15</td>
<td>1.16</td>
<td></td>
</tr>
<tr>
<td>Kerala</td>
<td>0.98</td>
<td>0.96</td>
<td>0.94</td>
<td></td>
</tr>
<tr>
<td>MP</td>
<td>1.03</td>
<td>0.46#</td>
<td>0.86</td>
<td></td>
</tr>
<tr>
<td>Maharashtra</td>
<td>1.50@</td>
<td>1.19</td>
<td>0.92</td>
<td></td>
</tr>
<tr>
<td>Orissa</td>
<td>0.84</td>
<td>0.63#</td>
<td>1.22@</td>
<td></td>
</tr>
<tr>
<td>Punjab</td>
<td>0.76</td>
<td>2.04@</td>
<td>1.49@</td>
<td></td>
</tr>
<tr>
<td>Rajasthan</td>
<td>1.19</td>
<td>0.98</td>
<td>0.94</td>
<td></td>
</tr>
<tr>
<td>Tamil Nadu</td>
<td>0.96</td>
<td>1.01</td>
<td>0.87</td>
<td></td>
</tr>
<tr>
<td>UP</td>
<td>0.61#</td>
<td>0.63#</td>
<td>0.72#</td>
<td></td>
</tr>
<tr>
<td>West Bengal</td>
<td>0.70#</td>
<td>1.18</td>
<td>1.04</td>
<td></td>
</tr>
</tbody>
</table>

**Note:** @ symbolizes the actual expenditure being significantly *higher* than the normative level.

# symbolizes the actual expenditure being significantly *lower* than the normative level.

The significance level is set at ± 20% of the normative expenditure level.
Appendix - I

Pooled Regression Models:

A pooled regression can be represented as:

\[ Y_{it} = \alpha + X'_{it} \beta + \epsilon_{it} \quad i = 1,2,\ldots,N. \]
\[ t = 1,2,\ldots,T. \]

where \( i \) denotes the cross-section and \( t \) denotes the time dimensions, \( \alpha \) is a scalar, \( \beta \) is \( K \times 1 \) vector of coefficients and \( X_{it} \) is the \( it^{th} \) observation on \( K^{th} \) explanatory variable, and \( \epsilon_{it} \) is classical disturbance term which is assumed to be homoskedastic and non-autocorrelated, that is:

\[ E[\epsilon_{it}] = 0, \quad \text{and} \quad \text{Var}[\epsilon_{it}] = \sigma \epsilon^2 \]

Violation of the assumptions of homoskedasticity and autocorrelated errors releases three different possibilities. They are:

i) Groupwise heteroskedasticity, \[ E[\epsilon_{it}^2] = \sigma_{ii} \]

ii) Cross-group correlation, \[ \text{Cov}[\epsilon_{it}, \epsilon_{jt}] = \sigma_{ij} \]

iii) Within group autocorrelation, \[ \epsilon_{it} = \rho_i \epsilon_{it-1} + u_{it} \]

With regard to homoskedasticity, three important cases may be considered:

Case (i) : \( S_0 \): It refers to the most na"ive situation of classical homoskedastic regression, where: \( \Sigma = \sigma^2 I \), where \( I \) is an identity Matrix and \( \Sigma \) is the error variance-covariance matrix.
Case (ii) \( S_1 \): It stands for group-wise heteroskedasticity, and thus

\[ \Sigma = \text{diag} [\sigma_{11}, \sigma_{22}, \ldots, \sigma_{NN}] \]

Case (iii) \( S_2 \): This is a general case, wherein, \( \Sigma \) is assumed to be a positive definite matrix signifying, apart from group-wise heteroskedasticity, cross group correlated errors. That is,

\[ \Sigma = N \times N \text{ positive definite matrix.} \]

In respect of autocorrelation, a similar set of assumptions may be considered. They are:

Case (a) \( R_0 \) : \( \rho = 0 \), representing a situation where disturbances are non-autocorrelated, \( \rho \) being an \( N \times 1 \) vector of group-specific autocorrelation coefficients.

Case (b) \( R_1 \) : \( \rho = (\rho_1, \rho_2, \ldots, \rho_N) \), where all the units have common autocorrelation coefficient.

Case (c) \( R_2 \) : \( \rho = (\rho_1, \rho_2, \ldots, \rho_N) \), where individual units have specific coefficients.

By combining these two sets of restrictions on \( \Sigma \) and \( \rho \), it is possible to generate nine (9) combinations leading to nine distinct models. They may be represented by \( (S_0R_0), (S_1R_0), (S_2R_0), (S_0R_1), (S_1R_1), (S_2R_1), (S_0R_2), (S_1R_2), (S_2R_2) \). The first eight (8) models form as special cases of the last one, by imposing appropriate restrictions on \( S_2R_2 \).
For non-autocorrelated models, the estimator is a two-step generalized least squares (GLS) and for models with autocorrelation the required estimator is a 3 step GLS.

For testing the assumptions of homoskedasticity and absence of cross-group error-correlation as restrictions on the most general case of errors being heteroskedastic and cross-group correlated, three diagnostic test statistics are computed, namely LM, LR and Wald. The test statistics are given by:

\[ \text{LM} = \frac{T}{2} - \sum_i \left[ \frac{S_i}{S^2} - 1 \right]^2 \]

\[ \text{LR} = T \left( N \ln S^2 - \sum_i \ln S_i \right) \]

\[ \text{Wald} = \frac{T}{2} - \sum_i \left[ \frac{S^2}{S_i} - 1 \right]^2 \]

where \( S^2 \) is the pooled OLS residual variance and \( S_i \) is the OLS residual variance of the \( i \)th state. All the three test statistics follow the Chi-squared distribution with \((N+R-1)\) degrees of freedom, where \( N \) is the number of units in the panel (in our case number of states), \( R \) is the number of restrictions imposed on the estimated models.

In this exercise, for each behavioral specification corresponding to expenditure heads, we have estimated all the 9 distinct models ranging from the most restricted case of \( S_0^R_0 \) to the most general case of \( S_2^R_2 \). Out of the 9 distinct models only one model is chosen. Since statistical significance of the individual coefficients undergo considerable variation over the range of models estimated (from \( S_0^R_0 \) to \( S_2^R_2 \)), the final model selection criteria rest upon a judicious compromise between the model diagnostic statistics and the desired statistical properties of the individual coefficients.
## Appendix - II

### Description of Variables

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Variable</th>
<th>Definition</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. PRIMARY</td>
<td>Per Capita Expenditure on Primary Education</td>
<td>Expenditure on Primary Education per child in the age group 5-9.</td>
<td>Finance Accounts of State Govts., CAG Govt. of India.</td>
</tr>
<tr>
<td>2. SECONDARY</td>
<td>Per capita expenditure on Secondary Education</td>
<td>Expenditure on Secondary Education per child in the age group 10-18.</td>
<td>-do-</td>
</tr>
<tr>
<td>3. HIGHER</td>
<td>Per Capita Expenditure on Higher Education</td>
<td>Expenditure on Higher Education per youth in the age group 20-24.</td>
<td>-do-</td>
</tr>
<tr>
<td>4. PENROL</td>
<td>Enrolment in Primary Education</td>
<td>Number of Students in Primary Education per 1000 children in the age group 5-9.</td>
<td>(a) Selected Educational Statistics, Ministry of HRD, Dept. of Education, Govt. of India</td>
</tr>
<tr>
<td>Symbol</td>
<td>Variable</td>
<td>Definition</td>
<td>Source</td>
</tr>
<tr>
<td>----------</td>
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<td>---------------------------------------------------------------------------------------------</td>
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</tr>
<tr>
<td>5.</td>
<td>PDROPOUT</td>
<td>Proportion of Dropout in Primary Education</td>
<td>-do-</td>
</tr>
<tr>
<td>6.</td>
<td>PSTRATIO</td>
<td>Student Teacher ratio in Primary Education</td>
<td>-do-</td>
</tr>
<tr>
<td>7.</td>
<td>SENROL</td>
<td>Enrolment in Secondary Education</td>
<td>-do-</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Number of students in Secondary Education per 1000 children in the age group 10-18</td>
<td></td>
</tr>
<tr>
<td>8.</td>
<td>SSTRATIO</td>
<td>Student Teacher ratio in Secondary Education</td>
<td>-do-</td>
</tr>
<tr>
<td>9.</td>
<td>HENROL</td>
<td>Enrolment in Higher Education</td>
<td>-do-</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Number of Students in Higher Education per 1000 youth in the age group 20-24</td>
<td></td>
</tr>
<tr>
<td>10.</td>
<td>HSTRATIO</td>
<td>Student-Teacher ratio in Higher Education</td>
<td>-do-</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Number of Students per Teacher in Higher Education</td>
<td></td>
</tr>
<tr>
<td>Symbol</td>
<td>Variable</td>
<td>Definition</td>
<td>Source</td>
</tr>
<tr>
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<td>---------------------------------------------</td>
</tr>
<tr>
<td>11.</td>
<td>LITERACY</td>
<td>Literacy Rate</td>
<td>Proportion of Literacy in the States</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Office of the Registrar General, Govt. of India.</td>
</tr>
<tr>
<td>12.</td>
<td>PRICEDIF</td>
<td>Price Differential</td>
<td>Across the States*</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* The Ninth Finance Commission had estimated the index of price differences based on the information on prices of different commodities collected in various urban centres by the Labour Bureau, Simla. Price differences between the states used in this exercise is obtained by applying the changes in prices recorded in different states (averaged for different centres) on the base year differences of 1986-87.
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